Baseline Riparian Vegetation Monitoring Report
Finniss Lithium Project

CORE LITHIUM

EcOz Environmental Consultants

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1 INTRODUCTION

This document presents the methodology and results of the post wet-season (May 2022) and post dry-season (October 2022) baseline surveys of riparian vegetation downstream of Observation Hill Dam (OHD) and the Proposed BP33 underground lithium mine within the Finniss Lithium Project, BP33 outlined within the Riparian Vegetation Monitoring Plan (RVMP) (EcOz 2022). The RVMP was developed and implemented to monitor potential impacts associated with surface water extraction from OHD under Surface Water Extraction Licence (SWEL) 8151018 and operation of the proposed Finniss Lithium Project, BP33 underground lithium mine (BP33) located on the Cox Peninsula (Figure 1-1). Riparian vegetation health downstream of OHD and surrounding BP33 could be affected by changes to:

- surface water flows associated with extraction of water from the Observation Hill Dam (OHD)
- groundwater drawdown associated with dewatering of BP33 underground mine.

Riparian vegetation monitoring is required as a condition of the following approvals and licences:

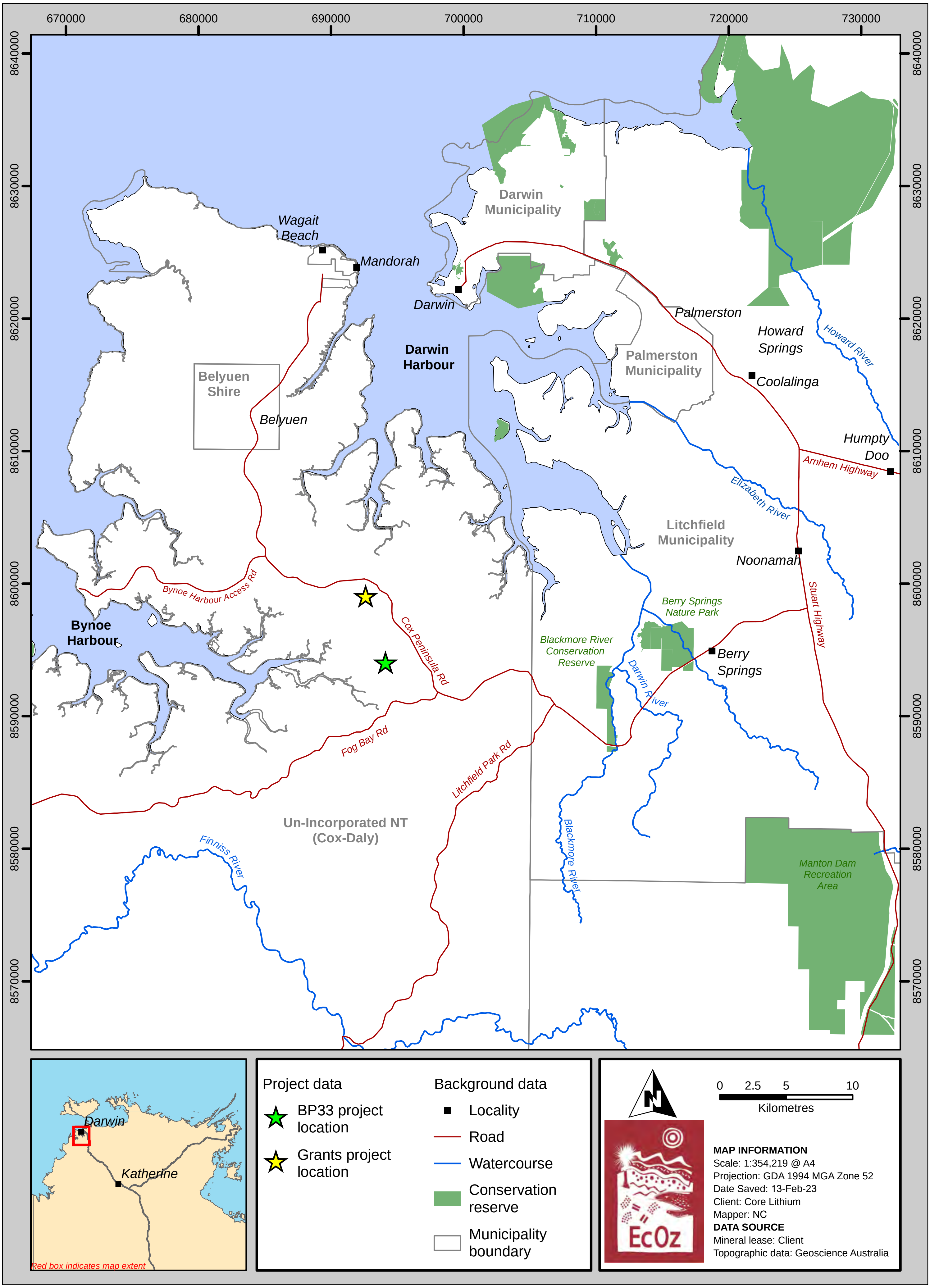
- Environmental Approval 2020/001-001 for BP33 underground lithium mine (Condition 6)
- SWEL 8151018 (Condition 4.1).

Riparian communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

The report includes monitoring parameters, methods and results of the baseline condition of riparian vegetation.

1.1 Background

The previous baseline survey, The Mangrove and Riparian Vegetation Assessment Grants Lithium Project was undertaken by EcOz Environmental Consultants (EcOz 2019) and where applicable, results derived from this survey will be added to the compared to the baseline dataset for future comparison. It is noted, only two sites (RVS4 & RVS5) can be used for future comparison as all other sites (RVS1, RVS2, RVS3, RVS6 and reference site) were monitored at different locations and considered baseline monitoring sites in this report.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19171 - BP33 NOI\01 Project Files\Report maps\Figure 1-1. Map of project location and regional setting.mxd

Figure 1 1. Location map of proposed Finniss Lithium Project, BP33 underground lithium mine

1.2 Climate

BP33 underground lithium mine lies within the wet-dry tropics. The wet season is typically November to March/April, and the dry season April to October. Figure 1-2 shows average monthly rainfall generated for the area from BOM (2022) indicating rainfall (mm) amount prior to post-wet season and post-dry season surveys.

The wettest months are typically January and February. Usually no rain falls during the dry season months of June, July and August.

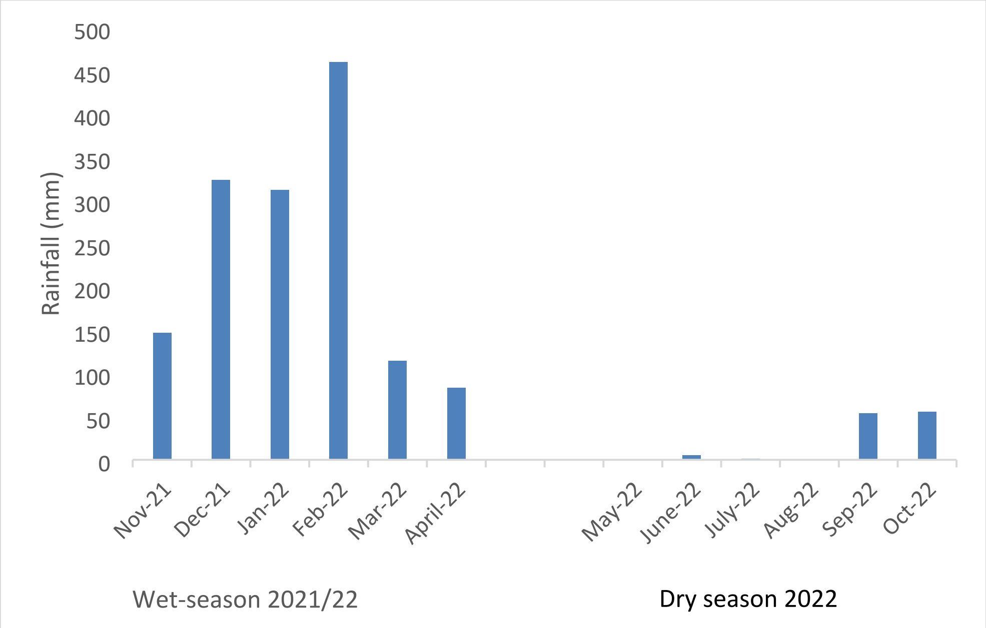


Figure 1-2. Average monthly rainfall generated for the area from BOM (2022) indicating rainfall (mm) amount prior to post-wet season and post-dry season surveys undertaken in 2022.

2 METHODOLOGY

2.1 Vegetation site assessment

The vegetation site assessment monitoring methods have been adopted utilising the potential consequences of the groundwater drawdown affect (Eamus, D., & Lamontagne 2006) (See Appendix A, Figure 4Table 2-2). The methods are largely outlined in the RVMP (Appendix A), though some minor changes to the methods were made since this plan was adopted. A summary of the updated methods applied to vegetation site assessments is addressed in this report (see section 2.2.3).

2.1.1 Site selection

Two existing sites from the EcOz (2019) baseline survey, RVS4 and RVS5 have been retained and will continue to be monitored. Additionally, three new riparian vegetation monitoring sites and one reference site have been selected to be monitored. Site selection is presented in Table 2-1.

Table 2-1. Summary of vegetation site selection

Site	Site selection
RVS1	• New monitoring site downstream of OHD just outside of the Zone of Impact (ZOI) (see RVMP, Figure 5) • Site selection based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI (see RVMP, Figure 5). • Suitable for monitoring as the sites lies within potential GDE areas
RVS2	• New monitoring site downstream of OHD • Suitable for monitoring as the sites lies within potential GDE areas • Align near existing bore for groundwater level monitoring and spatially correspond to immediate groundwater
RVS3	• New monitoring site downstream of OHD • Suitable for monitoring as the sites lies within potential GDE areas • Aligns near existing bore for groundwater level monitoring and spatially correspond to immediate groundwater
RVS4	• Existing baseline monitoring site (EcOz 2019) and designed to detect immediate impacts from reduced SW flows downstream of OHD. • Continue to be monitored using the updated monitoring method within this RVMP (Appendix A).
RVS5	• Existing baseline monitoring site and has been retained as it is nearby a groundwater monitoring bore SW1 and BPG3i (Appendix A). • Continue to be monitored using the updated monitoring method within RVMP (Appendix A).
Reference site	• New reference site upstream of Charlottes Creek (BP33 Control), in a similar riparian zone within the potential GDE area, established with baseline monitoring commencing post-wet season 2022. This site is outside of the predicted ZOI. The site was selected using various resources including up to date aerial imagery, mine components, and Land Units of the Greater Darwin Region (Fogarty et al. 1984).

2.1.2 Vegetation monitoring

Monitoring methods are outlined below:

- A plot size of 20 x 20m was established at each new riparian monitoring site, using star pickets. Existing plots RVS4 and RVS5 was re-monitored at established plots (existing star pickets present).
- In each plot the dominant layer/emergent layer species was recorded; this includes all seedlings (woody plants under 1m in height), saplings (woody plants between 1m and 3m high and < 2cm diameter at breast height, or DBH) and trees (woody plants with stems ≥ 2cm DBH and greater than 3m high) identified (both native plants and invasive plants included). For individual species occurring within upper and mid stratum, the height was estimated and the % cover measured. All individual woody plants within the plot was recorded alive or dead, whether the plant is fruiting/flowering. Note, deciduous trees are not recorded as dead during the dry-season monitoring.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) were recorded. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* (observed previously at RVS4, RVS5).
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) were recorded. The results from this method is used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation was recorded to a standard that is equivalent to Level 6 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity was monitored through the use reviewing drone imagery and looking for any gaps in the riparian corridor.

Table 2-2 summarises monitoring methods and how they are used to measure the potential consequences of the reduction in surface flows and/or groundwater drawdown. It is noted, within the RVMP (EcOz 2022) it was mentioned NVIS level 5 would be recorded as part of the data collection, however this was since altered to NVIS level 6 to obtain a more complex description of the riparian vegetation community.

Table 2-2. Summary of monitoring methods that are used to measure potential impacts of the reduction of surface water flows and groundwater drawdown

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree records	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 6 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

2.2 General observations

2.2.1 Objective

Monitoring of other environmental factors is critical as they are contributing factors that can severely impact the health of riparian vegetation. Objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is discussed below.

2.2.2 Other environmental factors

Weeds

Weed data collection is conducted in accordance with the Northern Territory Weed Management Branch (WMB 2015), Northern Territory Weed Data Collection Manual.

The percentage cover of weed species (declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat is visually estimated for each weed species.

A GPS is used to record locations of identified weed species, and record the following information:

- Weed name
- Distribution - size (20, 50 or 100m diameter)
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1-5, 1 (absent) to 5 (>50%)
- Growth stage (seedling, juvenile, adult)
- Seeded (has the weed seeded?)
- Treatment (has the weed been treated and if so with what method of treatment)
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data will was recorded outside of the plots to obtain surrounding data while traversing along the riparian area to visit each monitoring site.

Fire - broad scale and site based monitoring

Broadscale

Fire scar mapping and scoring is determined by drone survey and mapped with NAFI each year to investigate frequencies and severity across the mapped riparian area.

At each plot an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and for recently burnt sites the severity will be scored from 1 to 4. Categories for characterisation of fire are:

- No evidence of fire
- Evidence of groundcover fire only
- Evidence of burnt saplings
- Evidence of fire in canopy layer.

Erosion - broad scale and site based monitoring

Broadscale

- Monitoring the presence of erosion (on a broader scale basis) may be more effective using remote sensing with the use of the drone imagery captured as per section 2.2. Monitoring erosion using monitoring plots can often mean that issue areas can be missed.

- It is recommended to flag any potential erosion issues identification with aerial imagery and follow-up with on-ground monitoring so that erosion risks are to be measured and remedial actions implemented.

Site (plot) based

At each plot note the presence or absence of erosion is recorded, and if present the following characteristics recorded:

- Types of erosion i.e. gullying, sheet erosion etc
- The amount of bare ground above
- Tree root exposure – any roots exposed due to disturbance
- Slumping
- Fallen trees/woody debris
- Presence of surrounding erosion
- Width of riparian zone – measure or estimate the width of the riparian zone (facing downstream) for both sides of banks.

Aquatic life

Presence of aquatic life within the water recorded. This involves recording aquatic fauna and flora at the nearest water access point from each of the vegetation monitoring plots.

Surface water flows

Presence of water flows at the time of surveying, assessed in accordance with the surface water flows monitoring plan (WRM 2022).

Sedimentation

Presence of sedimentation within the water and on the riparian vegetation.

Contamination

Presence of potential contamination (foam/scum/oils) and odour.

Climatic conditions

Weather observation documented during the monitoring. The annual rainfall, evaporation and temperature recorded from the same weather station and discussed for survey data comparison.

2.2.3 Summary of changes made to methods

- Initially the method involved tagging or assigning a waypoint for individual, groundwater sensitive trees. This was revised since undertaking the field work as there were an abundance of these specific species present (mostly recruits <3 m tall).
- The RVMP indicated NVIS level 5 would be used when assessing riparian vegetation, though this was changed to NVIS level 6 to obtain a more complex description of the vegetation community compared to previous work. NVIS level 6 provides records of all upper canopy and mid stratum species, unlike NVIS 5, which only includes the dominant three species of each stratum.
- The method for collecting vegetation continuity was revised and with further thought, this information can be obtained from assessing the drone imagery and identifying any gaps in the vegetation as opposed to previous method, which was taking canopy cover measurement across the entire riparian corridor.

2.3 Drone survey

2.3.1 Objective

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey is to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover.

- A drone flight path based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI boundary. . The new flight path is an extension of the existing baseline survey (EcOz 2019) (Appendix A). to capture the riparian vegetation extent downstream of OHD to the modelled 1m contour groundwater drawdown ZOI. The drone flight path was established also using the selected Ground Water Dependant Ecosystem area (Appendix A, Figure 2).
- The timing of the post-wet season was selected to record maximum vegetation growth within the survey area. The timing of the post dry-season was selected in contrast of the post wet-season survey to represent seasonal changes.
- DJI Go app and Fly Litchi app was used to capture imagery at a height of 60m (75% front overlap and 65% side overlap)
- Images were stitched it together using the WebODM app to create an orthophoto.
- Drone will be flown in desirable conditions, i.e. in the morning to minimise strong winds or the middle of the day to avoid sun light interference i.e. shading. Observations will also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- Drone data analysis will be undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.
- These values will be categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, will then be calculated.
- Vegetation boundaries were delineated at a scale of 1:500 using the 5cm pixel orthomosaic aerial images captured during the drone survey. Individual trees, vegetation cover and soil colour was identified from the imagery to inform the mapping of vegetation boundaries.

3 RESULTS POST WET-SEASON SURVEY

The post wet-season riparian vegetation assessment (including both individual site assessments and the drone survey) was undertaken by Nicole Clark and Anna Lemon (EcOz Botanists) on 13 – 18 May 2022 at Core Lithium, BP33 site to assess the condition of the riparian vegetation. All sites selected as per section 2.1.1 were assessed as part of this monitoring event. Figure 3-12 represents sites monitored in the 2022 post wet-season survey. A few of the site locations were changed in the field (based on the initial proposed locations) due to a recent fire. These were only slight changes and will not affect the results. As there was evidence of fire at some sites when undertaking vegetation assessment site surveys, zoomed in drone images are provided for each site to see the extent and have this information recorded for future monitoring events.

3.1 Vegetation site assessment

3.1.1 RVS1

Site description

The upper stratum comprised of *Xanthostemon eucalyptoides*, *Melaleuca argentea* mid open forest (12-14 m) with a sub-stratum of emerging *Syzygium armstrongii* (10-12 m). The mid stratum contained a mixed low open forest with *Leptospermum madidum* subsp. *sativum*, *Pandanus aquaticus* and *Barringtonia acutangula* subsp. *acutangula* and *Carallia brachiata*. *Acacia holosericea*, *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii* were sparsely represented within the mid stratum with <2% cover each. Ground cover was mostly comprised of sedges including *Fimbristylis* sp. which accounted for ~40% cover. Low grass cover with *Eriachne triseta* and sparse *Pseudopogonatherum contortum* was restricted to the edges of the creek bank.

NVIS description

U1+ ^*Xanthostemon eucalyptoides*, *Melaleuca argentea* \^tree\7\c; U2 ^*Syzygium armstrongii* \^tree\7\r; M ^*Leptospermum madidum* subsp. *sativum*, *Pandanus aquaticus*, *Barringtonia acutangula* subsp. *acutangula*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\c; G1 ^*Eriachne triseta* \^tussock grass \2\i; G2 ^ Herb sp., *Fimbristylis* sp., \sedge, forb, *Lindsaea ensifolia*/ fern\1\c. Other species noted: *Cyclophyllum schultzii* f. *schultzii*, *Myrsine benthamiana*.

Vegetation height and cover

Species	Upper		Middle		Recruit	
	Height (m)	Cover %	Height (m)	Cover %	Height (m)	Cover %
Melaleuca argentea	12-14	15	-	-	-	-
Xanthostemon eucalyptoides	12-14	15-20	-	-	-	-
Syzygium armstrongii	10-12	5	-	-	-	-
Leptospermum madidum	-	-	4-8	20	-	-
Barringtonia acutangula	-	-	3-4	5	<3m	15
Pandanus aquaticus	-	-	3-5	5-10	-	-
Myrsine benthamiana	-	-	3-5	<1	<3m	15
Carallia brachiata	-	-	3-5	2	<3m	15
Acacia holosericea	-	-	4	2	-	-
Cyclophyllum schultzii	-	-	3-4	1	<3m	15
Fagraea racemosa	-	-	-	-	<3m	15
Total	**10-14**	**35**	**3-8**	**35-40**	**0-3**	**15**

General observations

Two aquatic plants – Eriocaulon sp. and Nymphaea sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present. Recent fire was observed north of the site in adjacent woodland, with scorch some *Acacia holosericea.* No weeds were observed.

Photo monitoring point

North

East

South

West

Figure 3-1. Photographs of the habitat at RVS1 using cardinal-directions for riparian monitoring

Figure 3-2. Drone imagery of RVS1

3.1.2 RVS2

Site description

The upper stratum is a mid open forest (10-12 m) dominated by *Melaleuca viridiflora*, with co-dominants *Syzygium armstrongii* and *Lophostemon lactifluus*. The mid stratum consists of a low open forest (4-8 m) with *Xanthostemon eucalyptoides* and co-dominants *Leptospermum madidum* subsp. *sativum* and *Acacia holosericea*. A dozen species were recruiting into the mid stratum and collectively comprised ~40% cover. Ground cover comprised of an open tussock grassland with *Eriachne triseta* and *Germania grandiflora*. Ferns, herbs and sedges were generally confined to the creek bank.

NVIS description

U+ ^*Melaleuca viridiflora*, *Syzygium armstrongii*, *Lophostemon lactifluus*, *Eucalyptus miniata*, *Melicope elleryana* \^tree\7\i; M ^*Xanthostemon eucalyptoides*, *Leptospermum madidum* subsp. *sativum*, *Acacia holosericea*, *Pandanus spiralis*, *Helicia australasica* \^tree, shrub\6\c; G1 ^*Eriachne triseta*, *Germania grandiflora* \^tussock grass \2\i; G2 ^Fern sp. \^fern\1\i. Other species noted: *Carpentaria acuminata*.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Eucalyptus miniata	10-12	3-5	-	-	-	-
Lophostemon lactifluus	10	3-5	-	-	-	-
Melaleuca viridiflora	10-12	5-10	-	-	-	-
Melicope elleryana	-	-	-	-	-	-
Syzygium armstrongii	10	5-10	3-6	1	<3	40
Acacia holosericea	-	-	3-4	3-5	<3	40
Carpentaria acuminata	-	-	6	>1	<3	40
Helicia australasica	-	-	3-5	1-3	<3	5
Leptospermum madidum	-	-	4-8	10-15	<3	40
Pandanus spiralis	-	-	3-5	1-3	<3	40
Xanthostemon eucalyptoides	-	-	6-8	10-15	<3	40
Alphitonia excelsa	-	-	-	-	<3	40
Breynia cernua	-	-	-	-	<3	40
Cyclophyllum schultzii	-	-	-	-	<3	1
Erythrophleum chlorostachys	-	-	-	-	<3	40
Exocarpos latifolius	-	-	-	-	<3	40
Total	**10-12**	**25-30**	**3-8**	**35-40**	**0-3**	**45**
**highlighted cells indicate overall % cover for combined species for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present. A recent fire had occurred in adjacent Eucalypt woodland and had burnt up to the outer edges of the riparian corridor.

Photo monitoring point

North

East

South **West**

Figure 3-3. Photographs of the habitat at RVS2 using cardinal-directions for riparian monitoring

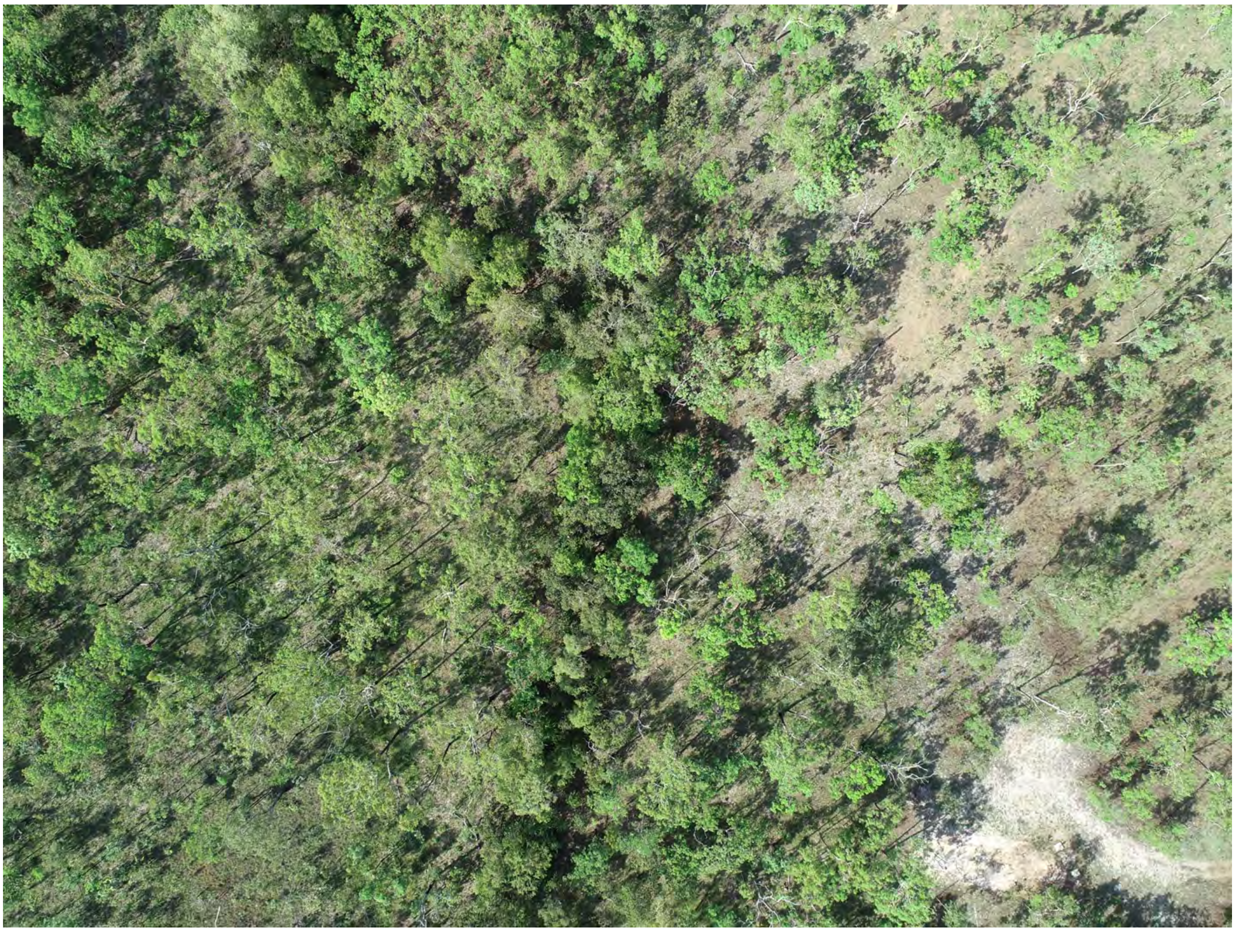


Figure 3-4. Drone imagery of RVS2

3.1.3 RVS3

Site description

The upper stratum consisted of a mid woodland (12-14 m) dominated by *Xanthostemon eucalyptoides* and *Lophostemon lactifluus*, with a mix of less dominant species *Melaleuca viridiflora*, *Erythrophleum chlorostachys* and *Syzygium armstrongii*. Two mid stratums were present within the system, with the taller stratum comprising of a mixed low woodland (5-10 m) with *Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura* and *Carallia brachiata*. The lower mid stratum contained a mix of shrubs and small trees with *Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* (2-5 m). The ground stratum was mostly a tussock grassland outside of the creek line with *Eriachne triseta* and *Germania grandiflora*, and ferns were typically growing along the creek bank.

NVIS description

U+ ^*Xanthostemon eucalyptoides*, *Lophostemon lactifluus*, *Melaleuca viridiflora*, *Erythrophleum chlorostachys*, *Syzygium armstrongii* \^tree\7\i; M1 ^*Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura*, *Carallia brachiata* \^tree\6\c; M2 ^*Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* \^shrub, tree\6\i; G1 ^*Eriachne triseta*, *Germania grandiflora* \^tussock grass \2\c; G2 ^Fern sp. \ ^fern\1\i. Other species noted: *Helicia australasica*, *Alphitonia excelsa*, *Livistona humilis*.

Vegetation structure

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Erythrophleum chlorostachys	12-14	<5	3	15	<3	10-15
Lophostemon lactifluus	12-14	5-10	-	-	-	-
Melaleuca viridiflora	12-14	5	4-5	15	<3	10-15
Syzygium armstrongii	12-14	5	-	-	<3	10-15
Xanthostemon eucalyptoides	12-14	5-10	3-8	5-10	<3	10-15
Acacia auriculiformis	-	-	8-10	5	-	-
Acacia holosericea	-	-	3-5	10-15	<3	10-15
Alphitonia excelsa	-	-	4-5	15	<3	10-15
Carallia brachiata	-	-	4-6	15	<3	10-15
Cyclophyllum schultzii	-	-	2-5	15	<3	10-15
Denhamia obscura	-	-	6-8	15	-	-
Leptospermum madidum	-	-	5-7	5	-	-
Livistona humilis	-	-	3-4	15	<3	10-15
Pandanus aquaticus	-	-	3	15	-	-
Pandanus spiralis	-	-	4	15	<3	10-15
Breynia cernua	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Total	**12-14**	**25-30**	**3-10**	**45-50**	**0-3**	**10-15**
***highlighted cells indicate overall % cover for combined species for combined species**						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present. A large patch of *Cenchrus pedicellatus* (Annual Mission Grass) is situated adjacent (north-east) the site near cleared access tracks.

Photo monitoring point

North

East

South

West

Figure 3-5. Photographs of the habitat at RVS3 using cardinal-directions for riparian monitoring

Figure 3-6. Drone imagery of RVS3

3.1.4 RVS4

Site description

The upper stratum consisted of a mid open forest (12-16 m) with *Syzygium armstrongii* and *Xanthostemon eucalyptoides*, with emerging *Corymbia polycarpa* (10-12 m). The mid stratum was fairly complex with two distinct height ranges. The taller of the mid stratums comprised of low open forest (5-10 m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Syzygium angophoroides*, *Gmelina schlechteri* and *Pandanus spiralis*. The lower mid stratum (2-5 m) contained a mix of small trees comprising of *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii*, *Melaleuca viridiflora* and *Carallia brachiata*. *Acacia holosericea* was also present and formed a small component of the lower mid stratum. The ground stratum was a tussock grassland containing *Eriachne triseta* and *Chrysopogon latifolia*. Smaller ferns and sedges were typically confined to the creek bank, and *Dianella odorata* and *Flagellaria indica* were also present within the creek.

NVIS description

U+ ^*Syzygium armstrongii*, *Xanthostemon eucalyptoides*, *Corymbia polycarpa* \^tree\7\c; M1 ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Syzygium angophoroides*, *Gmelina schlechteri*, *Pandanus spiralis* \^tree\6\c; M2 ^*Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii*, *Melaleuca viridiflora*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\c; G2 ^Fern sp., Sedge sp. \ ^fern, sedge\1\i. Other species noted: *Flagellaria indica*, *Dianella odorata*.

Vegetation structure

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Corymbia polycarpa	10-12	5	-	-	-	-
Syzygium armstrongii	14-16	20	6-8	10	<3	10-15
Xanthostemon eucalyptoides	12-14	15	4-8	25-30	-	-
Acacia holosericea	-	-	2-4	15-20	-	-
Carallia brachiata	-	-	2-4	15-20	-	-
Cyclophyllum schultzii	-	-	2-5	15-20	<3	10-15
Flagellaria indica	-	-	6	15-20	-	-
Gmelina?	-	-	6-8	15-20	-	-
Melaleuca viridiflora	-	-	2-4	15-20	-	-
Myrsine benthamiana	-	-	3-6	15-20	<3	10-15
Pandanus spiralis	-	-	4-6	15-20	<3	10-15
Syzygium angophoroides	-	-	6-8	15-20	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Melicope elleryana	-	-	-	-	<3	10-15
Total	**12-16**	**40**	**2-8**	**50-55**	**0-3**	**10-15**
**highlighted cells indicate overall % cover for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present. A recent fire had occurred in adjacent Eucalypt woodland and had burnt up to the top of the bank of the riparian corridor (approximately 5-10 m from the creek).

Photo monitoring point

North

East

South **West**

Figure 3-7. Photographs of the habitat at RVS4 using cardinal-directions for riparian monitoring

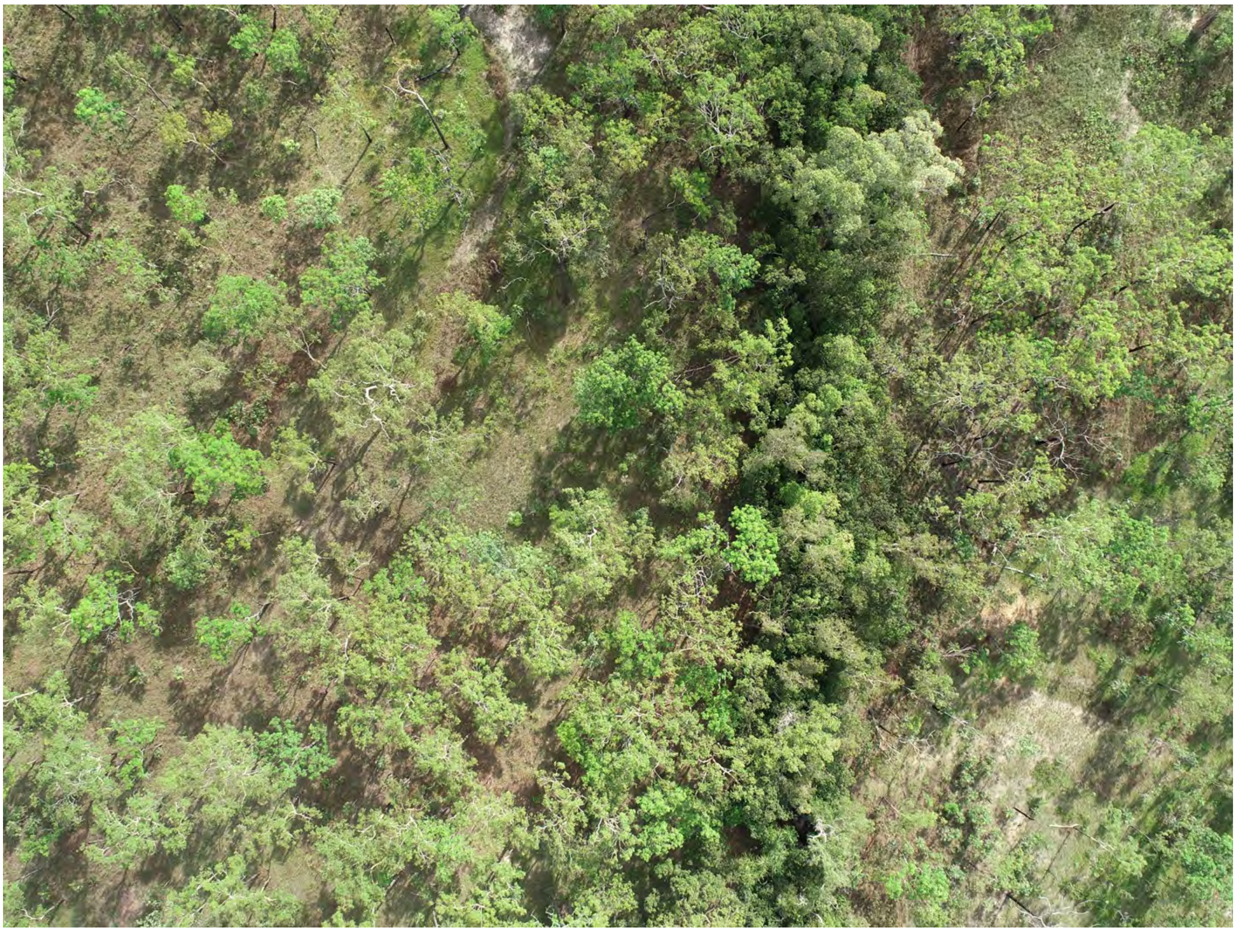


Figure 3-8. Drone imagery of RVS4

3.1.5 RVS5

Site description

The upper stratum is comprised of a mid woodland (12-14 m) with *Syzygium armstrongii* and *Xanthostemon eucalyptoides*, over low woodland (8-10 m) of *Melaleuca viridiflora* and *Lophostemon lactifluus*. The mid stratum was a mixed low open forest (3-8 m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus*. Under this was a lower mid stratum (2-5 m) of the same structure with *Helicia australasica*, *Acacia holosericea* and *Pandanus spiralis*. The ground stratum is a tussock grassland with *Eriachne triseta* and *Chrysopogon latifolia* with ferns present along the creek bank.

NVIS description

U1 ^*Syzygium armstrongii*, *Xanthostemon eucalyptoides* \^tree\7\i; U2 ^*Melaleuca viridiflora*, *Lophostemon lactifluus* \^tree\6\i; M1+ ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus* \^tree\6\c; M2 ^*Helicia australasica*, *Acacia holosericea*, *Pandanus spiralis* \^tree\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\i; G2 ^ *Lindsaea ensifolia* \^fern\1\r. Other species noted: *Cyclophyllum schultzii* f. *schultzii*.

Vegetation structure

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-10	5	4-6	5	<3	5-10
Melaleuca viridiflora	8-10	15	-	-	-	-
Syzygium armstrongii	10-12	15	6-8	15	<3	5-10
Xanthostemon eucalyptoides	12-14	10	4-8	15	<3	5-10
Acacia holosericea	-	-	3-5	3	<3	5-10
Carallia brachiata	-	-	6-8	5	<3	5-10
Cyclophyllum schultzii	-	-	5-6	<1	<3	5-10
Helicia australasica	-	-	3-6	10	<3	5-10
Leptospermum madidum	-	-	4-6	10	<3	5-10
Pandanus spiralis	-	-	3-5	2	<3	5-10
Erythrophleum chlorostachys	-	-	-	-	<3	5-10
Melicope elleryana	-	-	-	-	<3	5-10
Myrsine benthamiana	-	-	-	-	<3	5-10
Total	**10-14**	**45**	**3-8**	**60-65**	**0-3**	**5-10**
**highlighted cells indicate overall % cover for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present.

Photo monitoring point

North

East

South

West

Figure 3-9. Photographs of the habitat at RVS5 using cardinal-directions for riparian monitoring

Figure 3-10. Drone imagery of RVS5

3.1.6 Reference site

Site description

The upper stratum was a mid open forest (14-18 m) of *Melaleuca argentea* and *Syzygium armstrongii*, over a low-mid woodland (8-12 m) with *Xanthostemon eucalyptoides*, *Lophostemon lactifluus* and *Melicope elleryana*. The mid stratum comprised of a low open forest (3-8 m) with *Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides* and *Cyclophyllum schultzii* f. *schultzii*. The ground stratum comprised of a tussock grassland dominated by *Eulalia mackinlayi* which was dominant on the embankment, with sedges and herbs growing closer to the waters' edge.

NVIS description

U+ ^*Melaleuca argentea*, *Syzygium armstrongii*, *Xanthostemon eucalyptoides* \^tree\7\c; U2 ^*Lophostemon lactifluus*, *Melicope elleryana* \^tree\6\i; M ^*Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides*, *Cyclophyllum schultzii* f. *schultzii* \^tree, shrub\6\i; G1 ^*Eulalia* sp. \^tussock grass \2\i; G2 ^Sedge sp., Herb sp. \sedge, forb\1\i.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-10	5	-	-	-	-
Melaleuca argentea	16-18	15	-	-	-	-
Syzygium armstrongii	14-16	15	-	-	<3	10-15
Xanthostemon eucalyptoides	10-12	5	3-8	5	<3	10-15
Carallia brachiata	-	-	4-6	5	<3	10-15
Cyclophyllum schultzii	-	-	3-6	1	<3	10-15
Melicope elleryana	-	-	8-10	5	<3	10-15
Myrsine benthamiana	-	-	3-6	5	<3	10-15
Pandanus aquaticus	-	-	3-6	10	-	-
Barringtonia acutangula	-	-	-	-	<3	10-15
Carpentaria acuminata	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Pandanus spiralis	-	-	-	-	<3	10-15
Total	**8-16**	**40**	**3-10**	**30-35**	**0-3**	**10-15**
**highlighted cells indicate overall % cover for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present.

Photo monitoring point

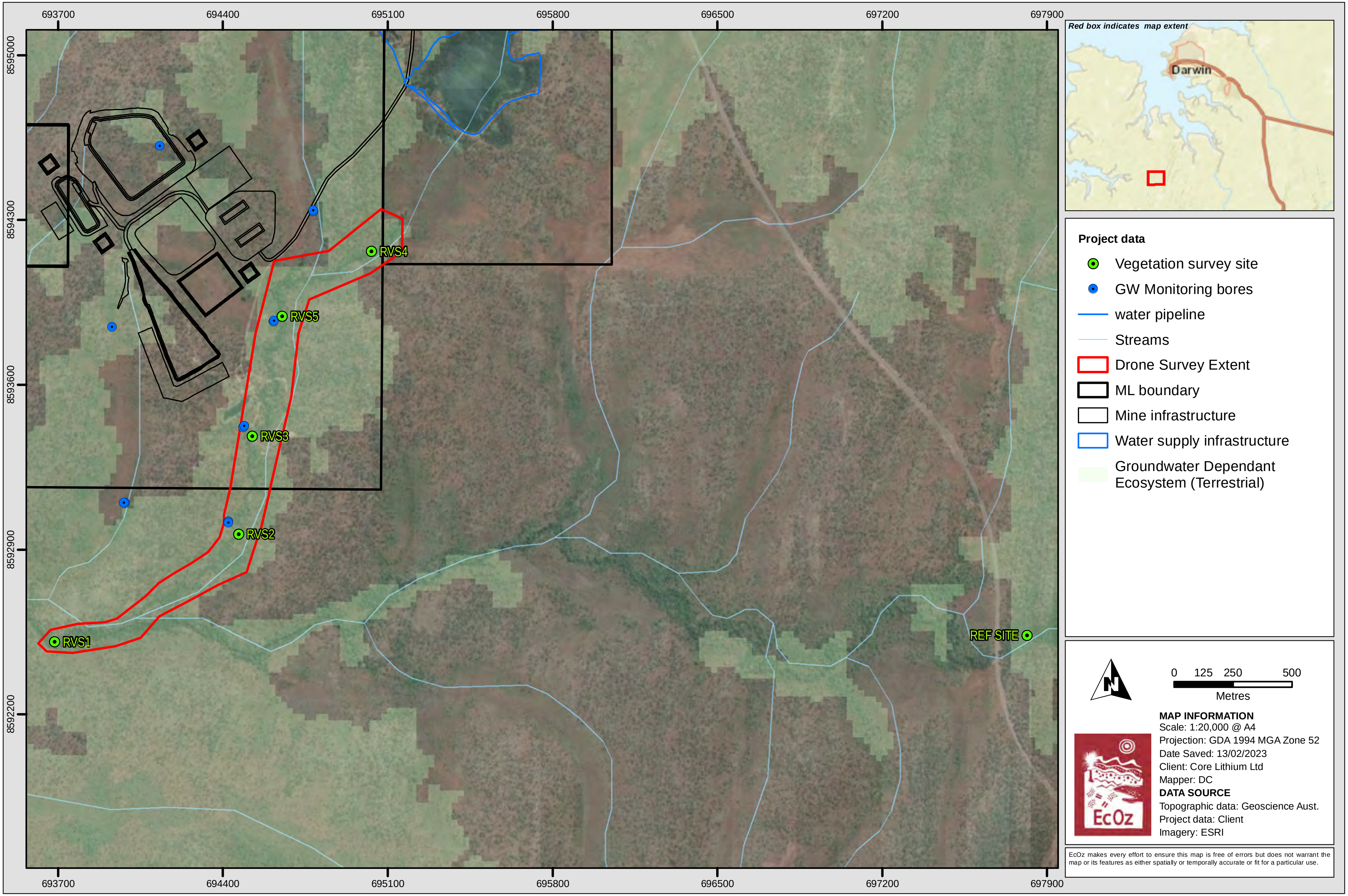
North

East

South

West

Figure 3-11. Photographs of the habitat at the reference site using cardinal-directions for riparian monitoring



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22099 - OHD SWEL riparian vegetation monitoring\2. Project Files\Report Maps\Riparian vegetation sites monitored.mxd

Figure 3-12. Riparian vegetation sites monitored in the post wet-season survey (May 2022)

3.2 Drone survey

3.2.1 Riparian vegetation boundary

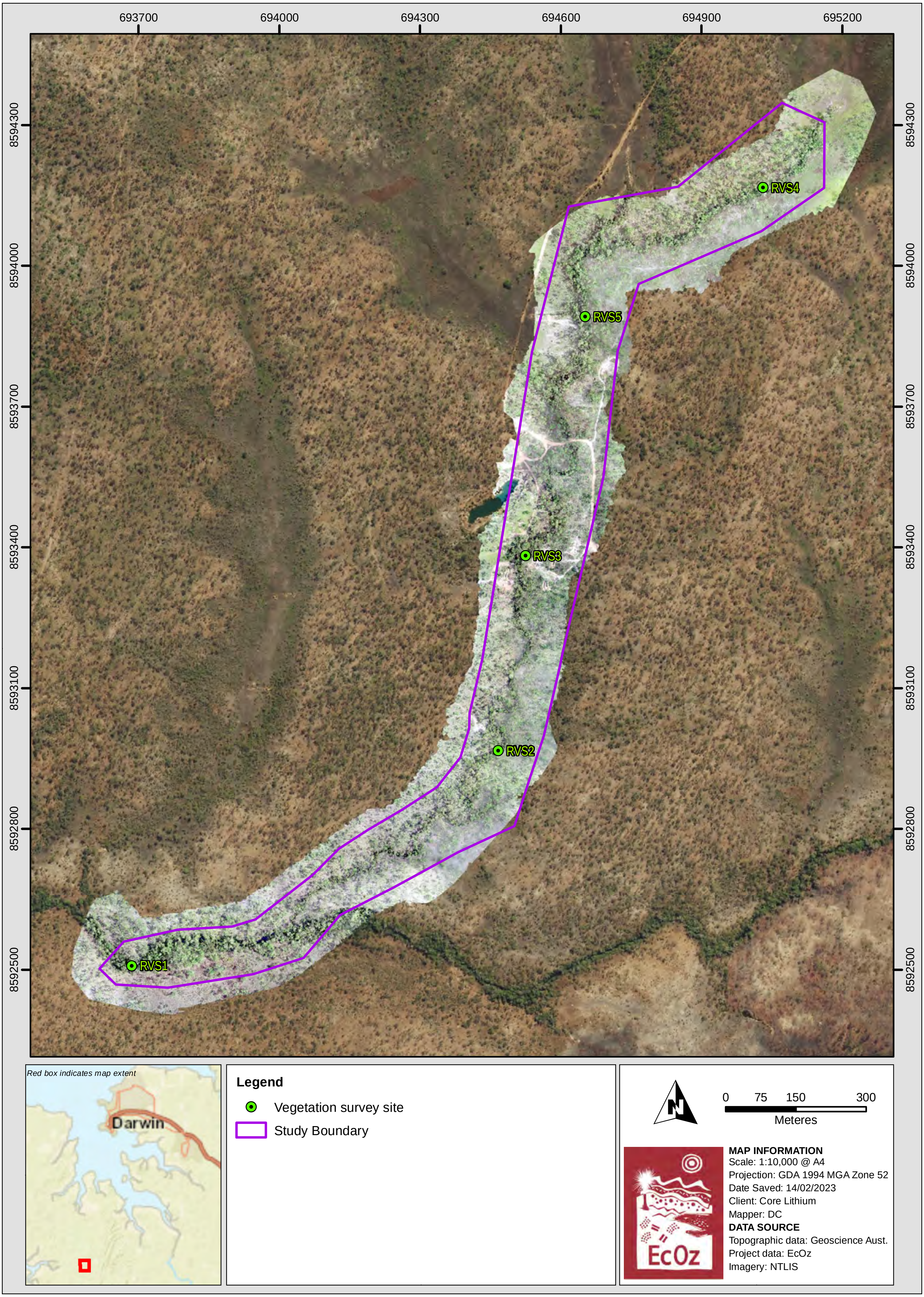
The riparian study site is approximately 2.5 km long and 150 m wide, with an area of 5 ha (Figure 3-13). The boundary of the GDE riparian vegetation community type was delineated within the study site (Figure 3-13).

3.2.2 VARI analysis

A geo-tiff displaying VARI pixel values was exported from WebODM using the built-in "Plant Health" function. The exported VARI raster was reclassified using the "Reclassify by Table" tool in QGIS, applying the following value ranges: -0.21 to 0.01 with a value of 5, 0.01 to 0.1 with a value of 4, 0.1 to 0.17 with a value of 3, 0.17 to 0.23 with a value of 2, and 0.23 to 0.6 with a value of 1 (Table 3-1). The raster was clipped to the study area polygon using QGIS's built-in masking tools. The Semi-Automatic Classification Plugin in QGIS was used to run the Classification Report postprocessing tool, determining the count, area, and percentage of each pixel value (ranging from 1 to 5) (Table 3-1). The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval). Based on the analysis, an area of 5.27 ha of the raster data falls within class intervals 1 & 2 (green band colour) indicating healthy vegetation - this equates to 13.7% of the total study area is considered healthy vegetation (Table 3-1). It appears the healthy vegetation lies within the main riparian corridor (see Figure 3-14).

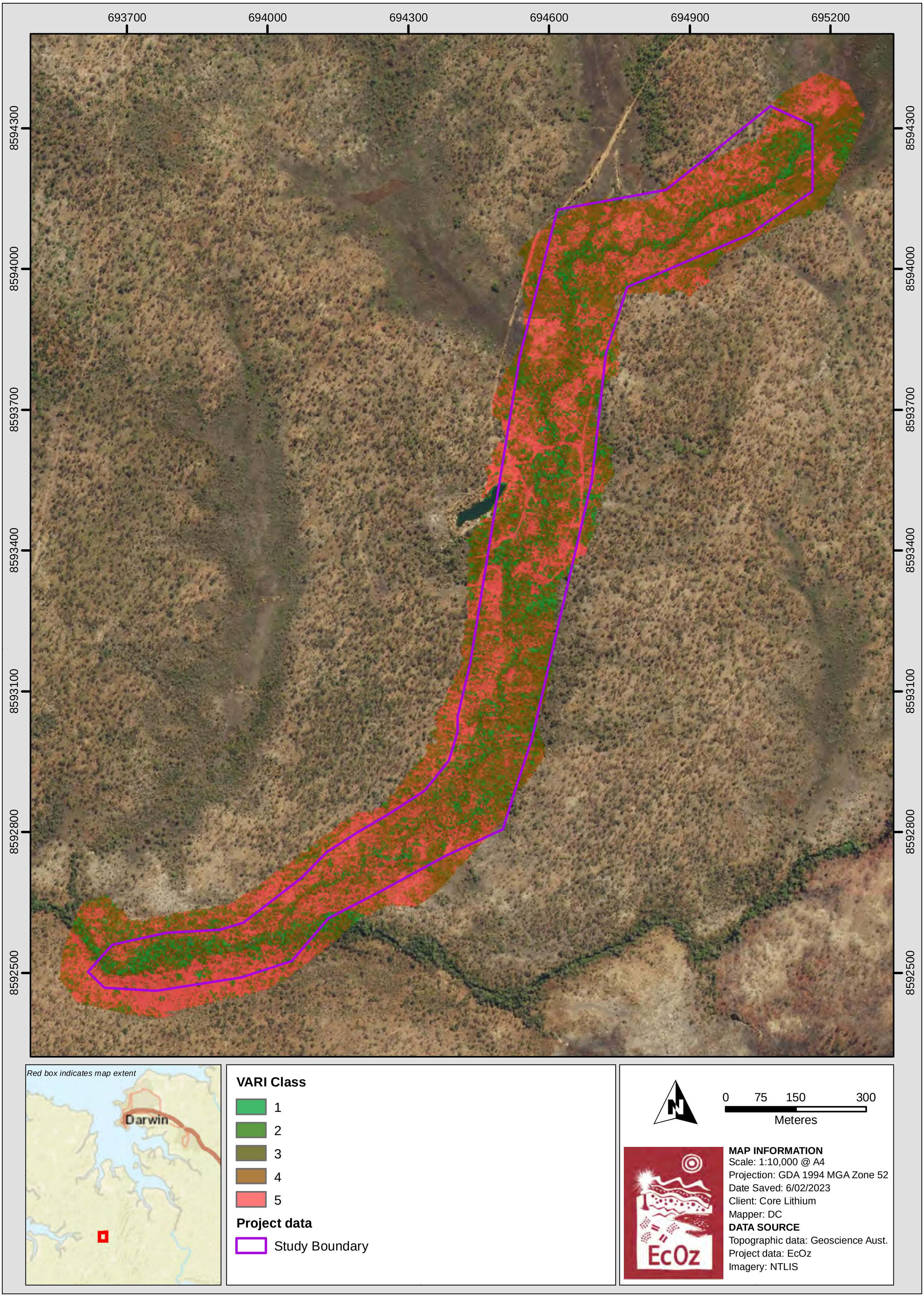
Table 3-1. VARI analysis based on post wet-season

Colour	Class	Class intervals	Percentage %	Area (ha)
	1	0.23 to 0.6	8.90	3.45
	2	0.17 to 0.23	4.70	1.82
	3	0.1 to 0.17	10.03	3.92
	4	0.01 to 0.1	21.83	8.47
	5	-0.21 to 0.01	54.52	21.15



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22099 - OHD SWEL riparian vegetation monitoring\2. Project Files\Report Maps\Post wet season imagery.mxd

Figure 3-13. Riparian vegetation drone imagery (post wet-season survey, May 2022)



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22099 - OHD SWEL riparian vegetation monitoring\2. Project Files\Report Maps\Post wet season VARI.mxd

Figure 3-14. Map of riparian corridor using VARI raster data

4 RESULTS POST-DRY SEASON SURVEY

The post dry-season riparian vegetation assessment (including both drone survey and individual site assessments) was undertaken by Nicole Clark and Anna Lemon (Botanists) on 26-27 October 2022 at Core Lithium, BP33 site to assess the condition of the riparian vegetation. All sites were monitored as per the post wet-season survey. Generally, the conditions of the vegetation was drier and limited standing water was observed. Where small bodies of water was present, no flow was detected. Site specific photo monitoring points and imagery obtained from the are also provided for future monitoring purposes.

4.1 Vegetation site assessment

4.1.1 RVS1

Site description

The upper stratum comprised of *Xanthostemon eucalyptoides*, *Melaleuca argentea* mid open forest (12-14 m) with a sub-stratum of emerging *Syzygium armstrongii* (10-12 m). The mid stratum contained a mixed low open forest with *Leptospermum madidum* subsp. *sativum*, *Xanthostemon eucalyptoides, Pandanus spiralis* and *Barringtonia acutangula* subsp. *acutangula* and *Carallia brachiata*. *Acacia holosericea*, *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii* were sparsely represented within the mid stratum with <5% cover each. Ground cover was mostly comprised of sedges including which accounted for ~40% cover. Low grass cover with *Eriachne triseta* and sparse *Pseudopogonatherum contortum* was restricted to the edges of the creek bank.

NVIS description

U1+ ^*Xanthostemon eucalyptoides*, *Melaleuca argentea* \^tree\7\c; U2 ^*Syzygium armstrongii* \^tree\7\r; M ^*Leptospermum madidum* subsp. *sativum*, *Xanthostemon eucalyptoides. Pandanus aquaticus*, *Barringtonia acutangula* subsp. *acutangula*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\c; G1 ^*Eriachne triseta* \^tussock grass \2\i; G2 ^ Herb sp., *Fimbristylis* sp., *Lindsaea ensifolia*, sedge, forb, fern\1\c.

Vegetation height and cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Melaleuca argentea	12-14	15	-	-	-	-
Xanthostemon eucalyptoides	12-14	15-20	5-8	10-15	-	-
Syzygium armstrongii	10-12	5 - 10	-	-	<3m	10-15
Leptospermum madidum	-	-	4-8	15-20	<3m	10-15
Barringtonia acutangula	-	-	3-5	5-10	<3m	10-15
Pandanus spiralis	-	-	3-6	5-10	<3m	10-15
Fagraea racemosa	-	-	-	-	<3m	10-15
Helicia australasica	-	-	-	-	<3m	10-15
Myrsine benthamiana	-	-	4	<1	<3m	10-15
Carallia brachiata	-	-	3-5	2-5	<3m	10-15
Acacia holosericea	-	-	3-4	1-5	-	-
Cyclophyllum schultzii	-	-	3-4	1	<3m	10-15
Total	**10-14**	**5-20**	**3-8**	**35-40**	**0-3**	**10-15**
**highlighted cells indicate overall % cover for combined species*						

General observations

Standing water present within the creek at the time of surveying, though water was stagnant. Fire scars were observed north of the site in adjacent woodland. Biofilm was present on the water's surface.

Photo monitoring point

North **East**


South **West**


Figure 4-1. Photographs of the habitat at RVS1 using cardinal-directions for riparian monitoring

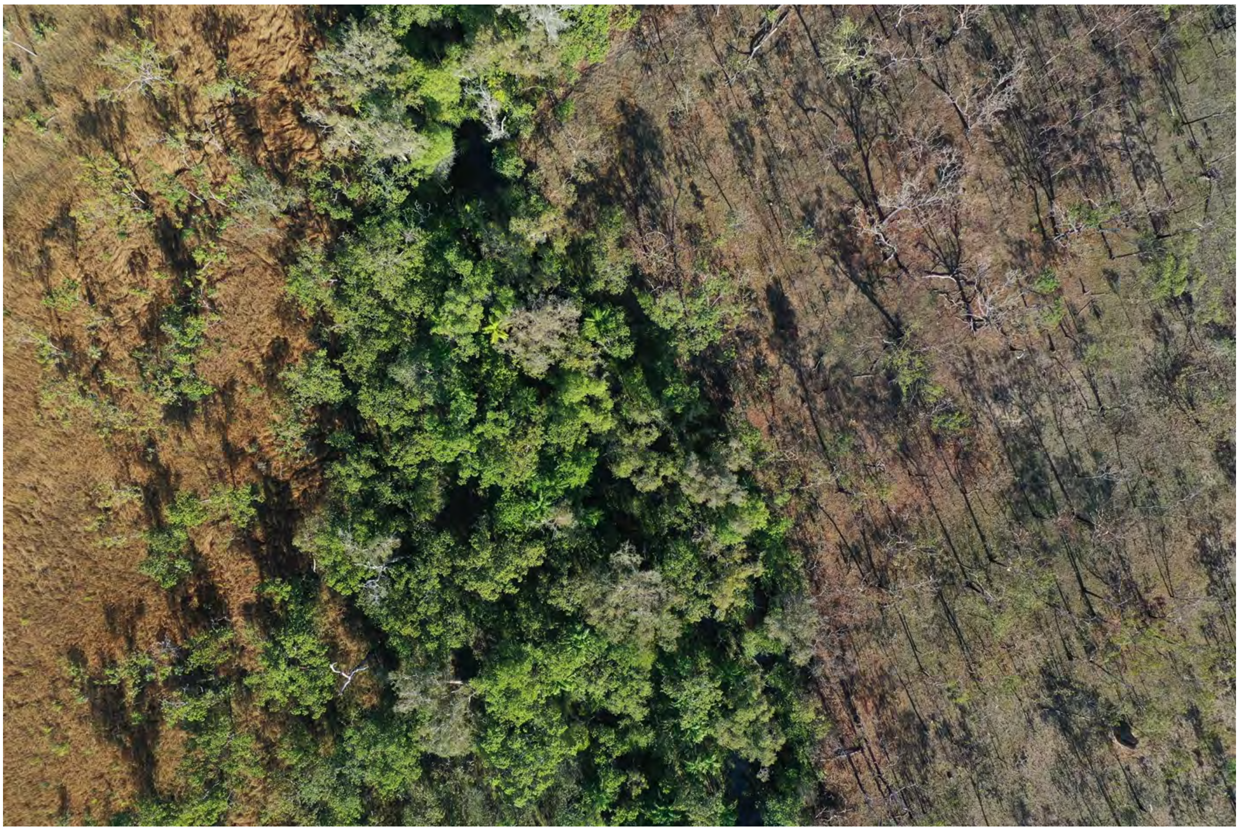


Figure 4-2. Drone imagery of RVS1

4.1.1 RVS2

Site description

The upper stratum is a mid open forest (10-12 m) dominated by *Melaleuca viridiflora*, with co-dominants *Syzygium armstrongii* and *Lophostemon lactifluus*. The mid stratum consists of a low open forest (4-8 m) with *Xanthostemon eucalyptoides* and co-dominants *Leptospermum madidum* subsp. *sativum* and *Acacia holosericea*. A dozen species were recruiting into the mid stratum and collectively comprised ~30-40% cover. Ground cover comprised of an open tussock grassland with *Eriachne triseta* and *Germania grandiflora*. Ferns, herbs and sedges were generally confined to the creek bank.

NVIS description

U+ ^*Melaleuca viridiflora*, *Syzygium armstrongii*, *Lophostemon lactifluus*, *Eucalyptus miniata*, *Melicope elleryana* \^tree\7\i; M ^*Xanthostemon eucalyptoides*, *Leptospermum madidum* subsp. *sativum*, *Acacia holosericea*, *Pandanus spiralis*, *Helicia australasica* \^tree, shrub\6\c; G1 ^*Eriachne triseta*, *Germania grandiflora* \^tussock grass \2\i; G2 ^ *Lindsaea ensifolia* \^fern\1\i. Other species noted: *Carpentaria acuminata*.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Eucalyptus miniata	10-12	3-5	-	-	-	-
Lophostemon lactifluus	10	5	-	-	-	-
Melaleuca viridiflora	10-12	5	-	-	-	-
Melicope elleryana	-	-	-	-	-	-

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Syzygium armstrongii	10	5-10	3-6	1-2	<3	30-40
Acacia holosericea	-	-	3-5	3-5	<3	30-40
Carpentaria acuminata	-	-	6	1	<3	30-40
Helicia australasica	-	-	3-5	<3	<3	30-40
Leptospermum madidum	-	-	4-8	10-15	<3	30-40
Pandanus spiralis	-	-	3-6	1-3	<3	30-40
Xanthostemon eucalyptoides	-	-	4-8	10-15	<3	30-40
Exocarpos latifolius	-	-	3-4	<1	<3	30-40
Cyclophyllum schultzii	-	-	3-4	<1	<3	30-40
Alphitonia excelsa	-	-	-	-	<3	30-40
Breynia cernua	-	-	-	-	<3	30-40
Erythrophleum chlorostachys	-	-	-	-	<3	30-40
Total	**10-12**	**20-25**	**3-8**	**35-40**	**0-3**	**35**

General observations

There was no standing water present within the creek at the time of surveying. There was a moderate amount of leaf litter documented on the creek bed floor. There was evidence of a fire scar adjacent to the riparian corridor (in the Eucalypt woodland).

Photo monitoring point

North

East

South **West**

Figure 4-3. Photographs of the habitat at RVS2 using cardinal-directions for riparian monitoring

Figure 4-4. Drone imagery of RVS2

4.1.2 RVS3

Site description

The upper stratum consisted of a mid woodland (12-15 m) dominated by *Xanthostemon eucalyptoides* and *Lophostemon lactifluus*, with a mix of less dominant species *Melaleuca viridiflora*, *Erythrophleum chlorostachys* and *Syzygium armstrongii*. Two mid stratums were present within the system, with the taller stratum comprising of a mixed low woodland (5-10 m) with *Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura* and *Carallia brachiata*. The lower mid stratum contained a mix of shrubs and small trees with *Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* (1-5 m). The ground stratum was mostly a tussock grassland outside of the creek line with *Eriachne triseta* and *Germania grandiflora*, and ferns were typically growing along the creek bank.

NVIS description

U+ ^*Xanthostemon eucalyptoides*, *Lophostemon lactifluus*, *Melaleuca viridiflora*, *Erythrophleum chlorostachys*, *Syzygium armstrongii* \^tree\7\i; M1 ^*Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura*, *Carallia brachiata* \^tree\6\c; M2 ^*Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* \^shrub, tree\6\i; G1 ^*Eriachne triseta*, *Germania grandiflora* \^Sorghum intrans \2\c; G2 ^ *Lindsaea ensifolia* \ ^fern\1\i.

Vegetation height and cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Erythrophleum chlorostachys	12-14	5-10	3-5	<1	<3	10-15
Melaleuca viridiflora	12-15	5-10	4-6	<1	<3	10-15
Syzygium armstrongii	12-15	5	-	-	<3	10-15
Xanthostemon eucalyptoides	10-14	5	3-10	10-15	<3	10-15
Leptospermum madidum	10-12	<5	5-8	5-10	-	-
Acacia auriculiformis	-	-	8-10	1-5	-	-
Acacia holosericea	-	-	3-5	5	<3	10-15
Alphitonia excelsa	-	-	4-5	<1	<3	10-15
Carallia brachiata	-	-	3-4	<1	<3	10-15
Cyclophyllum schultzii	-	-	3-4	1	<3	10-15
Denhamia obscura	-	-	6-8	1-3	-	-
Livistona humilis	-	-	3-4	1	<3	10-15
Pandanus aquaticus	-	-	1-4	2-5	-	-
Pandanus spiralis	-	-	1-4	1	<3	10-15
Breynia cernua	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Total	**10-15**	**25-30**	**3-10**	**25-30**	**<3**	**10-15**

General observations

There was only one small pool present within the creek at the time of survey. Some pig damage was observed. There was also one large *Syzygium armstrongii* present next to the water's edge (>60cm DBH).

Photo monitoring point

North

East

South

West

Figure 4-5. Photographs of the habitat at RVS3 using cardinal-directions for riparian monitoring

Figure 4-6. Drone imagery of RVS3

4.1.3 RVS4

Site description

The upper stratum consisted of a mid open forest (8-16 m) with *Syzygium armstrongii* and *Xanthostemon eucalyptoides*, with emerging *Corymbia polycarpa* (10-12 m). The mid stratum was fairly complex with two distinct height ranges. The taller of the mid stratums comprised of low open forest (5-10 m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Melaleuca viridiflora, Syzygium angophoroides*, *Gmelina schlechteri* and *Pandanus spiralis*. The lower mid stratum (3-5 m) contained a mix of small trees comprising of *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii* and *Carallia brachiata*. *Acacia holosericea* was also present and formed a small component of the lower mid stratum. The ground stratum was a tussock grassland containing *Eriachne triseta*, *Chrysopogon latifolia* and *Germania grandiflora*. Smaller ferns and sedges were typically confined to the creek bank, and *Dianella odorata* and *Flagellaria indica* were also present within the creek.

NVIS description

U+ ^*Syzygium armstrongii*, *Xanthostemon eucalyptoides*, *Corymbia polycarpa, Syzygium angophoroides* \^tree\7\c; M1 ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Melaleuca viridiflora*, *Gmelina schlechteri*, *Pandanus spiralis* \^tree\6\c; M2 ^*Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\c; G2 ^ *Lindsaea ensifolia*, Sedge sp. \ ^fern, sedge\1\i. Other species noted: *Flagellaria indica*, *Dianella odorata*.

Vegetation heights and cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Corymbia polycarpa	10-12	5	-	-	-	-
Syzygium armstrongii	14-16	20	6-8	10	<3	10-15
Xanthostemon eucalyptoides	12-14	15	4-8	25	-	-
Syzygium angophoroides	8-10	5				
Acacia holosericea	-	-	4-5	15	-	-
Carallia brachiata	-	-	3-5	15	-	-
Cyclophyllum schultzii	-	-	3-5	15	<3	10-15
Flagellaria indica	-	-	8-10	15	-	-
Gmelina schlechteri	-	-	5-8	15	-	-
Melaleuca viridiflora	-	-	8-10	15	-	-
Myrsine benthamiana	-	-	3-6	15	<3	10-15
Pandanus spiralis	-	-	4-6	15	<3	10-15
Syzygium angophoroides	-	-	6-8	15	<3	10-15
Ilex arnhemensis	-	-	6-8	15	-	-
Helicia australasica	-	-	-	-	<3	10-15
Melicope elleryana	-	-	-	-	<3	10-15
Total	**8-16**	**45**	**3-10**	**50**	**<3**	**10-15**

General observations

No standing water present within creek. The last fire was observed <1 year ago.

Photo monitoring point

North

East

South **West**

Figure 4-7. Photographs of the habitat at RVS4 using cardinal-directions for riparian monitoring

Figure 4-8. Drone imagery of RVS4

Comparison between previous work

Based on the post dry-season riparian vegetation assessment undertaken (EcOz 2019), it is noted the dominant species composition was similar compared to the 2022 post-dry season survey, though no other comparisons can be made relative to vegetation structure. The vegetation data obtained previously was recorded at NVIS level 5, compared to the 2022 post-dry season survey, which was undertaken at NVIS level 6.

4.1.4 RVS5

Site description

The upper stratum is comprised of a mid open forest (12-14m tall) with *Xanthostemon eucalyptoides*, over low woodland (8-12 m) of *Syzygium armstrongii, Melaleuca viridiflora* and *Lophostemon lactifluus*. The mid stratum was a mixed low open forest (3-8m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus*. Under this was a lower mid stratum (2-5 m) of the same structure with *Helicia australasica*, *Acacia holosericea* and *Pandanus spiralis*. The ground stratum is a tussock grassland with *Eriachne triseta*, *Heteropogon triticeus*, and *Chrysopogon latifolia*. Ferns were still present, but not as prominent.

NVIS description

U1 ^ *Xanthostemon eucalyptoides* \^tree\7\i; U2 ^*Melaleuca viridiflora*, *Syzygium armstrongii, Lophostemon lactifluus* \^tree\6\i; M1+ ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus* \^tree\6\c; M2 ^*Helicia australasica*, *Acacia holosericea*, *Pandanus spiralis* \^tree\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\i; G2 ^ *Lindsaea ensifolia* \^fern\1\r. Other species noted: *Cyclophyllum schultzii* f. *schultzii*.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-10	5-10	6-7	<5	<3	5-10
Melaleuca viridiflora	10-12	10-15	6	<1	-	-
Syzygium armstrongii	10-12	10-15	6-8	5	<3	5-10
Xanthostemon eucalyptoides	12-14	15	4-8	15	<3	5-10
Acacia holosericea	-	-	3-5	1-3	<3	5-10
Carallia brachiata	-	-	6-8	5	<3	5-10
Cyclophyllum schultzii	-	-	3-6	1-2	<3	5-10
Helicia australasica	-	-	3-6	10-15	<3	5-10
Leptospermum madidum	-	-	4-6	5-10	<3	5-10
Pandanus spiralis	-	-	4-5	1-2	<3	5-10
Myrsine benthamiana	-	-	3-4	<1	<3	5-10
Erythrophleum chlorostachys	-	-	-	-	<3	5-10
Melicope elleryana	-	-	-	-	<3	5-10
Total	**8-14**	**45-50**	**3-8**	**50-55**	**0-3**	**5-10**

General observations

No standing water present within creek. The last fire was observed <1 year ago.

Photo monitoring point

North

East

South

West

Figure 4-9. Photographs of the habitat at RVS5 using cardinal-directions for riparian monitoring

Figure 4-10. Drone imagery of RVS5

Comparison between previous work

Based on the post dry-season riparian vegetation assessment undertaken (EcOz 2019), it is noted the dominant species composition was similar compared to the 2022 post-dry season survey, though no other comparisons can be made relative to vegetation structure. The vegetation data obtained previously was recorded at NVIS level 5, compared to the 2022 post-dry season survey, which was undertaken at NVIS level 6.

4.1.5 Reference site

Site description

The upper stratum was a mid open forest (14-18 m) of *Melaleuca argentea* and *Syzygium armstrongii*, over a low-mid woodland (8-12 m) with *Xanthostemon eucalyptoides*, *Lophostemon lactifluus* and *Melicope elleryana*. The mid stratum comprised of a low open forest (3-8 m) with *Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides* and *Cyclophyllum schultzii* f. *schultzii*. The ground stratum comprised of a tussock grassland dominated by *Eulalia mackinlayi* which was dominant on the embankment, with sedges and herbs growing closer to the waters' edge.

NVIS description

U+ ^*Melaleuca argentea*, *Syzygium armstrongii*, *Xanthostemon eucalyptoides* \^tree\7\c; U2 ^*Lophostemon lactifluus*, *Melicope elleryana* \^tree\6\i; M ^*Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides*, *Cyclophyllum schultzii* f. *schultzii* \^tree, shrub\6\i; G1 ^*Eulalia* sp. \^tussock grass \2\i; G2 ^Sedge sp., Herb sp. \sedge, forb\1\i.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-10	5	-	-	-	-
Melaleuca argentea	16-18	15	-	-	-	-
Syzygium armstrongii	14-16	15	-	-	<3	10-15
Xanthostemon eucalyptoides	10-12	5-10	3-8	5-10	<3	10-15
Carallia brachiata	-	-	4-6	5	-	-
Cyclophyllum schultzii	-	-	3-6	1	<3	10-15
Melicope elleryana	-	-	8-10	5	<3	10-15
Myrsine benthamiana	-	-	3-6	1	<3	10-15
Pandanus aquaticus	-	-	3-6	5-10	-	-
Fagraea racemosa	-	-	6	<5	-	-
Corymbia polycarpa	-	-	4	<1	-	-
Barringtonia acutangula	-	-	-	-	<3	10-15
Carpentaria acuminata	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Pandanus spiralis	-	-	-	-	<3	10-15
Total	**8-18**	**4-45**	**3-10**	**25-30**	**<3**	**10-15**

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Standing water was stagnant, with no apparent sedimentation present.

Photo monitoring point

North

East

South

West

Figure 4-11. Photographs of the habitat at the reference site using cardinal-directions for riparian monitoring

4.2 Drone survey

4.2.1 Riparian vegetation boundary

The riparian study site is approximately 2.5 km long and 150 m wide, with an area of 5 ha (Figure 4-12). The boundary of the GDE riparian vegetation community type was delineated within the study site (Figure 4-12). The vegetation site assessments all lie within the GDE riparian corridor. Zoomed in images are provided for each site are also provided for future monitoring.

4.2.2 VARI analysis

Based on the VARI analysis, an area of 5.6 ha of the raster data falls within class intervals 1 & 2 (green band colour) indicating healthy vegetation - this equates to 13.81 % of the total study area is considered healthy vegetation (Table 4-1). It appears the healthy vegetation lies within the main riparian corridor (see Figure 4-13).

Table 4-1. VARI analysis results

Colour	Class	Class intervals	Percentage %	Area (ha)
	1	0.23 to 0.6	5.98	2.42
	2	0.17 to 0.23	7.86	3.18
	3	0.1 to 0.17	18.85	7.63
	4	0.01 to 0.1	35.87	14.51
	5	-0.21 to 0.01	31.41	12.71

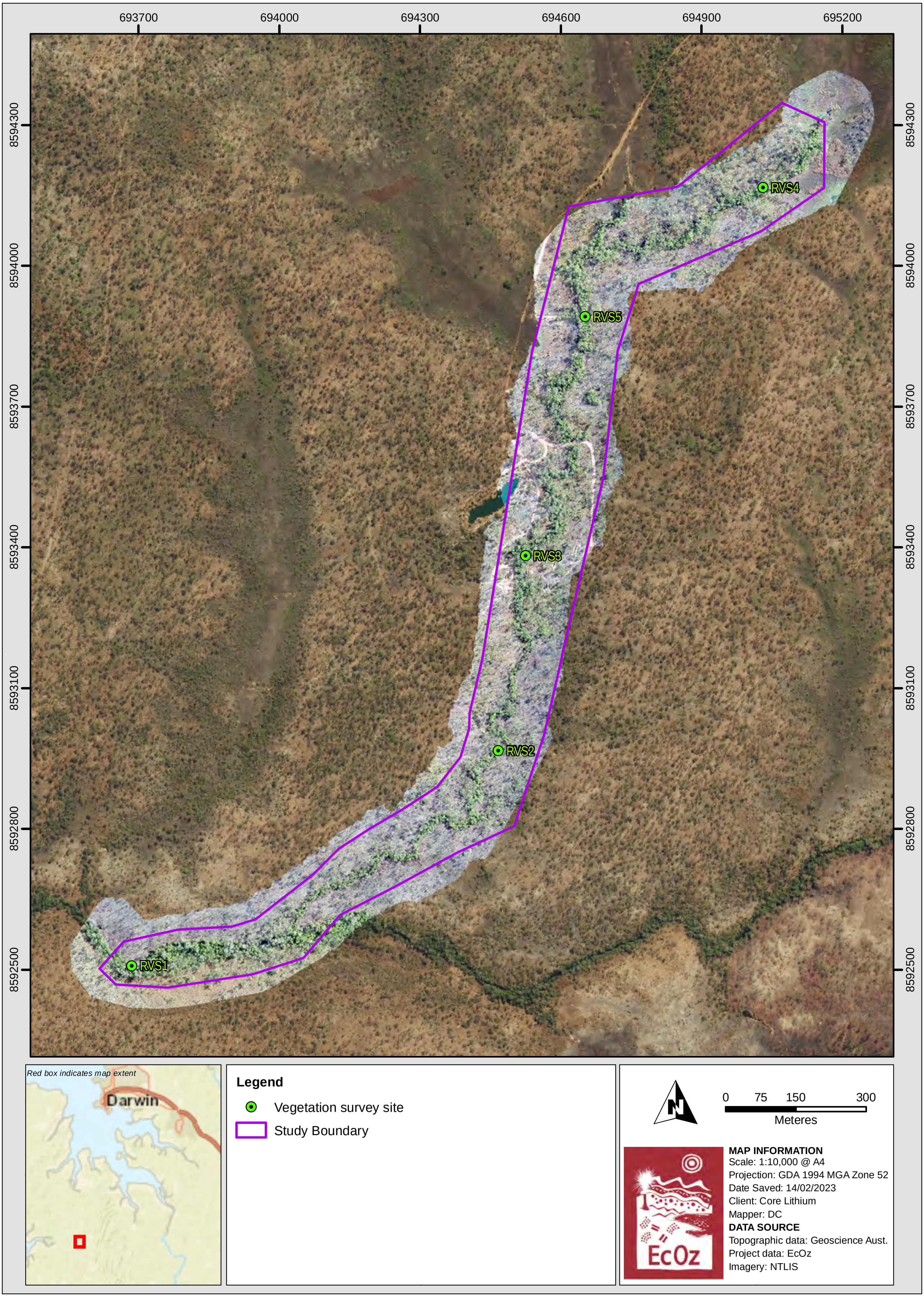


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Figure 4-12. Riparian vegetation drone imagery (post dry-season survey, October 2022)

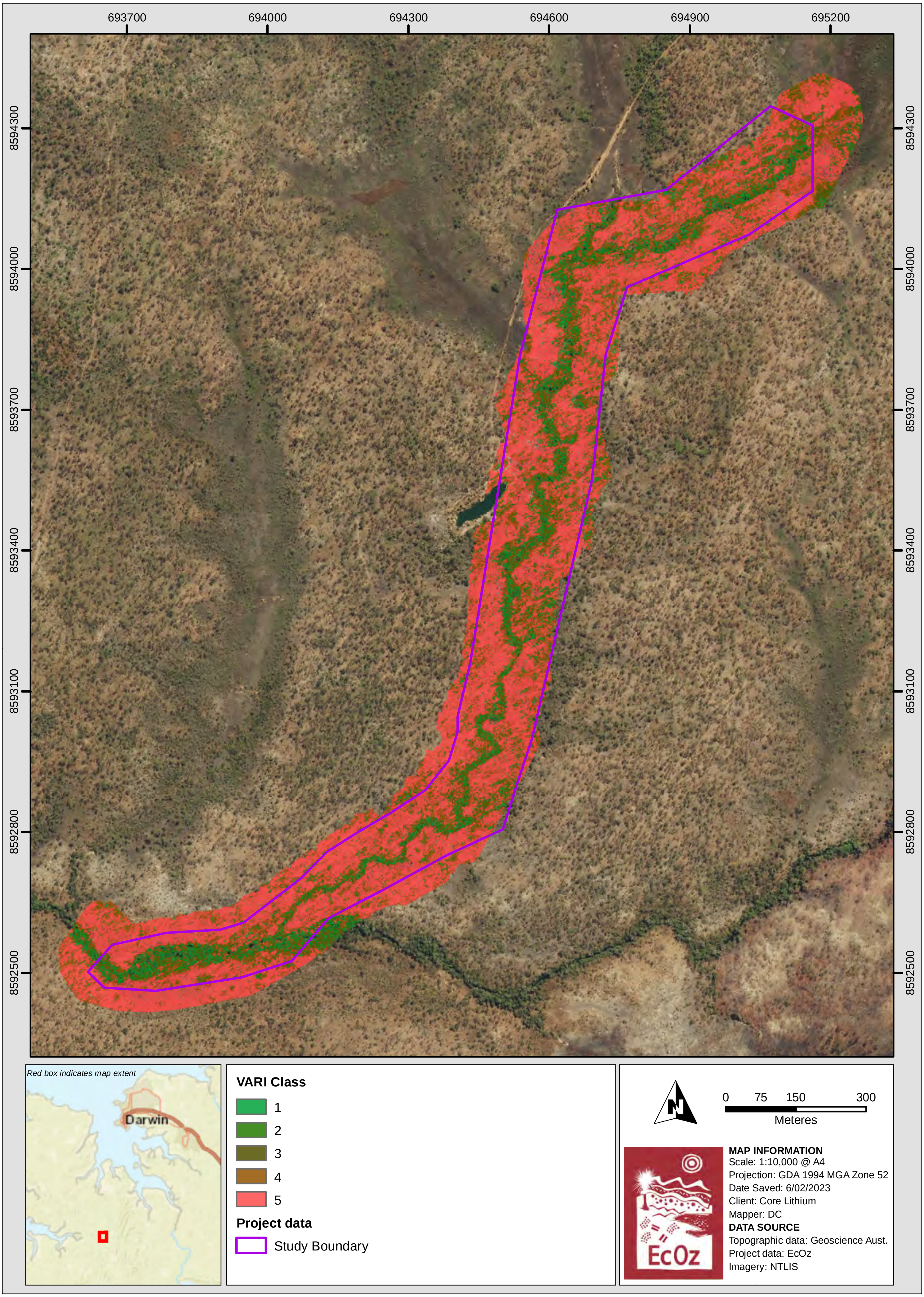

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Figure 4-13. Map of riparian corridor using VARI raster data

5 DATA ANALYSIS RESULTS

This section presents statistical analysis outlined in the RVMP (Appendix A) and presents analysis for both the post wet-season and post dry-season baseline surveys.

5.1 Species composition

5.1.1 Post wet-season

Syzygium armstrongii was represented in the upper stratum across all of the monitoring sites, including the reference site. *Xanthostemon eucalyptoides* was observed as the next abundant species, followed by *Lophostemon lactifluus* occurring at five and four sites, respectively.

Acacia holosericea, Carallia brachiate, Cyclophyllum schultzii f. schultzii and *Xanthostemon eucalyptoides* were all represented in the mid stratum across all of the monitoring sites, including the reference site. *Leptospermum madidum subsp. Sativum* and *Pandanus spiralis* were observed as the next abundant mid strata species, both occurring at four monitoring sites, respectively.

Many of the species occurring within the upper and mid strata are showing signs of recruitment. *Cyclophyllum schultzii f. schultzii* was represented in the understorey across all of the monitoring sites, and the reference site. *Helicia australasica, Pandanus spiralis* and *Syzygium armstrongii* were observed as the next abundant species, occurring at five monitoring sites, including the reference site.

See Appendix B for full data set.

5.1.2 Post dry-season

Syzygium armstrongii was represented in the upper stratum across all of the monitoring sites, including the reference site. *Xanthostemon eucalyptoides* was observed as the next abundant species, followed by *Melaleuca viridiflora.*

Cyclophyllum schultzii f. schultzii and *Xanthostemon eucalyptoides* were all represented in the mid stratum across all of the monitoring sites, including the reference site. *Pandanus spiralis* and *Acacia holosericea* were observed as the next abundant mid strata species, all occurring at five monitoring sites, excluding the reference site, *Carallia brachiate* was also recorded at five monitoring sites, including the reference site.

Many of the species occurring within the upper and mid strata are showing signs of recruitment, *Syzygium armstrongii, Helicia australasica, Cyclophyllum schultzii f. schultzii* and *Pandanus* spiralis were represented in the understorey across all of the monitoring sites, and the reference site. *Acacia holosericea, Myrsine benthamiana* and *Xanthostemon eucalyptoides* were observed as the next abundant species.

See Appendix C for full data set.

5.2 Overall plant height

Table 5-1 represents overall plant height for each site within varying stratums for both post wet-season survey and post dry season survey. In relation to the post wet-season survey, the upper strata ranged from 8-16 m tall (Table 5-1). Site RVS4 and the reference site contained the tallest trees ~16m. The mid strata is relatively consistent across the sites, ranging from 3-10 m tall. All recruits were <3 m tall.

The data represented similar height data in the post dry-season survey compared to the post wet-season survey (Table 5-1).

Table 5-1. Overall plant height for each site within varying stratums for both post wet-season survey and post dry season survey

Site	Upper		Middle		Recruit	
	Post wet-season	Post dry season	Post wet-season	Post dry season	Post wet-season	Post dry season
RVS1	10-14	10-14	3-8	3-8	0-3	0-3
RVS2	10-12	10-12	3-8	3-8	0-3	0-3
RVS3	12-14	10-15	3-10	3-10	0-3	0-3
RVS4	12-16	8-16	2-8	3-10	0-3	0-3
RVS5	10-14	8-14	3-8	3-8	0-3	0-3
Reference site	8-16	8-18	3-10	3-8	0-3	0-3

5.3 Canopy cover and recruit cover

Table 5-2 represents overall % cover of each stratum for both post wet-season survey and post dry season survey. In relation to the post wet-season survey, the % cover in the upper strata ranged between 25-40%, and the mid stratum ranged between 35-60%. The % cover of recruits ranged between 10-40%. Overall, the data represented similar structure in the post dry-season survey compared to the post wet-season survey, although the % covers were slightly higher in the post wet-season survey (Table 5-2).

Table 5-2. Canopy cover % and % cover of recruits for each site within varying stratums for both post wet-season survey and post dry season survey

Site	Upper		Middle		Recruit	
	Post wet-season	Post dry season	Post wet-season	Post dry season	Post wet-season	Post dry season
RVS1	35	5-20	35-40	35-40	15	10-15
RVS2	25-30	20-25	35-40	35-40	40	35
RVS3	25-30	25-30	45-50	25-30	10-15	10-15
RVS4	40	45	50-55	50	10-15	10-15
RVS5	45	45-50	60-65	50-55	5-10	5-10
Reference	40	40-45	30-35	25-30	10-15	10-15

5.4 Plant health

All plants were alive across monitoring plots in the post wet-season survey (Appendix B). This was consistent in the post dry-season survey, except for one unidentified tree stump, recorded at RVS3 in the mid stratum and an individual *Melaleuca viridiflora* recorded at RVS5 in the mid stratum (Appendix C).

Based on the post wet-season survey, of the total number of plants in the upper and mid stratum, 6% were flowering– these plants were *Carpentaria acuminata, Melaleuca argentea, Myrsine benthamiana, Carallia brachiata* and *Cyclophyllum schultzii f. schultzii.* Of the total number of plants in the upper and mid stratum, 13% were fruiting at the time of survey – plants included *Acacia auriculiformis, Acacia holosericea, Carallia* *brachiate, Melaleuca viridiflora, Melaleuca argentea, Pandanus spiralis, Cyclophyllum schultzii f. schultzii*, *Myrsine benthamiana* (Appendix A). In relation to the post dry-season survey, of the total number of plants in the upper and mid stratum, 25% were in flower at the time of survey – these plants were *Fagraea racemose, Cyclophyllum schultzii f. schultzii, Syzygium armstrongii, Helicia australasica, Syzygium angophoroides, Melaleuca viridiflora, Carallia brachiate, Acacia holosericea, Erythrophleum chlorostachys* and *Barringtonia acutangula subsp. Acutangular.* Of the total number of plants the upper and mid stratum, 17% were fruiting at the time of survey - these plants were *Myrsine benthamiana, Acacia holosericea, Carallia brachiate, Gmelina shirleyi, Syzygium armstrongii, Xanthostemon eucalyptoides, Acacia holosericea, Cyclophyllum schultzii f. schultzii, Carpentaria acuminata, Melaleuca viridiflora* and *Barringtonia acutangula subsp. Acutangular.*

5.5 Groundwater sensitive species

5.5.1 Upper and mid strata

The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site are presented in Table 5-3. It is noted this data was analysed by combing the upper and mid strata data.

Overall, the reference site recorded the highest portion of sensitive species. Of the total mid stratum and upper stratum species recorded, *Melicope elleryana* and *Cyclophyllum schultzii* each comprised 10% of the total mid stratum and upper stratum species recorded in the post wet-season survey. This was also consistent in the post dry-season survey, except a slightly lower portion (8.3%). RVS2 was the only site that documented all three groundwater sensitive species in the post wet-season survey. Only *Helicia australasica* was present in the post dry-season survey.

Table 5-3. Portion (%) of sensitive species recorded at monitoring sites

Site	*Melicope elleryana*		*Cyclophyllum schultzii*		*Helicia australasica*	
	Post wet-season	Post dry-season	Post wet-season	Post dry-season	Post wet-season	Post dry-season
RVS1	-	-	10	9.1	-	-
RVS2	8.3	-	-	7.7	8.3	7.6
RVS3	-	-	5.5	5.3	-	-
RVS4	-	-	7.1	6.7	-	-
RVS5	-	-	7.6	6.7	7.6	6.6
Reference	10	8.3	10	8.3	-	-

5.5.2 Recruits

The portion (%) of groundwater sensitive species observed in the recruit data across all riparian vegetation sites and the references site are presented in Table 5-4. The data indicates groundwater sensitive species are re-sprouting and there are similar potions of recruits present as there are in the canopy riparian vegetation.

Table 5-4. Portion (%) of sensitive species recorded at monitoring sites

Site	*Melicope elleryana*		*Cyclophyllum schultzii*		*Helicia australasica*	
	Post wet-season	Post dry-season	Post wet-season	Post dry-season	Post wet-season	Post dry-season
RVS1	-	-	20	11.1	-	11.1
RVS2	-	-	8.3	9.1	8.3	9.1
RVS3	-	-	8.3	8.3	8.3	8.3
RVS4	14.3	12.5	14.3	12.5	14.3	12.5
RVS4	8.3	8.3	8.3	8.3	8.3	8.3
Reference	10	11.1	10	11.1	10	11.1

5.6 Ground covers

5.6.1 Post wet-season

Figure 5-1 represents the overall ground cover across monitoring plots based on the post wet-season survey. Vegetation was the dominant ground cover across monitoring plots, followed by litter, soil and other (water) and rocks. Of the total vegetation percent cover, grass was the dominant ground cover material recorded (Figure 5-2). Appendix D provides a full summary of ground cover results.

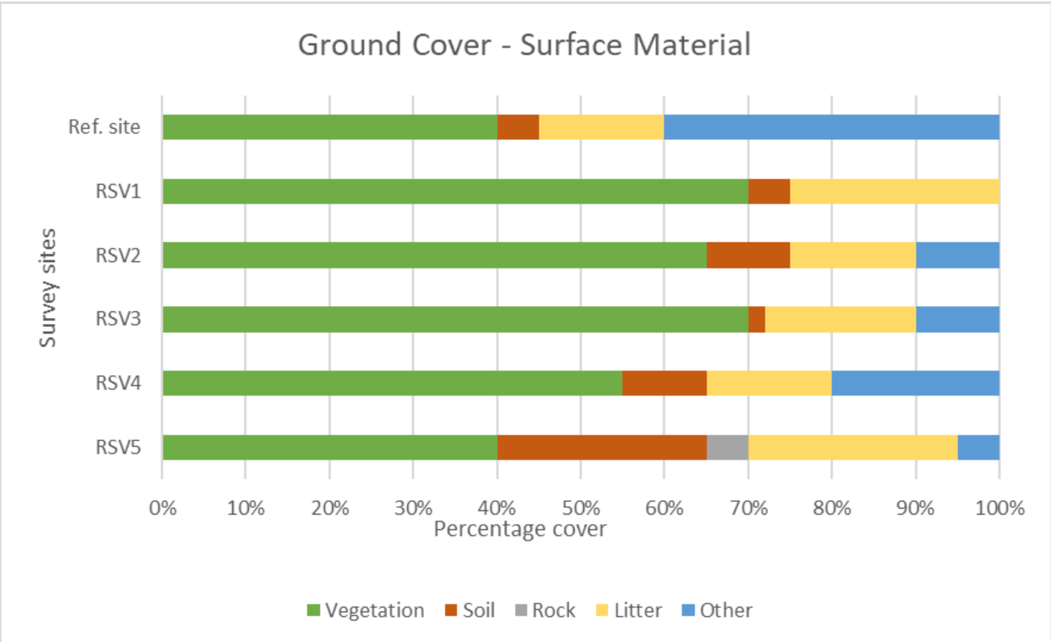

Figure 5-1. Graph showing percentage cover of ground cover by material type for each site

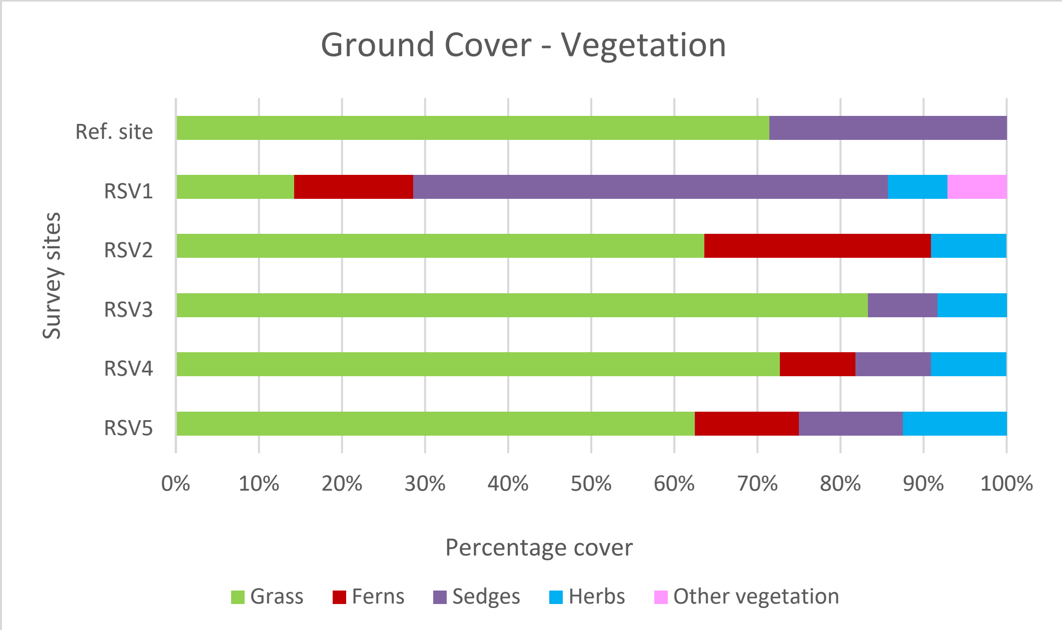

Figure 5-2. Graph showing percentage cover of ground cover by vegetation for each site

5.6.2 Post dry-season

Table 5-3 represents the overall ground cover across monitoring plots based on the post dry-season survey. Vegetation was the dominant ground cover across monitoring plots, followed by litter, soil and other (water), and rocks. Of the total vegetation percent cover, grass was the dominant ground cover material recorded (Table 5-4). Appendix E provides a full summary of ground cover results.

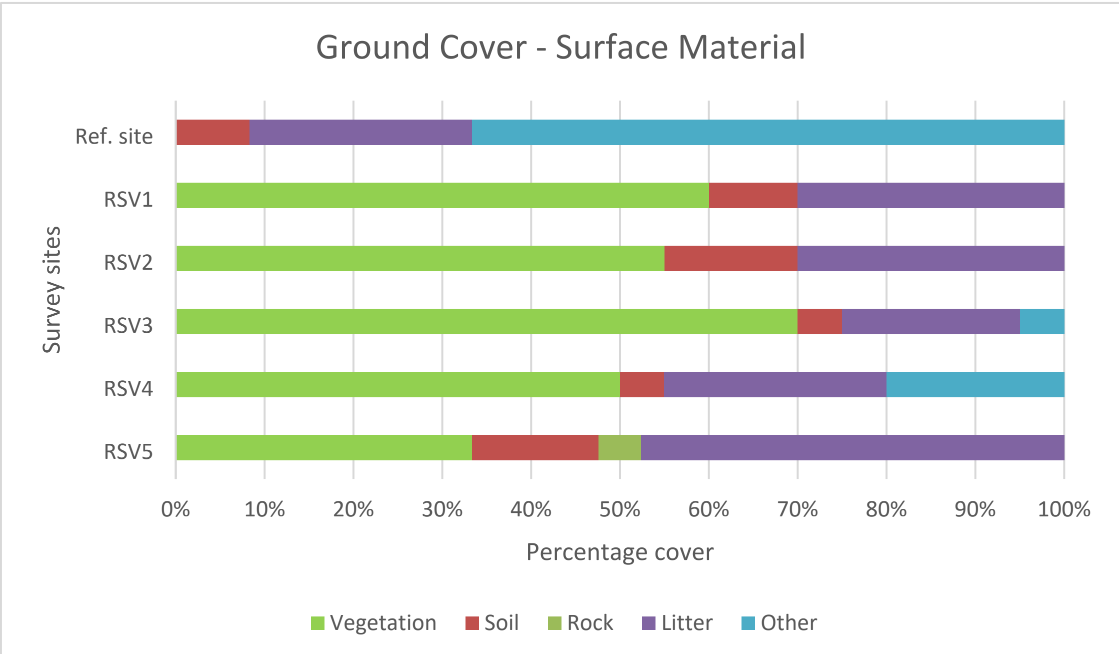

Figure 5-3. Graph showing percentage cover of ground cover by material type for each site

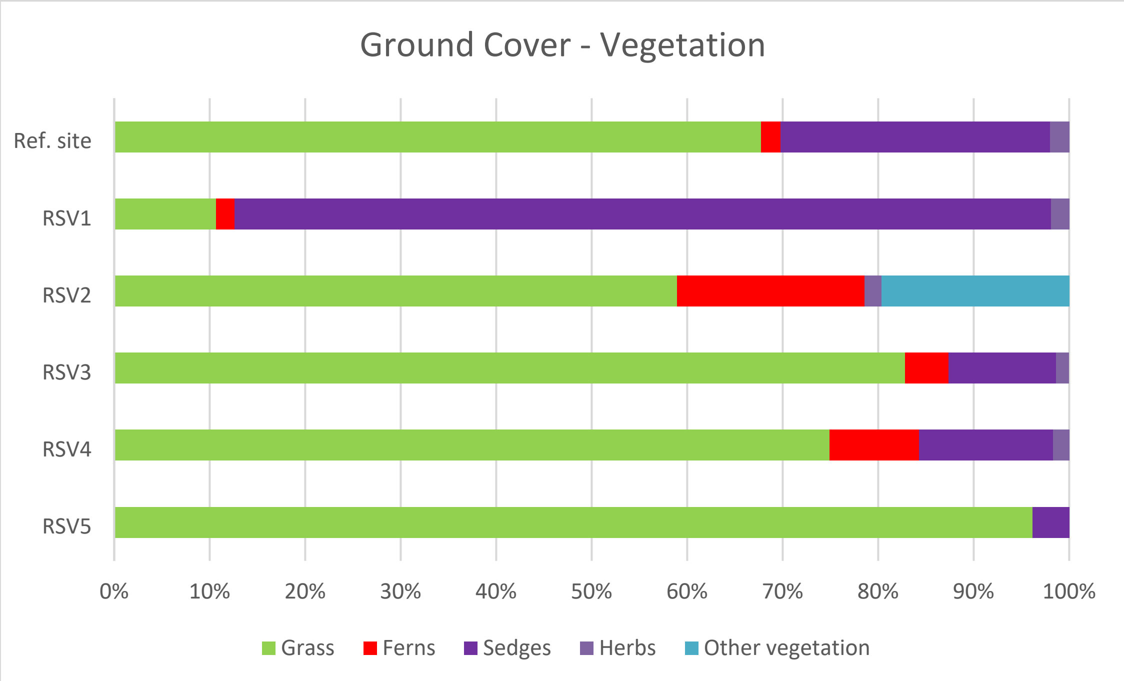

Figure 5-4. Graph showing percentage cover of ground cover by vegetation for each site

5.7 General observations

5.7.1 Post wet-season

Overall the riparian vegetation appeared in good health while undertaking the post wet-season survey (Appendix FAppendix E). The adjacent bushland had been severely burnt a few days prior to surveying, though this did not impact riparian vegetation health, except for a few patches of *Acacia Holosericea* that fell within site RVS1. No weeds were recorded within the monitoring plots. There were a few patches of Mission Grass observed adjacent to site RVS3. The creek intersecting the monitoring sties was flowing at the time of surveying with many aquatic plants, including native lilies and sedges, and aquatic animals i.e. small freshwater fish species and water insects were present in the waterway. No contamination was observed, except a slight red tinge was recorded at site RVS4 and red algal was recorded at site RVS5. A natural biofilm/sheen recorded at a few of the sites.

5.7.2 Post dry-season

The riparian appeared in good health while undertaking the post dry-season survey (Appendix F). There was some rainfall earlier in the month of October recorded around Cox Peninsula area, though conditions were dry for a week prior to surveying. The creek was mostly dry, with standing water only observed at some sites (RVS1, RVS3, RVS4 and the reference site). Many of the ferns, sedges and aquatic plants had decreased in cover and there was greater leaf litter on the surface. Appendix F provides a full description of general observation for all monitoring sites.

6 RECOMMENDATIONS

The following recommendations should be considered during and after water extraction, to assess whether any significant changes to the riparian community have occurred:

- As per the RVMP (EcOz 2022), the next monitoring event is scheduled in October 2023 (late dry season). It is recommended to continue riparian vegetation monitoring as per methods outlined in this baseline monitoring report to maintain consistent data collection for comparison.
- Conduct statistical analysis as outlined in the RVMP to compare data collected based on the on the vegetation site assessments that will be obtained in the following monitoring event and baseline surveys. For vegetation assessment sites Before After/Control Impact (BACI) will be applied to test whether there is a significant difference between the baseline health data and riparian vegetation assessment data at the same sites, and riparian vegetation assessment data compared to reference site data. Data captured for comparison will include:
    - o Species composition (%) using individual dominant/emergent plant data.
    - o Average heights of individual plants across riparian vegetation sites compared to reference site.
    - o Canopy cover (%) for each dominant, and emergent species across riparian vegetation
    - o Assessment sites compared to reference site data.
    - o Plants alive or dead (%) across all riparian vegetation sites compared to reference site data.
    - o The portion (%) of groundwater sensitive species, *Melicope elleryana, Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site.
    - o The ground cover percentages (vegetation type, soil, rock, litter).
    - o Type of ground cover percentages in the form of herbs/vines/grasses/ferns and sedges).
- Additionally, conduct Before After/Control Impact (BACI) statistical analysis (VARI) to test whether there is a significant difference between the baseline health data and the riparian vegetation health based on ongoing drone survey assessments. This will assess whether any significant changes to the riparian community have occurred.
- Adhere to the trigger action response plan (TARP) detailed in the RVMP (EcOz 2022). The TARP incorporates triggers and responses from the surface water monitoring program (WRM 2022) and GDE Management Plan and provided quantitative triggers and limits and/or adaptive management actions. There are a number of monitoring performance indicators that are relative to both vegetation site assessment survey and the drone survey.

7 REFERENCES

EcOz (2019). Mangrove and Riparian Vegetation Assessment, Grants Lithium Project. Prepared for Core Lithium by Ecoz Environmental Consultants Pty Ltd. October 2019.

EcOz (2022). Riparian Vegetation Monitoring Plan (RVMP), Finniss Lithium Project. Prepared for Core Lithium by Ecoz Environmental Consultants Pty Ltd, May 2022.

APPENDIX A RIPARIAN VEGETATION MONITORING PLAN

Riparian Vegetation Monitoring Plan

Finniss Lithium Project

Core Lithium

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DOCUMENT CONTROL RECORD

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Author(s)	Nicole Clark

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Tables

Figures

1 INTRODUCTION

This plan documents the riparian vegetation monitoring program (RVMP) that will be implemented to monitor impacts associated with water extraction from Observation Hill Dam (OHD) under Surface Water Extraction Licence (SWEL) 8151018 and operation of the Finniss Lithium Project, BP33 underground mine located on the Cox Peninsula (Figure 1). Riparian vegetation health downstream of the mines could be affected by changes to:

- surface water flows associated with extraction of water from the OHD
- groundwater levels due to dewatering of BP33 underground mine.

Riparian vegetation monitoring is required as a condition of the following approvals and licences:

- Environmental Approval 2020/001-001 for BP33 underground lithium mine
- SWEL 8151018.

The RVMP will be implemented in conjunction with the surface water, groundwater, sediment and biota monitoring programs detailed in the Grants Water Management Plan and BP33 Water Management Plan.

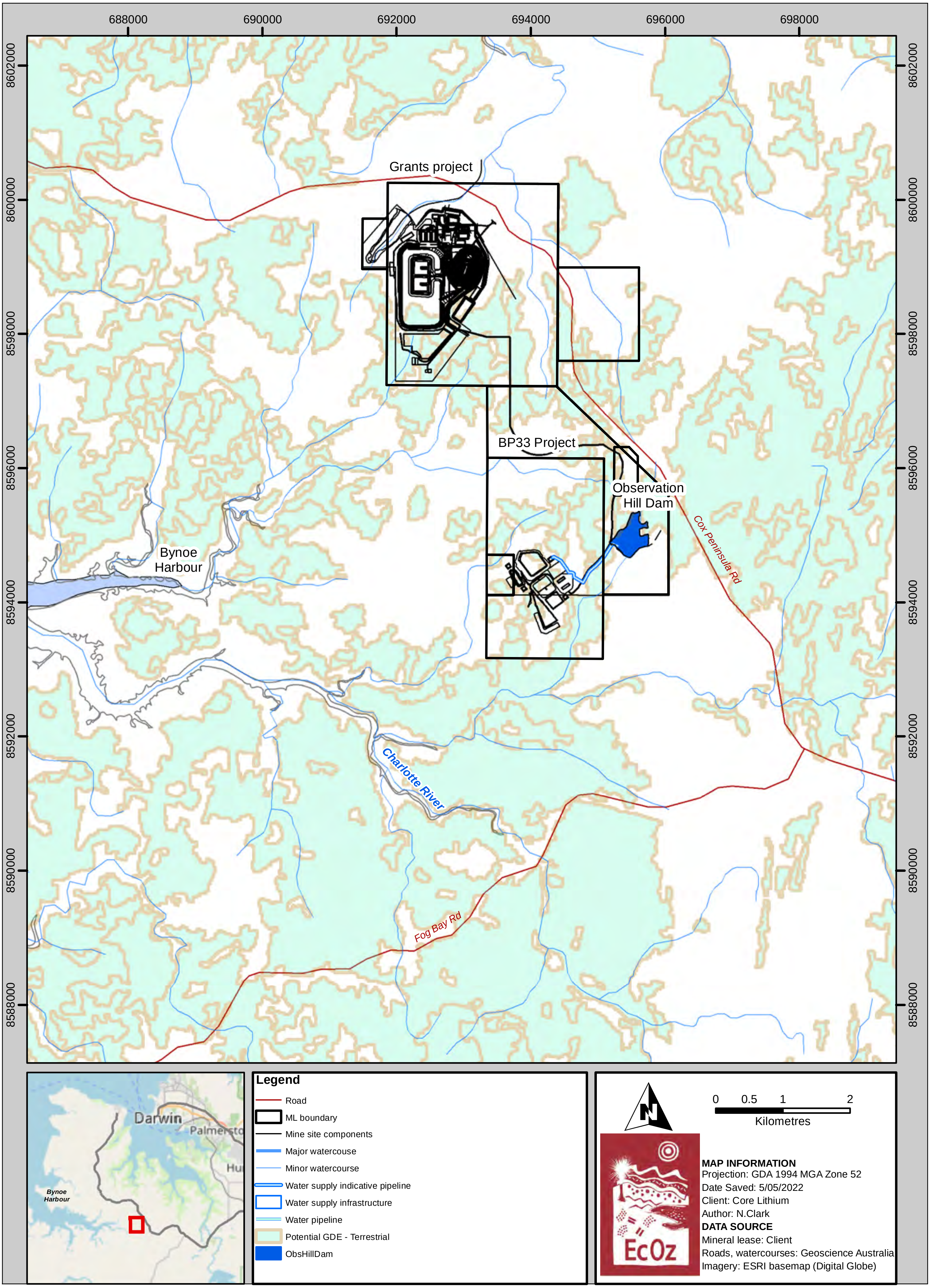
Riparian communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

The plan has been developed by EcOz botanist, Nicole Clark, whom is a suitable qualified professional. The plan includes:

- monitoring parameters, methods and frequency for monitoring downstream attributable to water under the SWEL on riparian vegetation
- a review process to ensure continuous improvement of the monitoring program.

To develop this RVMP, the following steps were undertaken:

- a desktop review of the existing baseline information available
- research of best practise methodologies in riparian monitoring including the monitoring of plant health
- addressing gaps in existing information to design a robust monitoring method.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 1. Map of the project location.mxd

Figure 1. Map of Finniss Lithium Project location

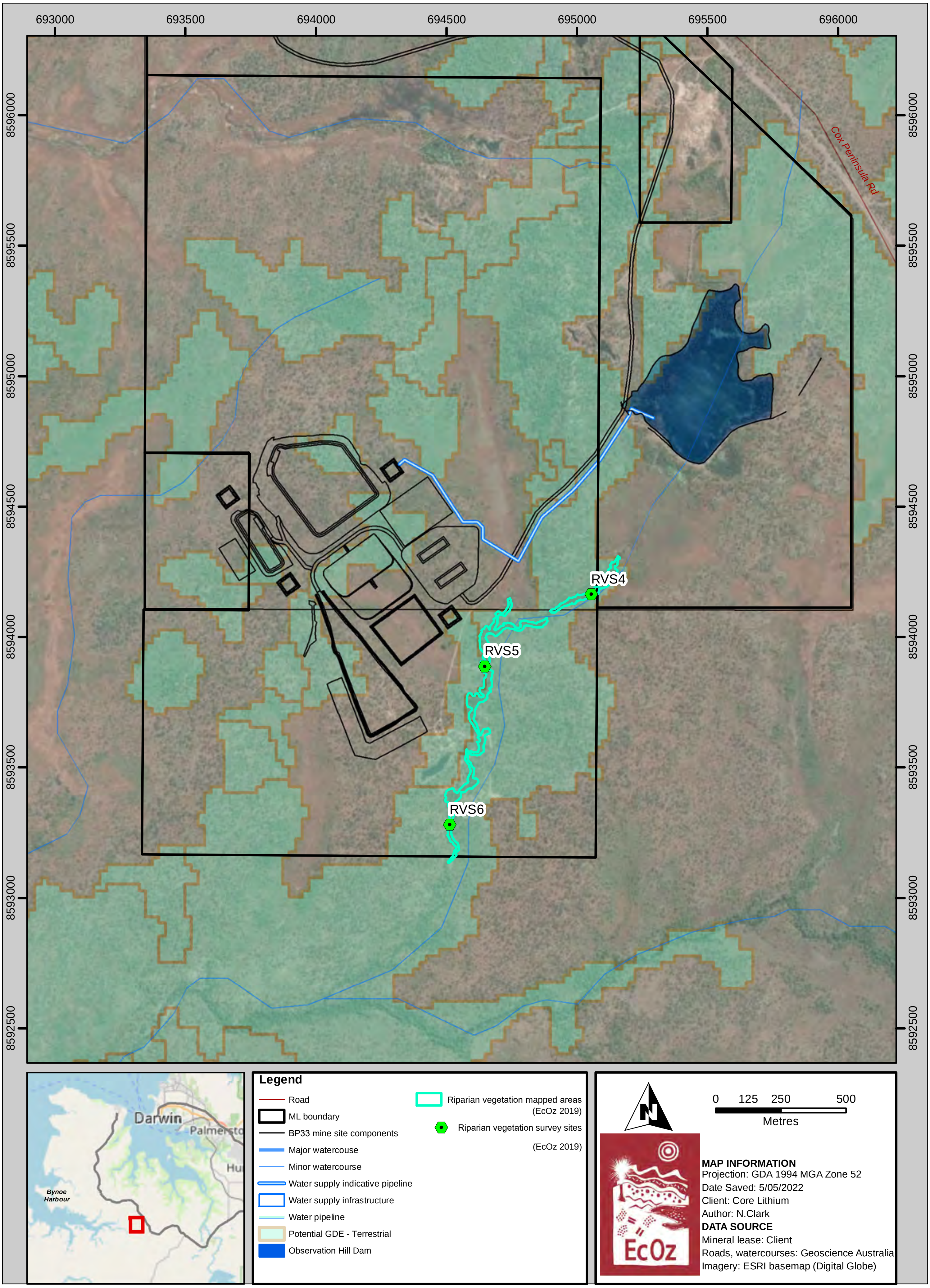
1.1 Summary of baseline surveys

Previous surveys and assessments undertaken for the Grants Environmental Impact Statement (EIS) identified presence of an ephemeral drainage line downstream of OHD which supports closed riparian vegetation identified as a potential Groundwater Dependent Ecosystem (GDEs) (see Figure 2) based on desktop modelling. These riparian vegetation communities downstream of the OHD water supply could be susceptible to impacts associated with changes to surface water flows. The Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019) baseline study (Appendix A) was undertaken to further assess the vegetation prior to mining activities commencing.

The intent of the baseline survey was to produce a vegetation map and record vegetation characteristics and condition of the sensitive vegetation communities downstream of OHD, which is now near the proposed BP33 underground mine.

Two types of baseline surveys were undertaken; an aerial drone survey to look at the overall riparian vegetation health and assist in mapping the riparian vegetation extent, and on-ground field survey to assess vegetation structure and composition within the mapped riparian vegetation extent. See Appendix A for the Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019).

Additional baseline surveys will be undertaken during 2022 to support implementation of this plan. Further details of additional baseline studies are provided in Section 1.1.1.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 2. Map of baseline studies for BP33 project area.mxd

Figure 2. Map of baseline riparian monitoring area and vegetation monitoring sites (EcOz 2019)

1.1.1 Gaps in baseline

Based on the existing information available, a few gaps were identified in the baseline surveys and are proposed to be addressed as outlined below.

- The drone survey was only undertaken post wet-season. It is recommended to undertake additional drone flight for BP33 project area in the dry season to account for seasonality differences.
- The orthomosaic images obtained from drone mapping only used false colour imagery (i.e. green indicating to examine vegetation health). Further remote sensing analysis is required to quantify vegetation health and compare data between 2019 and 2022.
- No upstream of Charlotte's River riparian vegetation site assessments undertaken outside of the modelled groundwater drawdown (CloudGMS 2021) for BP33 project area. A site will be established outside of the modelled 1m contour groundwater drawdown zone of influence (ZOI) to be used as a baseline reference site and assessed prior to significant water extraction from OHD and BP33 mining operations.
- No vegetation site assessment data was collected post-wet season. To account for seasonality differences, it is recommended to undertake biannual vegetation site assessment monitoring post-wet season for the 2022 baseline surveys. This data can be used for future reference if additional monitoring is required in accordance with the trigger action response plan (TARP) (see section 4).
- Though some data was obtained while undertaking vegetation site-based assessments post wet-season 2019, there was a lack of quantitative data collected - ground cover percentage, presence of recruitment, number of alive vs dead plants, erosion scoring etc. These attributes will assist in monitoring the condition of riparian vegetation and data comparison.
- Further investigation is required to determine the extent of the riparian vegetation within the identified ZOI of the BP33 predicted groundwater drawdown modelling. The ZOI has been defined by the one metre groundwater drawdown contour shown Figure 5. It is assumed that drawdown of less than that would only affect water availability for a short period of time in the mid-late dry season when groundwater levels are naturally lowered. The ZOI encompasses a 4.5 km section of stream order one ephemeral watercourse.
- Additional baseline surveys will be conducted biannually during 2022 to address these gaps. A baseline assessment report will be developed to include outcomes of the 2019 monitoring and the 2022 monitoring and the RVMP revised as required.

2 RIPARIAN VEGETATION MONITORING PLAN

Healthy riparian zones are essential for maintaining healthy ecosystems and economic productivity along rivers (Dixon & Douglas 2015). When maintaining a riparian vegetation system, it is vital to retain a diverse vegetation cover to assist in maintaining the functions that a riparian vegetation community provides i.e. supporting aquatic habitats, shading the river and regulating the temperature, bank stabilisation, filtering of sediments and improving water quality of river by reducing contaminants (Dixon & Douglas 2015).

Riparian vegetation are able to access water multiple ways i.e. through the upper un-saturated zone as a result from recent rain events, the groundwater at depth via the capillary fringe above an unconfined aquifer, and through creek water (generally a combination of groundwater and rain water in the wet season, but may be predominantly groundwater in the dry season) (SKM 2012) (see Figure 3). There are particular species that are more likely to be more sensitive to declines in available ground water such as monsoon forest species that grow in areas where there is perennial water supply.

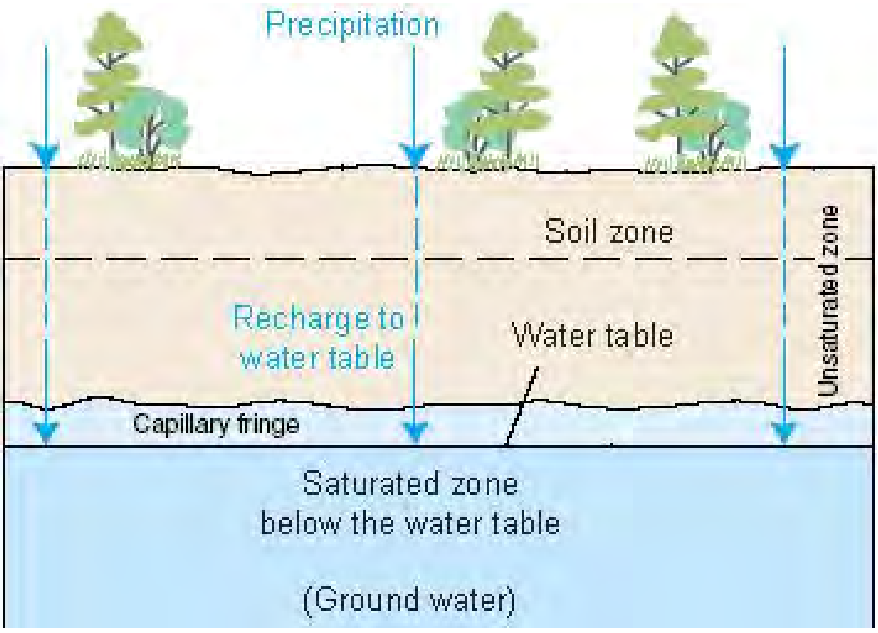


Figure 3. Diagram showing the capillary fringe (SKM 2012)

Riparian vegetation recruitment and germination heavily depends on the level of surface water and ground water regimes as plants depend on predictable patterns in terms of structure and diversity according to water availability in the landscape (Eamus & Lamontagne 2006). Riparian tree recruitment typically occurs after large floods when viable plant material is transported onto point bars and the floodplains of naturally flowing rivers (Eamus, D., & Lamontagne 2006). If dry season flow is modified, or the water table recedes too quickly, new cohorts fail to recruit and the species composition may alter over time (Figure 4). Ultimately the intent of monitoring the riparian vegetation a is to detect changes over time.

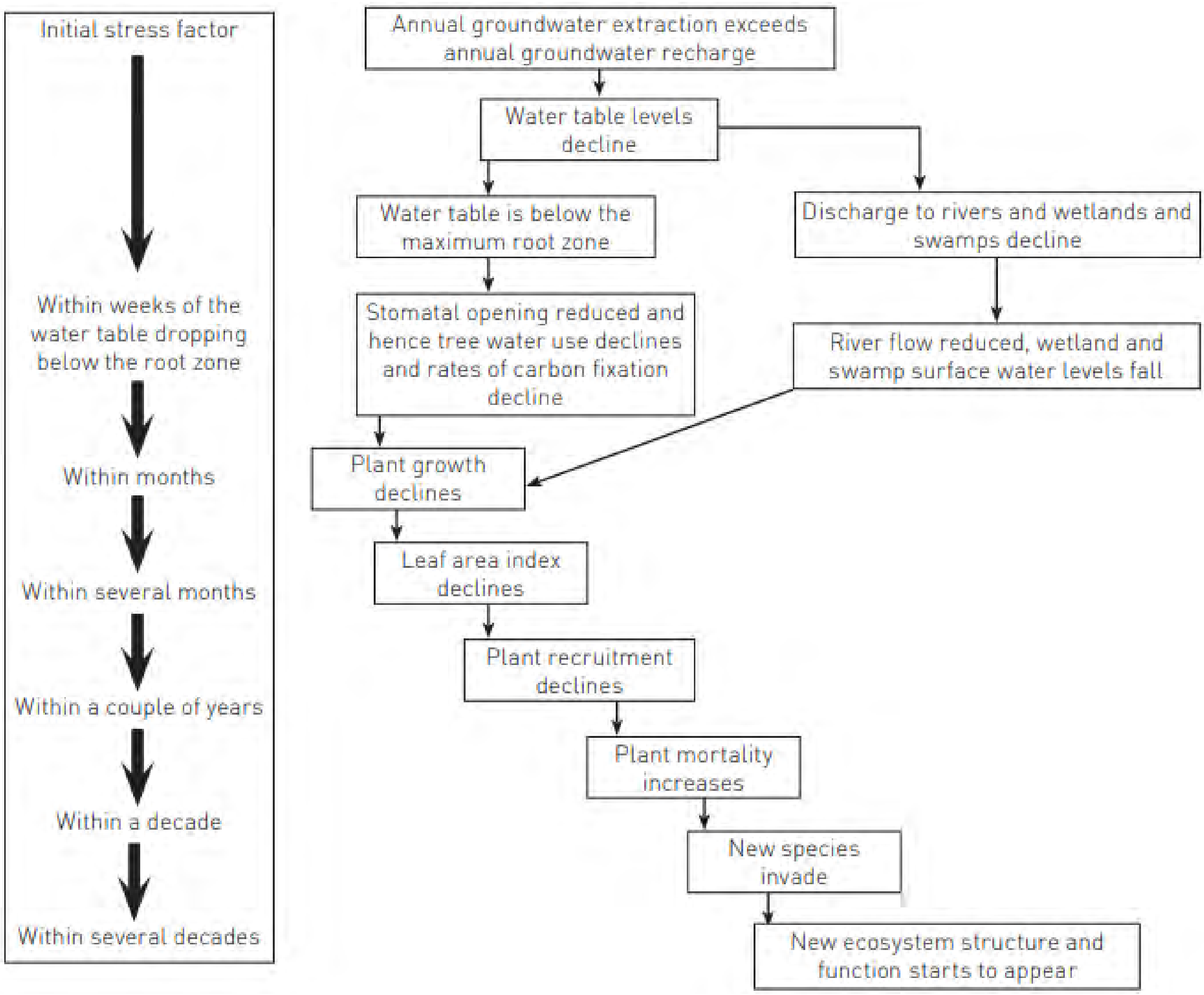


Figure 4. Diagram showing the potential consequences of groundwater drawdown affect (Eamus, D., & Lamontagne 2006)

Some of the information obtained from the baseline studies and the associated gaps identified have been used to develop this RVMP. The monitoring plan outlines objectives and parameters that can be used to assess the riparian vegetation health during the drawdown and reduced surface flows from OHD as part of operations. For each monitoring type, the following headings have been used:

- Objective
- Survey method – these may include ongoing methods previously used in the baseline surveys or additional (new) methods
- Record keeping - maintenance of data for analysis
- Data analysis.

2.1 Best practice and standards

The following best practice and standards for vegetation monitoring been adopted and assisted in developing this RVMP:

- Brocklehurst et al 2007. *Northern Territory Guidelines and field methodology for vegetation survey and mapping*
- Dixon, I., & Douglas, M (2015). *A Field Guide to Assessing Australia's Tropical Riparian Zones*, Tropical Savannas Cooperative Research Centre for Tropical Savannas Management.

- Eamus, D., & Lamontagne (2006). Groundwater use by riparian vegetation in the wet-dry tropics of Northern Australia, Australian Journal of Botany.
- Florabank (1999-2000) Florabank guidelines and codes of practice www.florabank.org.au/ Greening Australia. Revised 2016. Accessed March 15, 2016
- Lloyd, J., & Cook, S (1996). NT Sampling and Processing Manual, Natural Resources Division, *Department of Lands, Planning and Environment*
- International Erosion Control Association (IECA) (2008). *Best Practice Erosion and Sediment Control.* Picton, NSW. Available at: https://www.austieca.com.au/documents/item/57
- Society for Ecological Restoration (SER) (2018). *National Standards for the Practice of Ecological Restoration in Australia*. 2nd edition, Australia.
- Han., Y., Jung, S., & Kwon, O (2017). *How to utilize vegetation survey using drone image and image analysis software*, Journal of Ecology and Environment 41:18.
- Ancin-Murguzur, F., & Munoz, L., Monz C., &. Hausne V. (2019). *Drones as a tool to monitor human impacts and vegetation changes in parks and protected areas,* Remote Sensing in Ecology and Conservation*.*
- Wegmann, M., Leutner, B., & Dech, S. (2017). Remote Sensing and GIS for Ecologists using Open Source Software, *Pelagic publishing*

2.2 Drone survey

2.2.1 Objective

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey is to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover.

2.2.1 Methodology

- Create new drone flight path based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI. The new flight path will be an extension of the existing baseline survey (EcOz 2019) to capture the riparian vegetation extent downstream of OHD to the 1m contour groundwater drawdown ZOI (see Figure 5 for indicative drone survey boundary). The indicative flight path will be field verified during 2022 baseline surveys prior to establishing a set flight path.
- Previously Drone Deploy (Software program) was used to design the flight path, however WebODM will be used for this monitoring. WebODM was selected as it contains the correct platform selected for to measure plant health.
- Drone will be flown in the middle of the day to avoid sun light interference i.e. shading. Observations will also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- When importing drone data to create the orthomasoaic, the same methods as per methods in baseline report outlined in section 3 (Appendix A) will be applied, except using WebODM.
- The boundary of the riparian vegetation will then be delineated using the orthomosaic imagery and remote sensing techniques.
- Drone data analysis will be undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.

- These values will be categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, will then be calculated.
- Investigate other environmental factors that may affect results i.e. amount of rainfall between October – April compared to rainfall amounts based on baseline studies to discern environmental factors.

Frequency

- The drone survey will occur biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring during 2022, then the monitoring will be reduced to annual (in the late dry season only).

2.2.2 Record keeping

- Vegetation monitoring database comprised of:
    - The riparian vegetation area size (ha) based on drone mapping for each drone survey.
    - VARI calculations for each survey conducted including varying colour bands and associated class intervals, the area (ha) that occurs within the class intervals and a percentage (%) of pixels that lie within these class intervals.
    - Additional observations that may need to be recorded if further on-ground investigation is require.
- Spatial data
    - All drone images captured during the drone surveys organised in folders.
    - A zip-file of all tiff files derived from drone surveys (both orthomosaic and plant health image).

2.2.3 Data analysis

Before After/Control Impact (BACI) approach will be applied by performing statistical analysis (VARI) to test whether there is a significant difference between the baseline health data and the riparian vegetation health based on ongoing drone survey assessments.

2.3 Riparian vegetation site assessments

2.3.1 Objective

Monitoring and evaluating riparian vegetation diversity and composition at established vegetation sites within ZOI, and an additional site established outside of the ZOI (reference site) to detect changes in riparian vegetation according to diagram presented in Figure 4 (Eamus, D., & Lamontagne 2006).

2.3.2 Methodology

Site selection

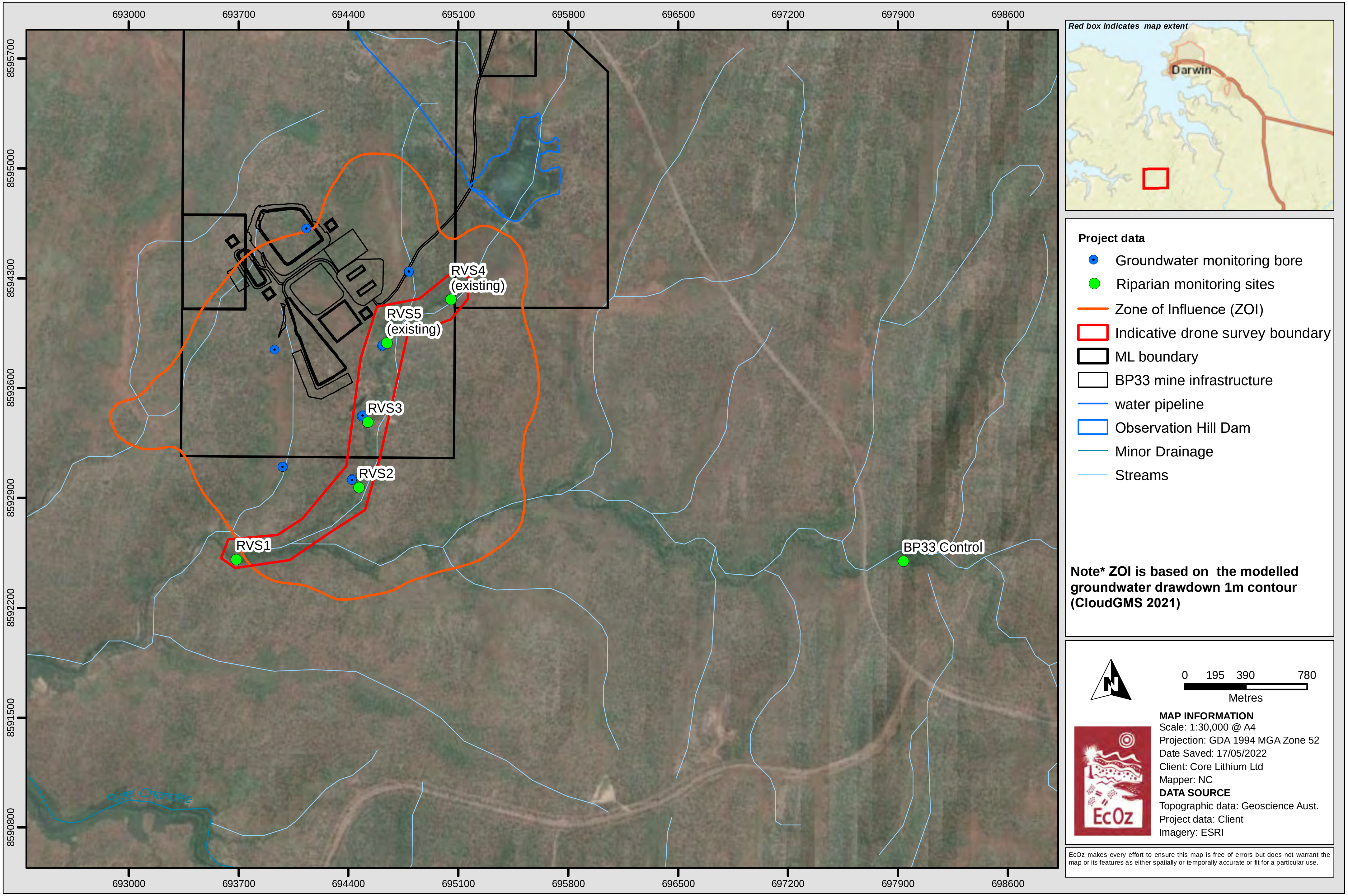
- Two existing sites RVS4 and RVS5 will continue to be monitored using the updated monitoring method within this RVMP. Site RVS4 has been kept in the monitoring plan to detect immediate

impacts from reduced SW flows downstream OHD. Existing site RVS5 has been retained as it is nearby a groundwater monitoring bore.

- Three new monitoring sites (RVS1, RVS2 and RVS3) will be established downstream of OHD within the ZOI (Figure 5). The location of these sites are suitable for monitoring as they lie within the potential GDE areas, align near existing bores for groundwater level monitoring (RVS3 and RVS2) and spatially correspond to immediate groundwater drawdown impacts (RVS3 located closest to the underground) and longer term potential impacts (RVS1 located near the 1m contour) (Figure 5).
- One new reference site upstream of Charlottes Creek (BP33 Control), in a similar riparian zone within the potential GDE area will be established with baseline monitoring commencing post-wet season 2022 (Figure 5). This site is outside of the predicted ZOI. The site was selected using various resources including up to date aerial imagery, mine components, and Land Units of the Greater Darwin Region (Fogarty et al. 1984).
- Sampling site locations for other BP33 project studies, such surface water, groundwater and biota monitoring have also been considered when selecting the new riparian vegetation monitoring sites. The precise locations will be verified in field during the 2022 post wet season survey.

Frequency

- Monitoring is to occur at all sites biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring, then monitoring will be reduced to annual (in the late dry season only).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 6. Map of all baseline monitoring sitesv2.mxd

Figure 5. Map of proposed riparian vegetation monitoring sites, indicative drone imagery boundary and modelled groundwater drawdown 1m contour

Vegetation monitoring

Vegetation site assessment monitoring methods have been adopted utilising the potential consequences of the groundwater drawdown affect as presented in the diagram outlined Figure 4. As indicated, the effect may take several years before physical changes become apparent. Monitoring methods are outlined below:

- A plot size of 20 x 20m will be established at each new riparian monitoring site, using star pickets. Existing plots RVS4 and RVS5 will be re-monitored at established plots (existing star pickets present).
- In each plot the dominant layer/emergent layer species will be recorded; this includes all seedlings (woody plants under 1m in height), saplings (woody plants between 1m and 3m high and < 2cm diameter at breast height, or DBH) and trees (woody plants with stems ≥ 2cm DBH and greater than 3m high) will be identified (both native plants and invasive plants included). For each individual the height will be estimated and the % cover will be measured. All individual woody plants within the plot will also be marked alive or dead, whether the plant is fruiting/flowering. Note, deciduous trees will not be recorded as dead during the dry-season monitoring.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) will be tagged on hand held GPS for future ongoing measurements. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* (observed at RVS4, RVS5).
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) will be recorded. The results from this method will be used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation will be recorded to a standard that is equivalent to Level 5 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity will be monitored by traversing along a 100m transect from the middle monitoring site and visually estimate the canopy cover (or by using a densitometer) of the native vegetation to indicate how continuous the canopy cover is along the transect. Note, a break in the continuity must be at least 5 m between tree crowns and span the entire width of the transect (Figure 6). If one tree is missing within a wide riparian zone it will not be counted as a break in the canopy continuity because the break must span the entire width of the riparian zone.

Table 2-1 summarises monitoring methods and how they will be used to measure the potential consequences of the reduction in surface flows and/or groundwater drawdown.

Table 2-1. Summary of monitoring methods that will be used to measure potential impacts of the reduction of surface water flows and groundwater drawdown

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree tagging	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 5 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

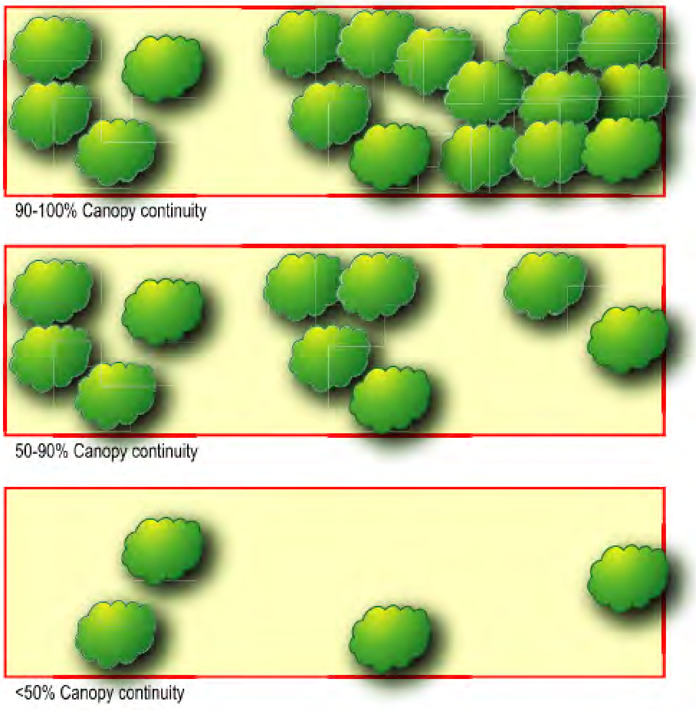


Figure 6. An example pictorial used for measuring canopy continuity (Dixon & Douglas 2015).

Photo point monitoring

- Four cardinal photo monitoring points (north, east, south, west) will be obtained within each plot.

2.3.3 Record keeping

- Vegetation monitoring database – comprised of seedling, sapling, and tree data for individual species and associated heights, DBH's and records of vegetation health e.g. % dead or sick plants.
- Ground cover data - percent cover and species richness.
- Photo monitoring point database.

2.3.4 Data analysis

The data collected based on monitoring methods outlined Table 2-1 will be statistically analysed using the Before After/Control Impact (BACI) approach. BACI will be applied by performing statistical analysis to test whether there is a significant difference between the baseline health data and riparian vegetation assessment data at the same sites, and riparian vegetation assessment data compared to reference site data.

Data captured for analysis includes:

- Species composition (%) using individual dominant/emergent plant data.
- Average heights of individual plants across riparian vegetation sites compared to reference site.
- Canopy cover (%) for each dominant, and emergent species across riparian vegetation assessment sites compared to reference site data.
- Plants alive or dead (%) across all riparian vegetation sites compared to reference site data.
- The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site.
- The ground cover percentages (vegetation type, soil, rock, litter).
- Type of ground cover percentages in the form of herbs/vines/grasses/ferns and sedges).

2.4 General observations

2.4.1 Objective

Monitoring of other environmental factors is critical as they are contributing factors that can severely impact the health of riparian vegetation. Objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is discussed below.

2.4.2 Other environmental factors

Weeds

Weed data collection will be conducted in accordance with the Northern Territory Weed Management Branch (WMB 2015), Northern Territory Weed Data Collection Manual.

The percentage cover of weed species (declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat will be visually estimated for each weed species.

A GPS will be used to record locations of identified weed species, and will record the following information:

- Weed name
- Distribution - size (20, 50 or 100m diameter)
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1-5, 1 (absent) to 5 (>50%)
- Growth stage (seedling, juvenile, adult)

- Seeded (has the weed seeded?)
- Treatment (has the weed been treated and if so with what method of treatment)
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data will also be recorded outside of the plots to obtain surrounding data while traversing along the riparian area to visit each monitoring site.

Fire - broad scale and site based monitoring

Broadscale

Fire scar mapping and scoring will be determined by drone survey and mapped with NAFI each year to investigate frequencies and severity across the mapped riparian area.

At each plot an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and for recently burnt sites the severity will be scored from 1 to 4. Categories for characterisation of fire are:

- No evidence of fire
- Evidence of groundcover fire only
- Evidence of burnt saplings
- Evidence of fire in canopy layer.

Erosion - broad scale and site based monitoring

Broadscale

- Monitoring the presence of erosion (on a broader scale basis) may be more effective using remote sensing with the use of the drone imagery captured as per section 2.2. Monitoring erosion using monitoring plots can often mean that issue areas can be missed.
- It is recommended to flag any potential erosion issues identification with aerial imagery and follow-up with on-ground monitoring so that erosion risks are to be measured and remedial actions implemented.

Site (plot) based

At each plot note the presence or absence of erosion will be recorded, and if present the following characteristics will be recorded:

- Types of erosion i.e. gullying, sheet erosion etc
- The amount of bare ground above
- Tree root exposure – any roots exposed due to disturbance
- Slumping
- Fallen trees/woody debris
- Presence of surrounding erosion
- Width of riparian zone – measure or estimate the width of the riparian zone (facing downstream) for both sides of banks.

Aquatic life

Presence of aquatic life within the water will also be recorded. This will involve a record of aquatic fauna and flora at the nearest water access point from each of the vegetation monitoring plots.

Surface water flows

Presence of water flows at the time of surveying will be documented. Surface water flows will be assessed in accordance with the surface water flows monitoring plan (WRM 2022).

Sedimentation

Presence of sedimentation within the water and on the riparian vegetation.

Contamination

- Presence of potential contamination (foam/scum/oils) and odour will be documented.

Climatic conditions

Weather observation will be documented during the monitoring. The annual rainfall, evaporation and temperature will be recorded from the same station and discussed for survey data comparison.

The following monitoring will be undertaken in accordance with the Grants and BP33 water management plans:

- surface and groundwater quality
- sediment monitoring
- macroinvertebrate monitoring
- groundwater levels will be assessed in accordance with the GDE Management plan (Groundwater Enterprises and RDM Hydro 2022).

2.4.3 Record keeping

All observations and data captured will be uploaded after each monitoring event, mapped as required and all records maintained in excel database.

3 MONITORING SCHEDULE

Table 3-1 outlines the RVMP schedule, prior to any significant disturbance and for the duration of the OHD SWEL, BP33 life of mine and three years post operations when the groundwater levels are predicted to return to pre-mining conditions (CloudGMS 2021).

Table 3-1. Riparian vegetation monitoring schedule

Monitoring	When	Monitoring undertaken	Frequency of monitoring	Locations
Baseline drone survey	End of Wet season (May) and end of dry season (October) 2022	Drone flight path to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Baseline riparian vegetation site assessment survey	End of Wet season (May) and end of dry season (October) 2022	Site assessment at all identified locations to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Drone survey	End of dry season (October) 2023 onwards	Drone flight	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Riparian vegetation site assessment survey	End of dry season (October) 2023 onwards	Site assessments	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control

4 PERFORMANCE INDICATORS AND TRIGGERS

A trigger action response plan (TARP) has been detailed in Table 4-1 below. The TARP incorporates triggers and responses from the surface water monitoring program (WRM 2022) and GDE Management Plan quantitative triggers and limits and/or adaptive management actions.

Table 4-1. Trigger action response plan

Level	Trigger	Monitoring Performance Indicator	Action	Response
Level 1 (normal)	No reduction in riparian vegetation extent and/or structure/ composition compared to baseline	Drone: • vegetation biomass using VARI analysis comparable to baseline mapping. Riparian vegetation site assessment: • No change in in general vegetation health compared to reference sites i.e. no tree mortality or physical changes to health of plants through the use of on-ground assessment and photo monitoring points	• No action required	• No response required
Level 2 (early warning)	10% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 10% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 10% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 10% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 10% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 90% of the dominant species present within each strata)	• Continue to monitor in accordance with RVMP • Investigate other potentially contributing environmental factors and likely reason for reduction in riparian vegetation extent. • Conduct drone monitoring in GDE reference site • Implement action in surface water flows monitoring program (WRM 2022) TARP Level 2. • Investigate management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022).	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 2. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		• Tree canopy continuity – there is no greater than 10% reduction in tree canopy cover (%) along transect compared to the representative reference sites		
Level 3a (elevated risk)	25% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 25% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 25% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 25% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 25% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 75% of the dominant species present within each strata) • Tree canopy continuity – there is no greater than 25% reduction in tree canopy cover (%) along transect compared to the representative reference sites	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Further investigate extent of riparian vegetation reduction within ZOI, including assessment of the drainage line flowing east to west within the ZOI. • Conduct biannual riparian vegetation site assessment (end of wet season and end of dry season) and compare seasonal variability to 2022 baseline data.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Report on the outcomes of the investigation of riparian vegetation health within ZOI to regulator. • Report on the outcomes of the seasonal variability (additional monitoring at end of wet season and dry season) to regulator. • Report on outcomes of the investigation of management actions as outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) to the regulator.
Level 3b (imminent Risk)	50% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 50% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 50% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 50% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Further investigate extent of riparian vegetation reduction outside 1m contour groundwater drawdown ZOI. • Revise BP33 mine closure plan (MCP) and rehabilitation management plan (RMP) to	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		representative reference sites • Tree mortality – there is no greater than 50% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 50% of the dominant species present within each strata) • Tree canopy continuity – there is no greater than 50% reduction in tree canopy cover (%) along transect compared to the representative reference sites	include reinstatement of habitat values in the affected riparian areas and monitoring of ecosystem recovery and submit to Controller or Water Resources and NT EPA CEO for approval.	
Level 4 (exceedance of approved limits)	Loss of >3.6 ha of identified GDE vegetation extent and/or structure/ composition	Drone: • There is no greater than a 100% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 100% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 100% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 100% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 does not align with the representative reference site descriptions (i.e. indicating new ecosystem structures and functions have appeared) • Tree canopy continuity – there is no greater than 100% reduction in tree canopy cover (%) along transect compared to the representative reference sites	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 4. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Implement approved RMP. • Notify NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 4. • Report on the outcomes of the actions undertaken to the regulator.

6 REVIEW PROCESS AND MANAGEMENT

A review process will be undertaken annually based on the biannual riparian vegetation monitoring to ensure continuous improvement of the monitoring program and in accordance with condition 4.1 of the SWEL (8151018) be implemented immediately following the DEPWS Water Resources Controller's approval. Data management and reporting is key to inform the review process.

The management during riparian monitoring is related to the management of water availability for the riparian vegetation/GDE's. Refer to management outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) and the Surface Water Management Plan (WRM 2022).

7 REPORTING

A monitoring reporting will be developed as per condition 4.2 of the SWEL (8151018) and include *data collected in accordance with the monitoring program under condition 4.1 for the previous water accounting year (1 May to 30 April)* and *discuss the measured and modelled impacts of water taken from SWEL (8151018) on the downstream riparian vegetation.*

In accordance with the NT EPA (2022), LDGNT will *notify the NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.*

The plan will be submitted to the:

- NT Department of Environment, Parks and Water Security (DEPWS) Controller of Water Resources Division as a Condition 4-1 of the SWEL (8151018)
- Chief Executive Officer (CEO) of the DEPWS for review and approval at least 3 months before substantial disturbance at BP33, as per condition 6-2 of the NT EPA BP33 Draft Environmental Approval (NT EPA 2022) as part of the GDE Management Plan.
- NT Department of Industry, Tourism and Trade (DITT) as appendices to BP33 Mine Management Plan (MMP).

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APPENDIX A RIPARIAN VEGETATION ASSESSMENT REPORT

Mangrove and Riparian Vegetation Assessment Grants Lithium Project

Core Lithium

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1 INTRODUCTION

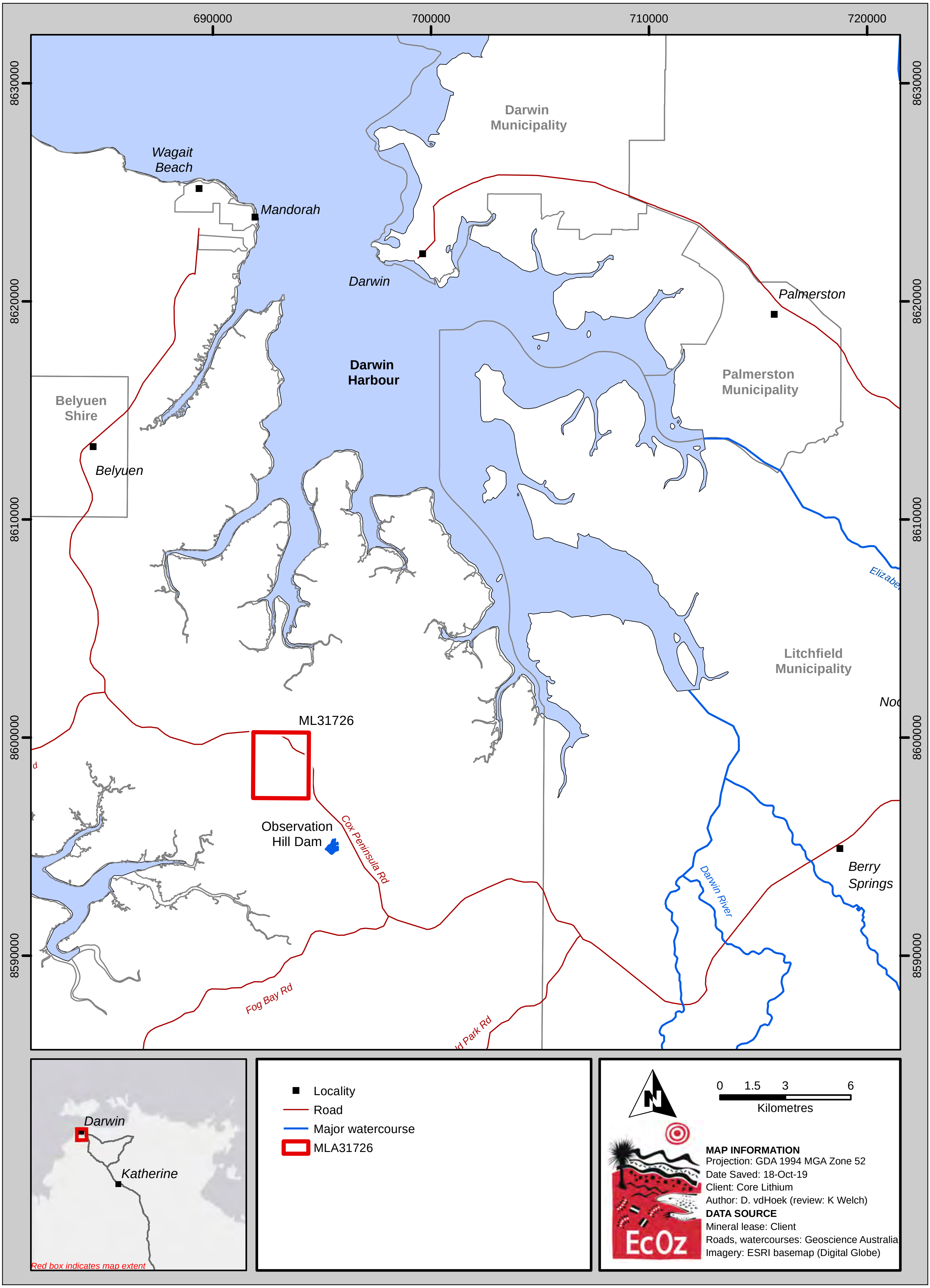
Core Lithium Ltd proposes to develop the Grants Lithium mine on the Cox Peninsula, approximately 90 km by road from Darwin CBD, or 25 km south as the crow flies, Northern Territory (Figure 1). The project area is located south of the Cox Peninsula Road, approximately 36 km west of the township of Berry Springs.

The proposal was assessed under the *Environmental Assessment Act* at the level of an Environmental Impact Statement (EIS). Surveys and assessments undertaken for the EIS process identified riparian mangrove communities downstream of the mine site and closed riparian vegetation communities downstream of the Observation Hill Dam (OHD) water supply that could be susceptible to impacts associated with changes to surface water flows. Both riparian and mangrove communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

To allow for future monitoring of impacts associated with mining activities on Core Lithium mineral leases, EcOz Environmental Consultants (EcOz) was engaged to map mangrove and riparian community boundaries and collect baseline information about community structure and condition prior to development. This report presents the survey methods and findings, including:

- Site selection.
- Methodology used to undertake drone aerial surveys and field surveys.
- Drone captured orthomosaic images (5cm/pixel) of the selected study sites
- Vegetation mapping at 1:500 scale of riparian vegetation boundaries
- Vegetation community descriptions for each mapped vegetation type

The baseline information documented in this report will allow future comparative assessments to detect any major changes in vegetation structure and composition because of project activities.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 1. Map of the project location.mxd

Figure 1. Map of the project location

2 SITE SELECTION

The objective of the baseline assessment was to record vegetation characteristics and condition of the sensitive vegetation communities downstream of the project area. The survey areas were determined with reference to the following spatial datasets:

- Proposed mine site components footprint (Core 2019)
- Digitalglobe aerial imagery (ArcGIS 10.6.1)
- Ground Water Dependant Ecosystem Atlas Dataset (BOM-GDE 2019)
- Land units of the Greater Darwin Area (Fogarty et al. 1984).

Assessment of the above datasets identified two riparian sites downstream of the project area. Mangrove communities associated with the West Arm of Darwin Harbour occur downstream of the proposed mine site. A closed riparian vegetation community occurs downstream of the OHD water supply, which based on community structure, is a potential Groundwater Dependent Ecosystem (GDE). The locations of the two selected study areas are shown in Figure 2.

2.1 Mangrove Ecosystem

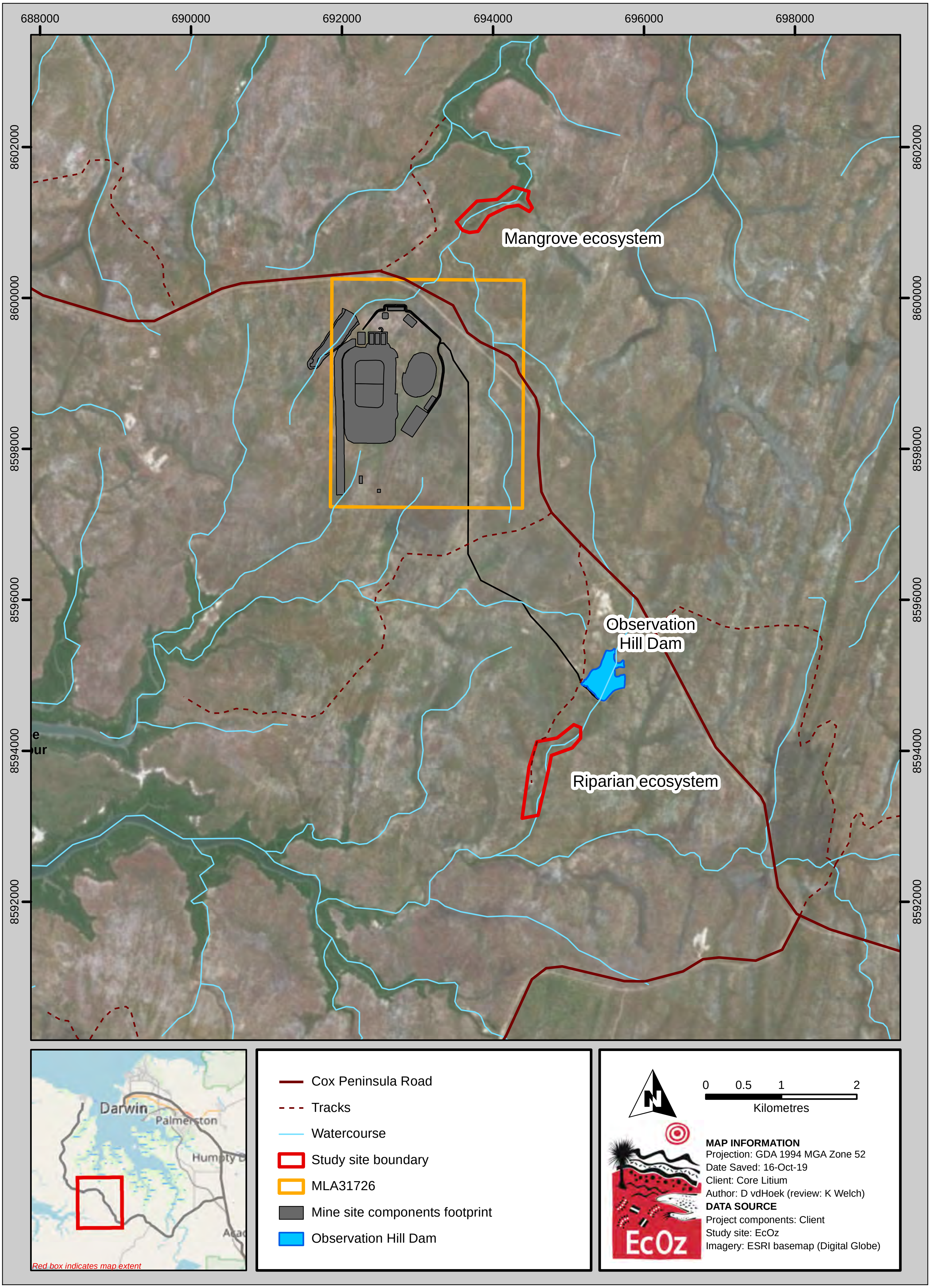
The proposed mine site and dam are located within the catchment of an ephemeral creek that flows into the West Arm of Darwin Harbour approximately 2.6 km to the north. Approximately 1.4 km north-east of the Mineral Lease (ML) boundary, the riparian zone of the creek supports mangrove vegetation. A baseline mangrove study site was established at this location.

Three vegetation survey plots were located within the mangrove study site, representing riparian, swamp and mangrove communities. The study site is located on two land units. The riparian and swamp survey sites are located within land unit 6b – Drainage System, and the mangrove survey site is in land unit 9b – Estuarine Fringes (Fogarty et al. 1984), see Figure 3.

2.2 Riparian Ground Water Dependant Ecosystem

The ephemeral drainage line downstream of OHD supports closed riparian vegetation identified as a potential GDE. The creek flows into the Charlotte River approximately 3 km downstream of the OHD wall, and discharges into Bynoe Harbour. The OHD is an artificial aquatic system that provides year round freshwater seepage into the downstream riparian system. Impacts to either the drainage system or the OHD can potentially result in impacts to downstream riparian vegetation communities.

One vegetation survey plot was located on the receiving channel of each surface water inflow to the riparian vegetation community allow future assessments to determine the potential upstream source of impact. A third survey plot was located downstream of both potential upstream inputs. The riparian study site is situated on land unit 5b1 – Drainage System. A neighbouring land unit 5a – Alluvial Plains is the source of surface water inflows into the study area (Fogarty et al. 1984), see Figure 4.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 2. The location of the riparian study sites.mxd

Figure 2. The location of riparian study sites in relation to the project infrastructure

3 METHODS

Assessment of the riparian vegetation was undertaken in two stages. Stage 1 involved an aerial drone survey to record an up to date orthomosaic photo of riparian vegetation boundaries. Stage 2 involved a ground field survey to assess vegetation structure and composition. A riparian vegetation map was created with reference to the drone orthomosaic image and mapped vegetation types were described with reference to the field vegetation assessments. The methods used for survey and mapping of the study sites are outlined in the sections below.

3.1 Drone survey

A drone survey was undertaken on the 13th of March, towards the end of the annual wet season. The timing of the survey was selected to record maximum vegetation growth within the survey area. Surveys were flown at both the Mangrove and Ri[arian Ground Water Dependant Ecosystem study sites. The drone survey was conducted by EcOz Chief Remote Pilot, David van den Hoek, according to the EcOz Remotely Piloted Aircraft Operations Manual. A DJI Phantom 4pro drone was used to capture images at a height of 75m (75% front overlap and 65% side overlap) using the DroneDeploy app. Images were then uploaded to the DroneDeploy website for processing and orthomosaic images were exported. Two 5cm pixel images were exported for each survey site, a colour orthomosaic and a plant health image, displayed in red, green and blue.

3.2 Vegetation mapping

Vegetation boundaries were delineated at a scale of 1:500 using the 5cm pixel orthomosaic aerial images captured during the drone survey. Individual trees, vegetation cover and soil colour was identified from the imagery to inform the mapping of vegetation boundaries. The following riparian vegetation types were mapped within each of the study sites:

Mangrove Ecosystem (downstream of mine site)

- Mangrove
- Riparian
- Swamp

Groundwater Dependant Ecosystem (downstream of OHD)

- Riparian

3.3 Field survey

Vegetation survey plots were located within each of the mapped riparian vegetation types. A baseline vegetation assessment was undertaken on the 5th of June 2019 by EcOz staff trained in botanical survey, Stephen Reynolds and Nicole Clark. Vegetation community assessments were undertaken based on the *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst et al. 2007).

Six vegetation survey plots, three in each study site, were surveyed to characterise vegetation types to a standard equivalent to NVIS Level V. Assessments were undertaken with a 20 m x 20 m quadrat and for each stratum (upper, mid and ground), three dominant species were recorded (but an attempt was made to record all species), cover was estimated and height values measured. Photographs were taken at the four cardinal directions for each site and NT declared weeds were recorded if present.

4 RESULTS

Vegetation maps were created to record the baseline boundary locations of riparian vegetation types situated within the study sites. The resulting maps and associated information is presented in the sections below.

4.1 Mangrove Ecosystem

The mangrove ecosystem study site records the ecotone between a freshwater creek and side swamp and a marine influenced mangrove community. The site is approximately 950 m long and 250 m wide, with an area of 23.2 ha. The boundaries of three riparian vegetation communities were delineated within the study site. Vegetation type descriptions and unit areas are provided below in Table 1. The vegetation map is presented in Figure 5. A table showing the results of field data collected at each survey site is present in Appendix A.

Incidental observations recorded during the survey noted that mangrove vegetation communities were generally in good condition. No major weed populations or fire impacts were observed within the mangrove and riparian communities. However, recent impacts were recorded within the landward swamp community where evidence of an off-road race track were observed. A number of weeds were also recorded within the swamp community, including Hyptis (*Hyptis suaveolens*), declared Class B – Spread to be controlled, under the Northern Territory *Weed Management Act* and environmental weeds including Annual mission grass (*Cenchrus pedicellatus*), Calopo (*Calopogonium mucunoides*) and Stinking passionfruit (*Passiflora foetida*).

Table 1. Mangrove Ecosystem - Riparian vegetation descriptions and unit areas

Vegetation Type	Vegetation Description	Survey site	Area (ha)
Mangrove	*Lumnitzera racemosa, Bruguiera exaristata, Avicennia marina* low open forest, over *Fimbristylis* sp. and *Xerochloa imberbis* mid sparse tussock grassland	MVS1	5.18
Riparian	*Melaleuca viridiflora* mid woodland over *Acacia plectocarpa* mid open shrubland over *Germainia grandiflora* mid tussock grassland	RVS2	0.76
Swamp	*Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa* mid woodland over *Lophostemon lactifluus* mid open shrubland over *Sorghum intrans* mid tussock grassland	SVS3	1.5

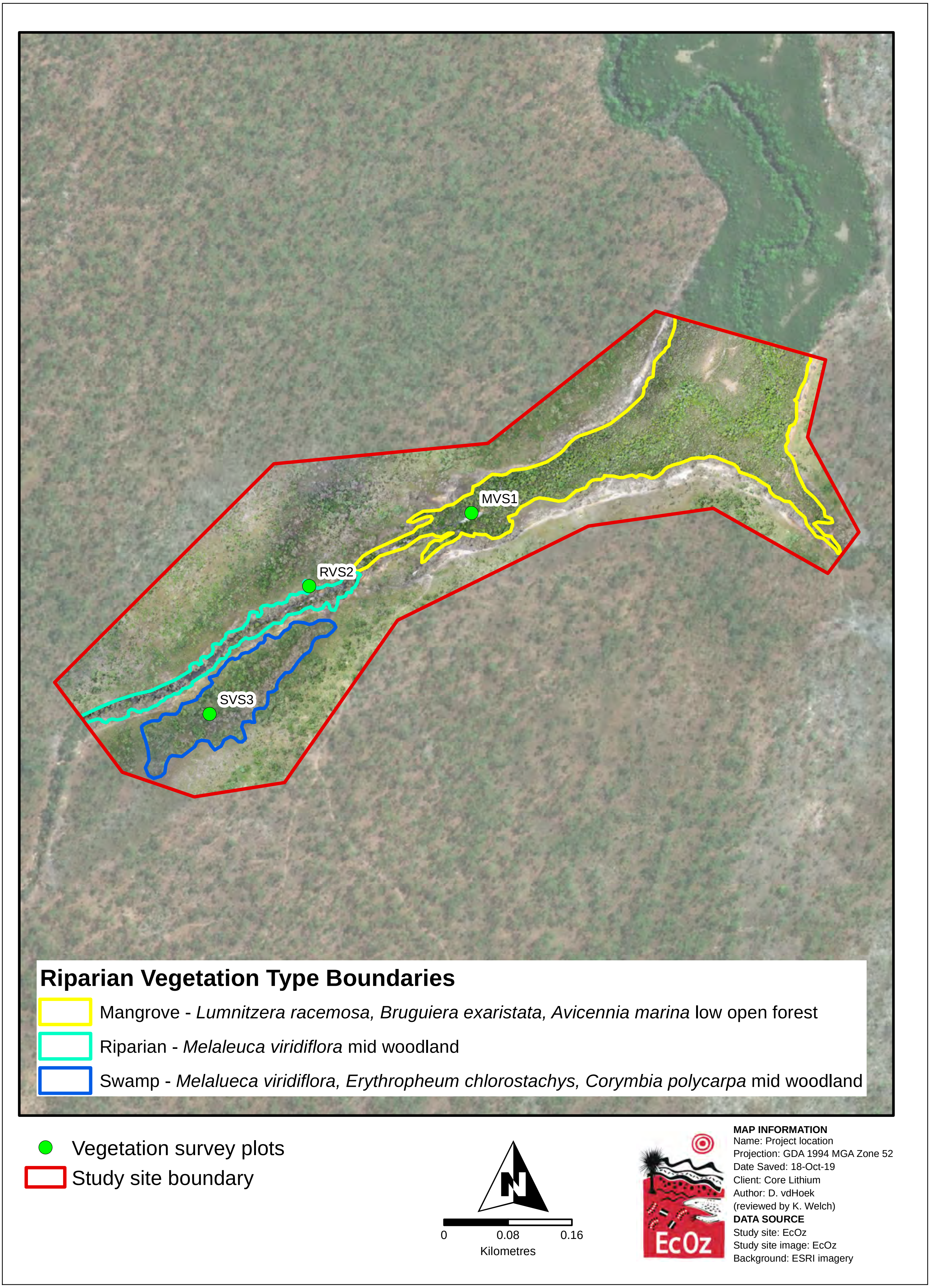
4.2 Riparian Groundwater Dependant Ecosystem

The riparian GDE study site is approximately 1.45 km long and 250 m wide, with an area of 33 ha. The boundary of one riparian vegetation community type was delineated within the study site. Vegetation type descriptions and unit areas are provided below in Table 2. A vegetation map is presented in Figure 6. A table showing the results of field data collected at each survey site is presented in Appendix A.

At the time of survey, riparian vegetation was observed to be in good condition. No major weed populations or fire impacts were recorded.

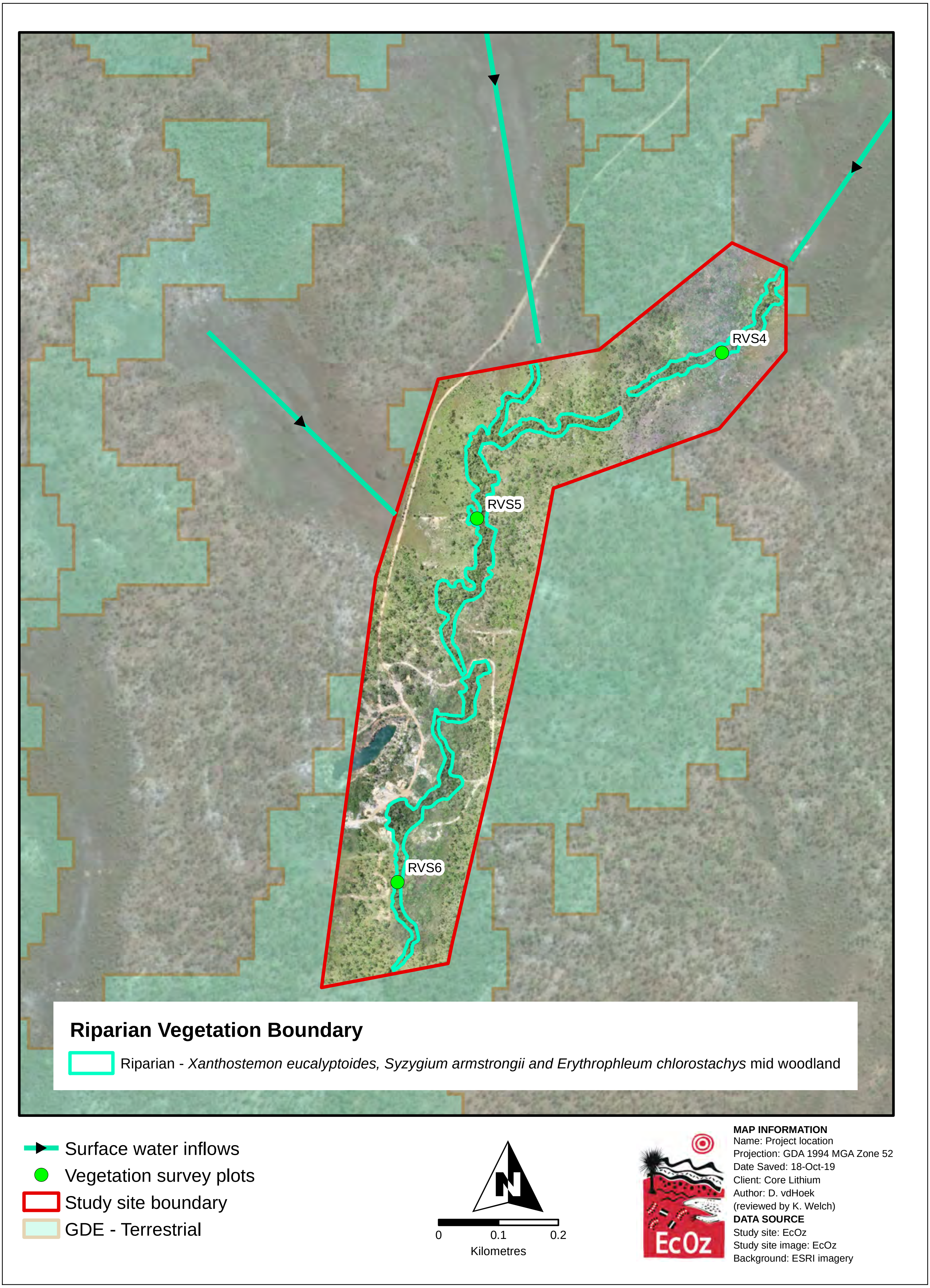
Table 2. Groundwater Dependant Ecosystem – Riparian vegetation descriptions and unit areas

Vegetation Type	Vegetation Description	Survey sites	Area (ha)
Riparian	*Xanthostemon eucalyptoides, Syzygium armstrongii* and *Erythrophleum chlorostachys* mid woodland over *Pandanus spiralis, Helicia australasica* and *Carallia brachiata* mid shrubland over *Eriachne triseta* mid tussock grassland	RVS4, RVS5, RVS6	3.62



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 3. Mangrove ecosystem vegetation boundaries.mxd

Figure 3. Mangrove ecosystem vegetation boundaries



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 4. GDE vegetation boundaries.mxd

Figure 4. Groundwater dependant ecosystem vegetation boundaries

5 CONCLUSION AND RECOMMENDATIONS

The assessment of vegetation boundaries presented within this report provides a baseline spatial dataset from which to monitor changes in riparian vegetation boundaries within the study sites. The baseline assessment indicates that vegetation communities within the study sites are in good condition, with limited pre-development disturbance. This is with the exception of the swamp community, which occurs downstream of the mine site in the West Arm catchment. Weeds and impacts from off-road racing tracks were observed within this vegetation community.

Future monitoring should repeat drone and vegetation surveys at the same time of the year that baseline surveys were conducted. This will allow for the capture of vegetation data in a similar seasonal state and enable more accurate analysis and interpretation of results.

When analysing the results of future drone survey against the baseline dataset, any significant retraction in riparian vegetation patch boundaries should trigger further assessment to determine the extent and potential cause of impact i.e. is the change confined to the impacted watercourse or occurring more broadly. This may require re-survey of vegetation plots to determine if there has been a change in vegetation structure and composition in response to vegetation boundary impacts.

Changes in vegetation structure and composition along the landward edge may indicate changes in surface and or groundwater flows entering those communities. However, further contextual assessment will be required as these changes could also occur because of bushfire and weed invasion unrelated to the project activities

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APPENDIX A FIELD VEGETATION PLOT DESCRIPTIONS

Site MVS1 – *Lumnitzera racemosa, Bruguiera exaristata, Avicennia marina* low open forest over *Fimbristylis* sp. and *Xerochloa imberbis* mid sparse tussock grassland
NVIS Code: T6c
Location (GDSA94, z52): 694035E, 8601220N
Upper 1: Mid open forest dominated by *Lumnitzera racemose* and *Avicennia marina*
Mid 1: *Bruguiera exaristata, Avicennia marina* with isolated *Excoecaria ovalis*
Ground 1: Sparse tussock grassland dominated by *Fimbristylis* sp. and *Xerochloa imberbis*
 
 
Other species **Upper stratum (U1):** - **Mid stratum (M1):** **Ground stratum (G1):** -
Land unit (Greater Darwin 25K) – 9b Marine
Landform: Mangrove flat near tidal creek
Soils: Brown sandy clay surface soils, some pebbles present ranging in size (2 – 6 cm)
Drainage: Very poorly drained
Fire history: No fire impact
Weeds: Absent
Disturbance: None
Hydrology: tidal, towards upper tide limit. Large pool located adjacent to vegetation assessment site – approximately 4 m wide.

Site RVS2 – *Melaleuca viridiflora* mid woodland over *Acacia plectocarpa* mid open shrubland over *Germainia grandiflora* mid tussock grassland

NVIS Code: T7i

Location (GDA94, z52): 693834E 8601132N

Upper 1: Mid woodland dominated by *Melaleuca viridiflora*

Mid 1: Mid open shrubland dominated by *Acacia plectocarpa, Lumnitzera racemosa* (on the edge of creek) and *Avicennia marina* (in creek channel)

Ground 1: Mid tussock grassland dominated by *Germainia grandiflora, Dapsilanthus* sp. and *Xerochloa imberbis*



Other species

Upper stratum (U1): -

Mid stratum (M1): *Thespesia populneoides*

Ground stratum (G1): - *Asteraceae sp.*, *Wrightia saligna, Flagellaria indica, Acrostichum speciosum, Gymnanthera nitida, Lindernia lobelioides, Diospyros littorea*

Land unit (Greater Darwin 25K) – 6b Drainage system

Landform: Flat, adjacent to creek channel

Soils: Brown clay loam; rocks and pebbles common in channel adjacent to site

Drainage: Poorly drained

Fire history: 2+ years since last fire causing minimal impact

Weeds: None

Disturbance: Motorbike tracks nearby

Hydrology: Some pools nearby, inundated on large high tides and with freshwater during wet season

Site SVS3 – *Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa* mid woodland over *Lophostemon lactifluus* mid open shrubland over *Sorghum intrans* mid tussock grassland

NVIS Code: T7i

Location (GDA94, z52): 693708E, 8600969N

Upper 1: Mid woodland dominated by *Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa*

Mid 1: Mid open shrubland dominated by *Lophostemon lactifluus, Clerodendrum floribundum* and *Denhamia obscura*

Ground 1: Mid open tussock grassland dominated by *Sorghum intrans, Aristida* sp. and *Pandanus spiralis*




Other species
Upper stratum (U1): -
Mid stratum (M1): *Alphitonia excelsa, Grevillea decurrens*
Ground stratum (G1): - *Germainia grandiflora, Acacia difficilis,* Fern sp., *Themeda* sp., *Wrightia saligna, Livistona humilis, Osbeckia australiana, Dianella odorata, Brachychiton megaphyllus, Fern sp.1, Antidesma ghesaembilla*

Land unit (Greater Darwin 25K) – 6b: Drainage system

Landform: Lower slope, flat open depression

Soils: Brown sandy loam. Some quartz present near creek

Drainage: Poorly drained – some wet season inundation

Fire history: Last year (relatively low impact fire)

Weeds: Annual mission grass scattered near site. Patches of *Hyptis suaveolens*, *Calopogonium mucunoides* and *Passiflora foetida* recorded nearby

Disturbance: None

Hydrology: Wet season inundation

Site RVS4 – *Syzygium armstrongii and Xanthostemon eucalyptoides* mid open woodland over *Pandanus spiralis* mid shrubland over *Scleria lingulata* mid open tussock grassland

NVIS Code: T7r

Location (GDA94, z52): 695055E 8594164N

Upper 1: Mid open woodland dominated by *Syzygium armstrongii* and *Xanthostemon eucalyptoides*

Mid 1: Mid shrubland dominated by *Pandanus spiralis, Flagellaria indica* and *Helicia australasica*

Ground 1: Mid open tussock grassland dominated by *Scleria lingulata*, *Sorghum intrans* and *Eriachne triseta*



Other species

Upper stratum (U1): *Lophostemon lactifluus*

Mid stratum (M1): *Myrsine benthamiana*, *Melicope elleryana, Cyclophyllum schultzii, Carallia brachiata, Gmelina australis, Grevillea pluricaulis*

Ground stratum (G1): *Melastoma malabathricum* (*polyanthum*), *Themeda triandra, Eulalia mackinlayi, Osbeckia australiana, Dianella odorata, Cheilanthes* sp

Land unit (Greater Darwin 25K) – 5b1: Drainage System

Landform: Flat, adjacent to creek channel

Soils: Black clay in channel

Drainage: Poorly drained

Fire history: Very recent adjacent (other side of the creek) but 2+ years since last fire at the site

Weeds: None

Disturbance: Some pig damage

Hydrology: Site situated adjacent to large pool (approximately 8 m x 15 m) 40 cm ~ 1m deep, steep bank (0.5 m).

Site RVS5 – *Xanthostemon eucalyptoides* mid woodland over *Leptospermum madidum* mid open shrubland over *Eriachne triseta* mid tussock grassland
NVIS Code: T6d
Location (GDA94, z52): 694646E 8593887N
Upper 1: Mid woodland dominated by *Xanthostemon eucalyptoides; Syzygium armstrongii;* and *Melaleuca viridiflora*
Mid 1: Mid shrubland dominated by *Leptospermum madidum; Helicia australasica; Carallia brachiata* and *Cyclophyllum schultzii*
Ground 1: Mid tussock grassland dominated by *Eriachne triseta, , Fern sp.2* and *Mnesithea rottboellioides*
 
 
Other species **Upper stratum (U1):** - *Melaleuca viridiflora; Syzygium armstrongii; Corymbia polycarpa* **Mid stratum (M1): -** *Pandanus spiralis; Helicia australasica; Acacia 'pellita'; Carallia brachiate; Cyclophyllum schultzii; Carpentaria acuminata,* **Ground stratum (G1):** - *Livistona humilis; Grevillea pluricaulis; Osbeckia Australiana; Mnesithea rottboellioides; Dianella odorata; Eulalia mackinlayi; Heteropogon triticeus, Fern sp.2 Cyperus sp., Themeda triandra; Germainia grandiflora; Philydrum lanuginosum*
Land unit (Greater Darwin 25K) – 5b1: Drainage System
Landform: open depression (watercourse/gully)
Soils: Brown loam sand. Clay in channel
Drainage: Poorly-very poorly drained
Fire history: unburnt-fire nearby
Weeds: Absent
Disturbance: Some pig disturbance
Hydrology: Some pools nearby, inundated with freshwater during wet season

Site RVS6 – *Erythrophleum chlorostachys* mid woodland over *Xanthostemon eucalyptoides* mid open shrubland over *Eriachne triseta* mid tussock grassland	
NVIS Code: T7i	
Location (GDA94, z52): 694513E 8593280N	
Upper 1: Mid woodland dominated by *Erythrophleum chlorostachys*	
Mid 1: Mid open shrubland dominated by *Xanthostemon eucalyptoides; Melicope elleryana; Carallia brachiate; Lophostemon lactifluus; Pandanus spiralis*	
Ground 1: Mid tussock grassland dominated by *Eriachne triseta;* Fern *sp1*; *Xanthostemon eucalyptoides*	
	
	
Other species **Upper stratum (U1):** - *Erythrophleum chlorostachys; Xanthostemon eucalyptoides; Corymbia polycarpa* **Mid stratum (M1):** *Xanthostemon eucalyptoides; Melicope elleryana; Carallia brachiate; Lophostemon lactifluus; Pandanus spiralis* **Ground stratum (G1):** - *Asteraceae sp., Wrightia saligna, Flagellaria indica, Acrostichum speciosum, Gymnanthera nitida, Lindernia lobelioides, Diospyros littorea; Mnesithea rottboellioides; Eulalia mackinlayi; Themeda triandra*	
Land unit (Greater Darwin 25K) – 5b1: Drainage System	
Landform: Lower slope adjacent to creek. Open depression from edge.	
Soils: Brown clay loam	
Drainage: Moderately well drained. Poorly drained FP. Very poorly drained channel seasonal creek.	
Fire history: 2+ years since last fire causing minimal impact	
Weeds: None	
Disturbance: No visible impact	
Hydrology: Seasonal freshwater in the creek during wet season	

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APPENDIX B POST WET-SEASON SURVEY TREE DATA

Site name	Species	Strata	Height (m)	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
Reference	*Lophostemon lactifluus*	U	8-10	5	1	0	0	0
Reference	*Melaleuca argentea*	U	16-18	15	1	0	0	0
Reference	*Syzygium armstrongii*	U	14-16	15	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	U	10-12	5	1	0	0	0
Reference	*Carallia brachiata*	M	4-6	5	1	0	1	0
Reference	*Cyclophyllum schultzii f. schultzii*	M	3-6	1	1	0	0	1
Reference	*Melicope elleryana*	M	8-10	5	1	0	0	1
Reference	*Myrsine benthamiana*	M	3-6	5	1	0	0	1
Reference	*Pandanus aquaticus*	M	3-6	10	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	M	3-8	5	1	0	0	0
Reference	*Barringtonia acutangula subsp. acutangula*	R	<3	10-15	1	0	0	0
Reference	*Carallia brachiata*	R	<3	10-15	1	0	0	0
Reference	*Carpentaria acuminata*	R	<3	10-15	1	0	0	0
Reference	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	0
Reference	*Helicia australasica*	R	<3	10-15	1	0	0	0
Reference	*Melicope elleryana*	R	<3	10-15	1	0	0	0
Reference	*Myrsine benthamiana*	R	<3	10-15	1	0	0	0
Reference	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
Reference	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS1	*Melaleuca argentea*	U	12-14	15	1	1	1	0
RVS1	*Syzygium armstrongii*	U	10-12	5	1	0	0	0
RVS1	*Xanthostemon eucalyptoides*	U	12-14	15-20	1	0	0	0
RVS1	*Acacia holosericea*	M	4	2	1	0	0	0
RVS1	*Barringtonia acutangula subsp. acutangula*	M	3-4	5	1	0	0	0
RVS1	*Carallia brachiata*	M	3-5	2	1	0	0	0
RVS1	*Cyclophyllum schultzii f. schultzii*	M	3-4	1	1	0	0	1
RVS1	*Leptospermum madidum subsp. sativum*	M	4-8	20	1	0	0	0
RVS1	*Myrsine benthamiana*	M	3-5	<1	1	1	1	1
RVS1	*Barringtonia acutangula subsp. acutangula*	M	3-4	5	1	0	0	0
RVS1	*Barringtonia acutangula subsp. acutangula*	R	<3	15	1	0	0	0
RVS1	*Carallia brachiata*	R	<3	15	1	0	0	0
RVS1	*Cyclophyllum schultzii f. schultzii*	R	<3	15	1	0	0	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS1	*Fagraea racemosa*	R	<3	15	1	0	0	0
RVS1	*Myrsine benthamiana*	R	<3	15	1	0	0	1
RVS2	*Eucalyptus miniata*	U	10-12	3-5	1	0	0	0
RVS2	*Lophostemon lactifluus*	U	10	3-5	1	0	0	0
RVS2	*Melaleuca viridiflora*	U	10-12	5-10	1	0	1	0
RVS2	*Melicope elleryana*	U	-	-	1	0	0	1
RVS2	*Syzygium armstrongii*	U	10	5-10	1	0	0	0
RVS2	*Acacia holosericea*	M	3-4	3-5	1	0	1	0
RVS2	*Carpentaria acuminata*	M	6	>1	1	1	0	0
RVS2	*Helicia australasica*	M	3-5	1-3	1	0	0	1
RVS2	*Leptospermum madidum subsp. Sativum*	M	4-8	10-15	1	0	0	0
RVS2	*Pandanus spiralis*	M	3-5	1-3	1	0	1	0
RVS2	*Syzygium armstrongii*	M	3-6	1	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	M	6-8	10-15	1	0	0	0
RVS2	*Acacia holosericea*	R	<3	40	1	0	0	0
RVS2	*Alphitonia excelsa*	R	<3	40	1	0	0	0
RVS2	*Breynia cernua*	R	<3	40	1	0	0	0
RVS2	*Carpentaria acuminata*	R	<3	40	1	0	0	0
RVS2	*Cyclophyllum schultzii f. schultzii*	R	<3	40	1	0	0	1
RVS2	*Erythrophleum chlorostachys*	R	<3	40	1	0	0	0
RVS2	*Exocarpos latifolius*	R	<3	40	1	0	0	0
RVS2	*Helicia australasica*	R	<3	5	1	0	0	1
RVS2	*Leptospermum madidum subsp. sativum*	R	<3	40	1	0	0	0
RVS2	*Pandanus spiralis*	R	<3	40	1	0	0	0
RVS2	*Syzygium armstrongii*	R	<3	40	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	R	<3	40	1	0	0	0
RVS2	*Carpentaria acuminata*	Other species	-	-	1	0	0	0
RVS2	*Diospyros sp*	Other species	-	-	1	0	0	0
RVS3	*Erythrophleum chlorostachys*	U	12-14	<5	1	0	0	0
RVS3	*Lophostemon lactifluus*	U	12-14	5-10	1	0	0	0
RVS3	*Melaleuca viridiflora*	U	12-14	5	1	0	1	0
RVS3	*Syzygium armstrongii*	U	12-14	5	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	U	12-14	5-10	1	0	0	0
RVS3	*Acacia auriculiformis*	M	8-10	5	1	0	1	0
RVS3	*Acacia holosericea*	M	3-5	10-15	1	0	1	0
RVS3	*Alphitonia excelsa*	M	4-5	15	1	0	0	0
RVS3	*Carallia brachiata*	M	4-6	15	1	1	1	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS3	*Cyclophyllum schultzii f. schultzii*	M	2-5	15	1	0	0	1
RVS3	*Denhamia obscura*	M	6-8	15	1	0	0	0
RVS3	*Erythrophleum chlorostachys*	M	3	15	1	0	0	0
RVS3	*Leptospermum madidum subsp. sativum*	M	5-7	5	1	0	0	0
RVS3	*Livistona humilis*	M	3-4	15	1	0	0	0
RVS3	*Melaleuca viridiflora*	M	4-5	15	1	0	0	0
RVS3	*Pandanus aquaticus*	M	3	15	1	0	0	0
RVS3	*Pandanus spiralis*	M	4	15	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	M	3-8	5-10	1	0	0	0
RVS3	*Acacia holosericea*	R	<3	10-15	1	0	0	0
RVS3	*Alphitonia excelsa*	R	<3	10-15	1	0	0	0
RVS3	*Breynia cernua*	R	<3	10-15	1	0	0	0
RVS3	*Carallia brachiata*	R	<3	10-15	1	0	0	0
RVS3	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
RVS3	*Erythrophleum chlorostachys*	R	<3	10-15	1	0	0	0
RVS3	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS3	*Livistona humilis*	R	<3	10-15	1	0	0	0
RVS3	*Melaleuca viridiflora*	R	<3	10-15	1	0	0	0
RVS3	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS3	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS4	*Corymbia polycarpa*	U	10-12	5	1	0	0	0
RVS4	*Syzygium armstrongii*	U	14-16	20	1	0	0	0
RVS4	*Xanthostemon eucalyptoides*	U	12-14	15	1	0	0	0
RVS4	*Acacia holosericea*	M	2-4	15-20	1	0	0	0
RVS4	*Carallia brachiata*	M	2-4	15-20	1	0	0	0
RVS4	*Cyclophyllum schultzii f. schultzii*	M	2-5	15-20	1	1	1	1
RVS4	*Flagellaria indica*	M	6	15-20	1	0	0	0
RVS4	*Gmelina shirleyi*	M	6-8	15-20	1	0	0	0
RVS4	*Melaleuca viridiflora*	M	2-4	15-20	1	0	0	1
RVS4	*Myrsine benthamiana*	M	3-6	15-20	1	0	0	0
RVS4	*Pandanus spiralis*	M	4-6	15-20	1	0	0	0
RVS4	*Syzygium angophoroides*	M	6-8	15-20	1	0	0	0
RVS4	*Syzygium armstrongii*	M	6-8	10	1	0	0	0
RVS4	*Xanthostemon eucalyptoides*	M	4-8	25-30	1	0	0	0
RVS4	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS4	*Helicia australasica*	R	<3	10-15	1	0	0	0
RVS4	*Melicope elleryana*	R	<3	10-15	1	0	0	0
RVS4	*Myrsine benthamiana*	R	<3	10-15	1	0	0	0
RVS4	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS4	*Syzygium angophoroides*	R	<3	10-15	1	0	0	0
RVS4	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS5	*Lophostemon lactifluus*	U	8-10	5	1	0	0	0
RVS5	*Melaleuca viridiflora*	U	8-10	15	1	0	0	0
RVS5	*Syzygium armstrongii*	U	10-12	15	1	0	0	0
RVS5	*Xanthostemon eucalyptoides*	U	12-14	10	1	0	0	0
RVS5	*Acacia holosericea*	M	3-5	3	1	0	0	0
RVS5	*Carallia brachiata*	M	6-8	5	1	0	0	0
RVS5	*Cyclophyllum schultzii f. schultzii*	M	5-6	<1	1	0	0	1
RVS5	*Helicia australasica*	M	3-6	10	1	0	0	1
RVS5	*Leptospermum madidum subsp. sativum*	M	4-6	10	1	0	0	0
RVS5	*Lophostemon lactifluus*	M	4-6	5	1	0	0	0
RVS5	*Pandanus spiralis*	M	3-5	2	1	0	0	0
RVS5	*Syzygium armstrongii*	M	6-8	15	1	0	0	0
RVS5	*Xanthostemon eucalyptoides*	M	4-8	15	1	0	0	0
RVS5	*Acacia holosericea*	R	<3	5-10	1	0	0	0
RVS5	*Carallia brachiata*	R	<3	5-10	1	0	0	0
RVS5	*Cyclophyllum schultzii f. schultzii*	R	<3	5-10	1	0	0	0
RVS5	*Erythrophleum chlorostachys*	R	<3	5-10	1	0	0	0
RVS5	*Helicia australasica*	R	<3	5-10	1	0	0	0
RVS5	*Leptospermum madidum subsp. sativum*	R	<3	5-10	1	0	0	0
RVS5	*Lophostemon lactifluus*	R	<3	5-10	1	0	0	0
RVS5	*Melicope elleryana*	R	<3	5-10	1	0	0	0
RVS5	*Myrsine benthamiana*	R	<3	5-10	1	0	0	0
RVS5	*Pandanus spiralis*	R	<3	5-10	1	0	0	0
RVS5	*Syzygium armstrongii*	R	<3	5-10	1	0	0	0
RVS5	*Xanthostemon eucalyptoides*	R	<3	5-10	1	0	0	0

APPENDIX C POST DRY-SEASON SURVEY TREE DATA

Site name	Species	Strata	Height (m)	Cover (%)	Dead-0 Live-1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
Reference	*Lophostemon lactifluus*	U	8-10	5	1	0	0	0
Reference	*Melaleuca viridiflora*	U	16-18	15	1	0	0	0
Reference	*Syzygium armstrongii*	U	14-16	15	0	1	0	0
Reference	*Xanthostemon eucalyptoides*	U	10-12	5-10	1	0	0	0
Reference	*Carallia brachiata*	M	4-6	5	1	0	0	0
Reference	*Corymbia polycarpa*	M	4	<1	1	0	0	0
Reference	*Cyclophyllum schultzii f. schultzii*	M	3-6	1	1	1	0	1
Reference	*Fagraea racemosa*	M	6	<5	1	1	0	1
Reference	*Melicope elleryana*	M	8-10	5	1	0	0	1
Reference	*Myrsine benthamiana*	M	3-6	5	1	0	1	1
Reference	*Pandanus aquaticus*	M	3-6	5-10	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	M	3-8	5-10	1	0	0	0
Reference	*Barringtonia acutangula subsp. acutangula*	R	<3	10-15	1	0	0	0
Reference	*Carpentaria acuminata*	R	<3	10-15	1	0	0	0
Reference	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
Reference	*Helicia australasica*	R	<3	10-15	1	0	0	1
Reference	*Melicope elleryana*	R	<3	10-15	1	0	0	1
Reference	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
Reference	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
Reference	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS1	*Melaleuca argentea*	U	12-14	15	1	0	0	0
RVS1	*Syzygium armstrongii*	U	10-12	5-10	1	0	0	0
RVS1	*Xanthostemon eucalyptoides*	U	12-14	15-20	1	0	0	0
RVS1	*Acacia holosericea*	M	3-4	1-5	1	0	1	0
RVS1	*Barringtonia acutangula subsp. acutangula*	M	3-5	5-10	1	1	1	0
RVS1	*Carallia brachiata*	M	3-5	2-5	1	0	0	0
RVS1	*Cyclophyllum schultzii f. schultzii*	M	3-4	1	1	1	0	1
RVS1	*Leptospermum madidum subsp. sativum*	M	4-8	15-20	1	0	0	0
RVS1	*Myrsine benthamiana*	M	4	<1	1	0	0	1
RVS1	*Pandanus spiralis*	M	3-6	5-10	1	0	0	0
RVS1	*Xanthostemon eucalyptoides*	M	5-8	10-15	1	0	0	0
RVS1	*Barringtonia acutangula subsp. acutangula*	R	<3	10-15	1	0	0	0
RVS1	*Carallia brachiata*	R	<3	10-15	1	0	0	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead-0 Live-1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS1	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
RVS1	*Fagraea racemosa*	R	<3	10-15	1	0	0	1
RVS1	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS1	*Leptospermum madidum subsp. Sativum*	R	<3	10-15	1	0	0	0
RVS1	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
RVS1	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS1	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS2	*Eucalyptus miniata*	U	10-12	3-5	1	0	0	0
RVS2	*Lophostemon lactifluus*	U	10	5	1	0	0	0
RVS2	*Melaleuca viridiflora*	U	10-12	5	1	0	1	0
RVS2	*Syzygium armstrongii*	U	10	5-10	1	0	0	0
RVS2	*Acacia holosericea*	M	3-5	3-5	1	0	1	0
RVS2	*Carpentaria acuminata*	M	6	1	1	0	1	0
RVS2	*Cyclophyllum schultzii f. schultzii*	M	3-4	<1	1	1	1	1
RVS2	*Exocarpos latifolius*	M	3-4	<1	1	0	0	0
RVS2	*Helicia australasica*	M	3-5	<3	1	0	0	1
RVS2	*Leptospermum madidum subsp. sativum*	M	4-8	10-15	1	0	0	0
RVS2	*Pandanus spiralis*	M	3-6	1-3	1	0	0	0
RVS2	*Syzygium armstrongii*	M	3-6	1-2	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	M	4-8	10-15	1	0	0	0
RVS2	*Acacia holosericea*	R	<3	30-40	1	0	0	0
RVS2	*Alphitonia excelsa*	R	<3	30-40	1	0	0	0
RVS2	*Breynia cernua*	R	<3	30-40	1	0	0	0
RVS2	*Carpentaria acuminata*	R	<3	30-40	1	0	0	0
RVS2	*Cyclophyllum schultzii f. schultzii*	R	<3	30-40	1	1	0	1
RVS2	*Exocarpos latifolius*	R	<3	30-40	1	0	0	0
RVS2	*Helicia australasica*	R	<3	30-40	1	0	0	1
RVS2	*Leptospermum madidum subsp. sativum*	R	<3	30-40	1	0	0	0
RVS2	*Pandanus spiralis*	R	<3	30-40	1	0	0	0
RVS2	*Syzygium armstrongii*	R	<3	30-40	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	R	<3	30-40	1	0	0	0
RVS3	*Erythrophleum chlorostachys*	U	12-14	5-10	1	1	0	0
RVS3	*Leptospermum madidum subsp. sativum*	U	10-12	<5	1	0	0	0
RVS3	*Melaleuca viridiflora*	U	12-15	5-10	1	1	0	0
RVS3	*Syzygium armstrongii*	U	12-15	5	1	1	1	0
RVS3	*Xanthostemon eucalyptoides*	U	10-14	5	1	0	0	0
RVS3	*Acacia auriculiformis*	M	8-10	1-5	1	0	0	0
RVS3	*Acacia holosericea*	M	3-5	5	1	1	1	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead-0 Live-1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS3	*Alphitonia excelsa*	M	4-5	<1	1	0	0	0
RVS3	*Carallia brachiata*	M	3-4	<1	1	1	0	0
RVS3	*Cyclophyllum schultzii f. schultzii*	M	3-4	1	1	1	1	1
RVS3	*Dead stump - unknown tree*	M	10	<1	0	0	0	0
RVS3	*Denhamia obscura*	M	6-8	1-3	1	0	0	1
RVS3	*Erythrophleum chlorostachys*	M	3-5	<1	1	0	0	0
RVS3	*Leptospermum madidum subsp. sativum*	M	5-8	5-10	1	0	0	0
RVS3	*Livistona humilis*	M	3-4	1	1	0	0	0
RVS3	*Melaleuca viridiflora*	M	4-6	<1	1	1	0	0
RVS3	*Pandanus aquaticus*	M	1-4	2-5	1	0	0	0
RVS3	*Pandanus spiralis*	M	1-4	1	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	M	3-10	10-15	1	0	0	0
RVS3	*Acacia holosericea*	R	<3	10-15	1	0	0	0
RVS3	*Alphitonia excelsa*	R	<3	10-15	1	0	0	0
RVS3	*Breynia cernua*	R	<3	10-15	1	0	0	0
RVS3	*Carallia brachiata*	R	<3	10-15	1	0	0	0
RVS3	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	1	0	1
RVS3	*Erythrophleum chlorostachys*	R	<3	10-15	1	0	0	0
RVS3	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS3	*Livistona humilis*	R	<3	10-15	1	0	0	0
RVS3	*Melaleuca viridiflora*	R	<3	10-15	1	0	0	0
RVS3	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS3	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS4	*Corymbia polycarpa*	U	10-12	5	1	0	0	0
RVS4	*Syzygium angophoroides*	U	8-10	5	1	1	0	0
RVS4	*Syzygium armstrongii*	U	14-16	20	1	1	0	0
RVS4	*Xanthostemon eucalyptoides*	U	12-14	15	1	0	0	0
RVS4	*Acacia holosericea*	M	4-5	15	1	0	0	0
RVS4	*Carallia brachiata*	M	3-5	15	1	0	0	0
RVS4	*Cyclophyllum schultzii f. schultzii*	M	3-5	15	1	1	0	1
RVS4	*Flagellaria indica*	M	8-10	15	1	0	0	0
RVS4	*Gmelina shirleyi*	M	5-8	15	1	0	1	0
RVS4	*Ilex arnhemensis*	M	6-8	15	1	1	0	1
RVS4	*Melaleuca viridiflora*	M	8-10	15	1	0	0	0
RVS4	*Myrsine benthamiana*	M	3-6	10	1	0	0	1
RVS4	*Pandanus spiralis*	M	4-6	15	1	0	0	0
RVS4	*Syzygium armstrongii*	M	6-8	10	1	1	1	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead-0 Live-1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS4	*Xanthostemon eucalyptoides*	M	4-8	25	1	0	1	0
RVS4	*Acacia holosericea*	R	<3	10-15	1	0	0	0
RVS4	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	1	1	1
RVS4	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS4	*Melicope elleryana*	R	<3	10-15	1	0	0	1
RVS4	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
RVS4	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS4	*Syzygium angophoroides*	R	<3	10-15	1	0	0	0
RVS4	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS5	*Lophostemon lactifluus*	U	8-10	5-10	1	0	0	0
RVS5	*Melaleuca viridiflora*	U	10-12	10-15	1	0	0	0
RVS5	*Syzygium armstrongii*	U	10-12	10-15	1	1	0	0
RVS5	*Xanthostemon eucalyptoides*	U	12-14	15	1	0	0	0
RVS5	*Acacia holosericea*	M	3-5	1-3	1	0	1	0
RVS5	*Carallia brachiata*	M	6-8	5	1	0	1	0
RVS5	*Cyclophyllum schultzii f. schultzii*	M	3-6	1-2	1	1	0	0
RVS5	*Helicia australasica*	M	3-6	10-15	1	1	0	1
RVS5	*Leptospermum madidum subsp. sativum*	M	4-6	5-10	1	0	0	0
RVS5	*Lophostemon lactifluus*	M	6-7	<5	1	0	0	0
RVS5	*Melaleuca viridiflora*	M	6	<1	0	0	0	0
RVS5	*Myrsine benthamiana*	M	3-4	<1	1	0	0	1
RVS5	*Pandanus spiralis*	M	4-5	1-2	1	0	0	0
RVS5	*Syzygium armstrongii*	M	6-8	5	1	1	0	0
RVS5	*Xanthostemon eucalyptoides*	M	4-10	15	1	0	0	0
RVS5	*Acacia holosericea*	R	<3	5-10	1	0	0	0
RVS5	*Carallia brachiata*	R	<3	5-10	1	0	0	0
RVS5	*Cyclophyllum schultzii f. schultzii*	R	<3	5-10	1	0	0	1
RVS5	*Helicia australasica*	R	<3	5-10	1	0	0	1
RVS5	*Leptospermum madidum subsp. Sativum*	R	<3	5-10	1	0	0	0
RVS5	*Livistona humilis*	R	<3	5-10	1	0	0	0
RVS5	*Melaleuca viridiflora*	R	<3	5-10	1	0	0	0
RVS5	*Melicope elleryana*	R	<3	5-10	1	0	0	1
RVS5	*Myrsine benthamiana*	R	<3	5-10	1	0	0	1
RVS5	*Pandanus spiralis*	R	<3	5-10	1	0	0	0
RVS5	*Syzygium armstrongii*	R	<3	5-10	1	0	0	0
RVS5	*Xanthostemon eucalyptoides*	R	<3	5-10	1	0	0	0

APPENDIX D GROUND COVER POST WET-SEASON SURVEY

Site name	Ground cover type	% cover	Vegetation type	% cover
RVS1	Vegetation	70	Grass	10
RVS1	Soil	5	Ferns	10
RVS1	Rock	0	Sedges	40
RVS1	Litter	25	Herbs	5
RVS1	Other	0	Other vegetation	5
RVS2	Vegetation	65	Grass	35
RVS2	Soil	10	Ferns	15
RVS2	Rock	0	Sedges	0
RVS2	Litter	15	Herbs	5
RVS2	Other (water)	10	Other vegetation	0
RVS3	Vegetation	70	Grass	50
RVS3	Soil	2	Ferns	5-10
RVS3	Rock	0	Sedges	5
RVS3	Litter	18	Herbs	5
RVS3	Other (water)	10	Other vegetation	0
RVS4	Vegetation	55	Grass	40
RVS4	Soil	10	Ferns	5
RVS4	Rock	0	Sedges	5
RVS4	Litter	15	Herbs	5
RVS4	Other	20	Other vegetation	0
RVS5	Vegetation	40	Grass	25
RVS5	Soil	25	Ferns	5
RVS5	Rock	5	Sedges	5
RVS5	Litter	25	Herbs	5
RVS5	Other	5	Other vegetation	0
Reference	Vegetation	40	Grasses	25
Reference	Soil	5	Ferns	0
Reference	Rock	0	Sedges	10
Reference	Litter	15	Herbs	<1
Reference	Other (water)	40	Other vegetation	0

APPENDIX E GROUND COVER POST DRY-SEASON SURVEY

Site name	Ground cover type	% cover	Vegetation type	% cover
RVS1	Vegetation	60	Grass	5
RVS1	Soil	10	Ferns	<1
RVS1	Rock	0	Sedges	40
RVS1	Litter	30	Herbs	<1
RVS1	Other	0	Other vegetation	0
RVS2	Vegetation	55	Grass	30
RVS2	Soil	15	Ferns	10
RVS2	Rock	<1	Sedges	5
RVS2	Litter	30	Herbs	<1
RVS2	Other	0	Other vegetation	10
RVS3	Vegetation	70	Grass	55
RVS3	Soil	5	Ferns	2-5
RVS3	Rock	0	Sedges	5-10
RVS3	Litter	20	Herbs	<1
RVS3	Other	5	Other vegetation	0
RVS4	Vegetation	50	Grass	40
RVS4	Soil	5	Ferns	0
RVS4	Rock	0	Sedges	5-10
RVS4	Litter	25	Herbs	<1
RVS4	Other	20	Other vegetation	0
RVS5	Vegetation	35	Grass	25
RVS5	Soil	15	Ferns	5
RVS5	Rock	5	Sedges	1
RVS5	Litter	50	Herbs	0
RVS5	Other	<1	Other vegetation	0
Reference	Vegetation	40	Grass	30
Reference	Soil	5	Ferns	<1
Reference	Rock	0	Sedges	10-15
Reference	Litter	15	Herbs	<1
Reference	Other	40	Other vegetation	0

APPENDIX F GENERAL OBSERVATIONS POST WET-SEASON AND POST-DRY SEASON SURVEY

Site name	Survey date	Fire	Weeds	Erosion	Surface water flows	Aquatic life flora/fauna	Sedimentation (present/absent)	Climatic conditions	Contamination	Additional notes
RVS1	May	<1 year	None	Absent	Trickling	Present	Absent	Sunny, slightly hazy	Bio-film/sheen	Eriocaulon sp, Nymphaea sp alive in stream
RVS2	May	<1 year	None	Absent	Trickling	Present	Absent	Humid, partly cloudy	Nil	Eriocaulon sp, Nymphaea sp alive in stream
RVS3	May	>3 year, part of, site <1 yr for remaining	Mission grass patch adjacent to site	Absent	Trickling	Present	Absent	Humid, partly cloudy	Nil	Eriocaulon sp, Nymphaea sp alive in stream
RVS4	May	<1 year	None	Absent	Tricking	Present	Absent, slight red tinge to water	Humid, partly cloudy	Nil	Eriocaulon sp, Nymphaea sp alive in stream.
RVS5	May	<1 year	None	Absent	Slow trickle	Present	Absent, red algal present	Humid, partly cloudy	Bio-film/sheen	Eriocaulon sp, Nymphaea sp, Fimbristylis sp. all alive in stream; snake spotted, fish and insect also present
Reference	May	>3 year	None	Absent	Slow trickle	Present	Absent	Sunny	Natural biofilm present on surface water	Eriocaulon sp, Nymphaea sp all alive in stream, 8m wide bank side sloping bank 3-5% slope towards the water. 1-2m deep from the bank
RVS1	October	<1 year	None	Absent	Stagnant no flow	Present	Absent	Partly cloudy	Bio-film/sheen and red algae present	Nil
RVS2	October	<1 year (moderate severity)	None	Absent	No standing water present	None	None	Partly cloudy	Nil	Nil
RVS3	October	<1 year	None	Absent	Stagnant no flow, x1 small pool	None	Absent	Sunny	Nil	Some pig damage x1 large Syzygium 6-cm DBH recorded on GPS next to water
RVS4	October	<1 year (moderate severity)	None	Absent	Stagnant, no flow	None	Absent	Sunny, partial cloud cover	Bio-film/sheen, some plant matter on surface brown stagnant water	Nil
RVS5	October	<1 year	None	Absent	No standing water present	None	Absent	Sunny	Nil	Nil
Reference	October	Nil	None	Absent	Not flowing, water stagnant	Present	Absent	Sunny	Nil	Eriocaulon sp, Nymphaea sp all alive in stream

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Surface Water Extraction Licence Monitoring Plan Observation Hill Dam

Core Lithium

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RELIANCE, USES and LIMITATIONS

This study, report and analyses have been based on the information available to EcOz Environmental Consultants at the time of preparation. EcOz Environmental Consultants accepts responsibility for the report and its conclusions to the extent that the information was sufficient and accurate at the time of preparation. EcOz Environmental Consultants does not take responsibility for errors and omissions due to incorrect information or information not available to EcOz Environmental Consultants at the time of preparation of the study, report or analyses.

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Appendices

1 INTRODUCTION

1.1 Finniss Lithium Project Summary

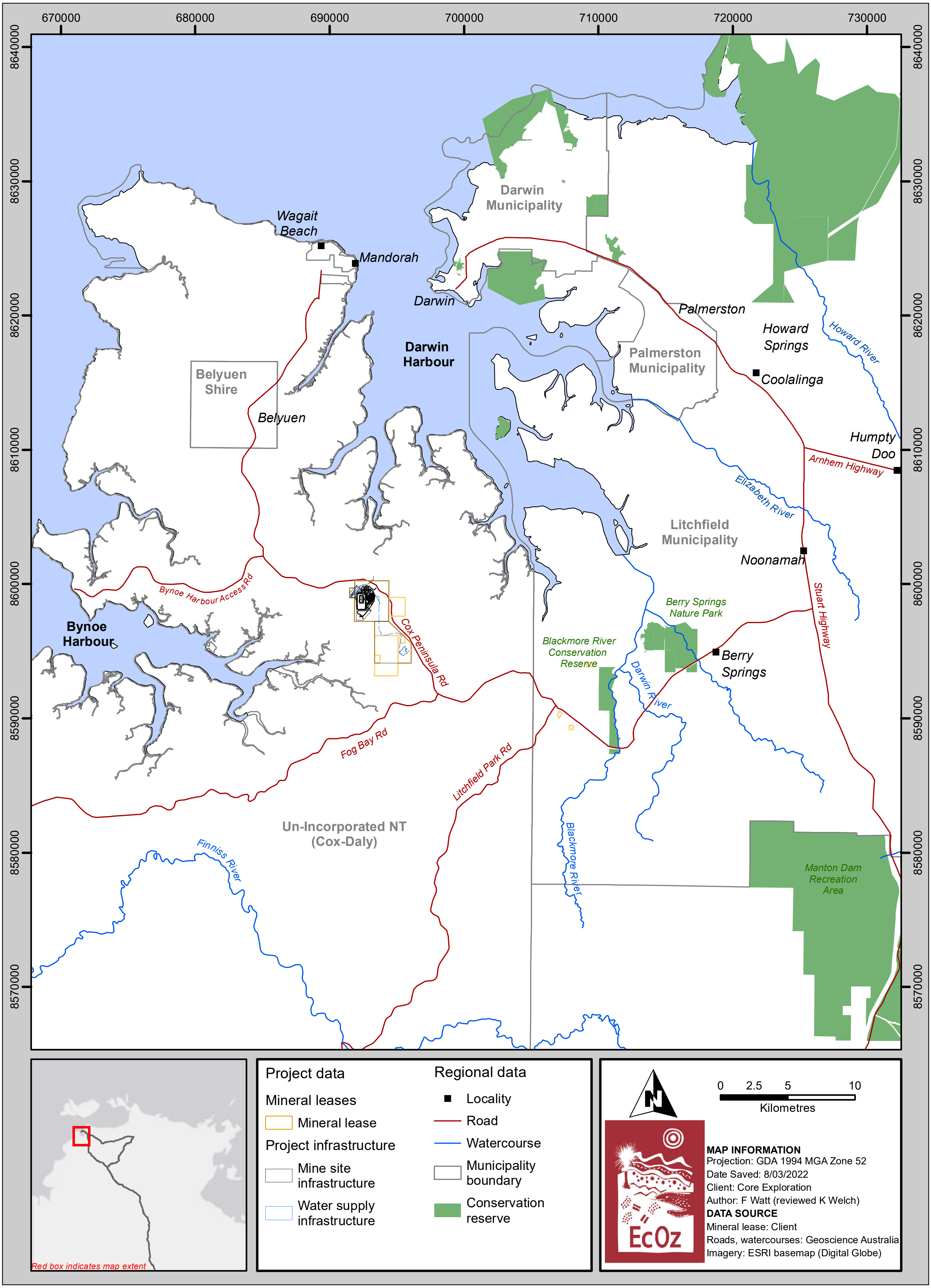
Core Lithium Limited (Core) is an Australian Stock Exchange ASX-listed company (ASX: CXO) targeting lithium production through the development of the Finniss Lithium Project (the Project). Core owns 100 percent (%) of the Project, located near Darwin in the Northern Territory (NT) (Figure 1-1).

Lithium Developments (Grants NT) Pty Ltd (LDGNT) is a 100% owned subsidiary of Core and is the operator of the Grants Lithium Project (Grants). Construction activities at Grants commenced 30 September 2021. The operation will consist of an open cut pit (200 m final depth) and a processing facility on Mineral Lease (ML) 31726 (Figure 1-2). The key activities at Grants will include:

- Mining of approximately two (2) million tonnes (Mt) of spodumene (a lithium-bearing ore) using simple drill and blast mining methods.
- Crushing, screening and Dense Media Separation (DMS) processing of ore to increase the lithium concentration in the product from 1.5 % to 5.5 % Li_2O.
- Establishment of an onsite waste rock dump (WRD) and co-located tailings storage facility (TSF) to accept waste rock and tailings from the mining and processing activities.
- Haulage of the product in road trains along public roads to Darwin Port for export. The processed lithium concentrate will be transported via Cox Peninsula Road and Stuart Highway to Darwin Port, for shipping to China.
- Rehabilitation and closure of the site.

An old mine dam (Observation Hill Dam [OHD]) is located 5 km to the south of the mine site on ML32074. The dam is used for drinking water and as a back-up water supply for mining should onsite sources be insufficient. Water is transported to the site via a six (6) kilometre (km) long buried pipeline which traverses across both ML32074 and ML31726. A secondary water supply dam is planned on an ephemeral watercourse that flows through ML31726, immediately to the west of the mine site. The life of mine is three to four years.

In addition to Grants, LDGNT propose to develop and operate an underground lithium mine at the BP33 resource (BP33) located approximately 4km south of Grants, and 1.5km southwest of OHD (Figure 1-2). Operations at BP33 have not commenced to date and are expected to occur in late 2022 or 2023. Once operational, ore mined from BP33 will be hauled to the Grants processing facility.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22022 - Grants Project - ESCP amendment\01 Project Files\EMR Maps\EMR Figure 1-1 Map of location and regional setting of Grants Lithium Project.mxd

Figure 1-1. Map of location and regional setting of Finniss Lithium Project

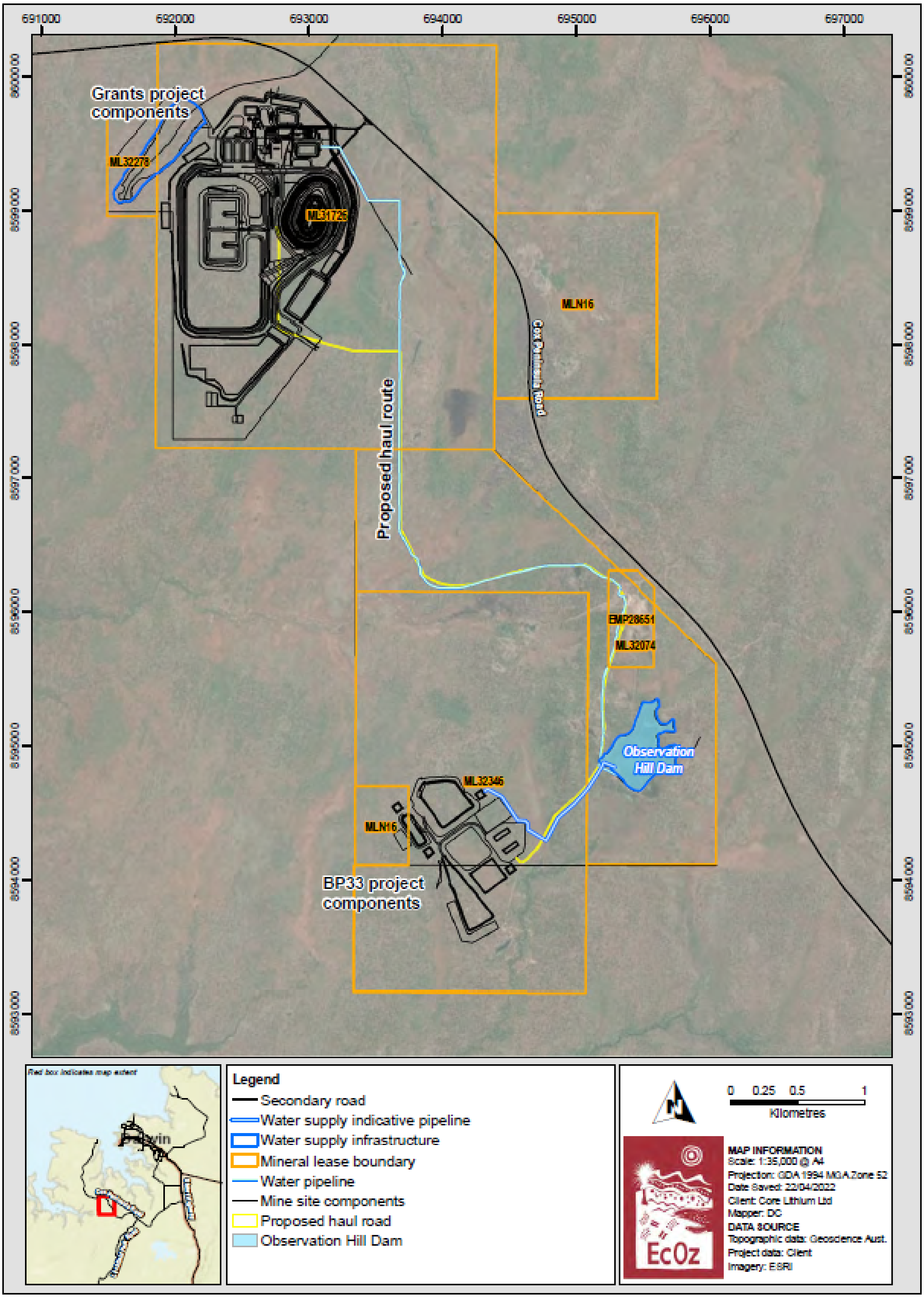


Figure 1-2. Map of Finniss Lithium Project site layout

1.2 Water Extraction Licence

LDGNT was granted a Licence to Take or Use Surface Water (Licence No: 8151018) (herein referred to as Surface Water Extraction Licence [SWEL] 8151018) on 18 November 2021, pursuant to Section 45 of the *Water Act 1992*. The licence allows for the extraction of surface water from OHD to facilitate mining activities including dust suppression, processing, and amenities. Core is obligated to meet the requirements outlined as conditions of SWEL 8151018.

The entitlement volumes for extraction of surface water from OHD vary for set periods, as shown in Table 1-1 below (reproduced from Table 1 of SWEL 8151018). Core will ensure that any extraction is within the entitled volumes for the relevant time period.

Table 1-1. Entitlement extraction volumes for Observation Hill dam

Entitlement (ML)	Period
310	Commencement date to 30 April 2022
310	1 May 2022 to 31 October 2022
61	1 November 2022 to 30 April 2023
121	1 May 2023 to 30 April 2024
121	1 May 2024 to 30 April 2025

1.3 Purpose and Scope

This Monitoring Plan has been developed to satisfy Condition 4.1 of SWEL 8151018. The Monitoring Plan outlines the monitoring parameters, methodology and frequency for monitoring downstream impacts associated with water extraction from OHD on both surface water flows and riparian vegetation. The Monitoring Plan includes Trigger Action Response Plans (TARPs) for both surface water flow monitoring and riparian vegetation monitoring, which stipulate triggers for action/investigation of potential impacts from surface water extraction to ensure early intervention and allow for adaptive management.

The Monitoring Plan will be implemented immediately following the Controllers approval and will be reviewed annually (as per Section 5) to ensure continuous improvement.

2 SITE SETTING

2.1 Catchment Hydrology

OHD is located in the Charlotte River catchment of Bynoe Harbour. The dam catchment is situated at the headwaters of an ephemeral drainage line that flows south and discharges into the lower reaches of the Charlotte River, approximately 3 km downstream. Site inspections of the dam and downstream watercourse in dry season and wet season conditions over the period 2017-2020 have observed that flows downstream of the dam typically commence in December/January and cease by May, after which some isolated pools persist into the late dry season. The catchments and surface watercourses are shown in Figure 2-1.

Figure 2-2 shows the local drainage features within the vicinity of Grants and OHD, and the location of surface water monitoring sites which have been monitored for water quality for a number of years.

WRM (2022) have developed a Technical Memorandum for Surface Water Extraction from Observation Hill Dam, which details the characteristics of OHD and the catchment, and assesses potential downstream impacts from water extraction, which has informed this Monitoring Plan (see Appendix A).

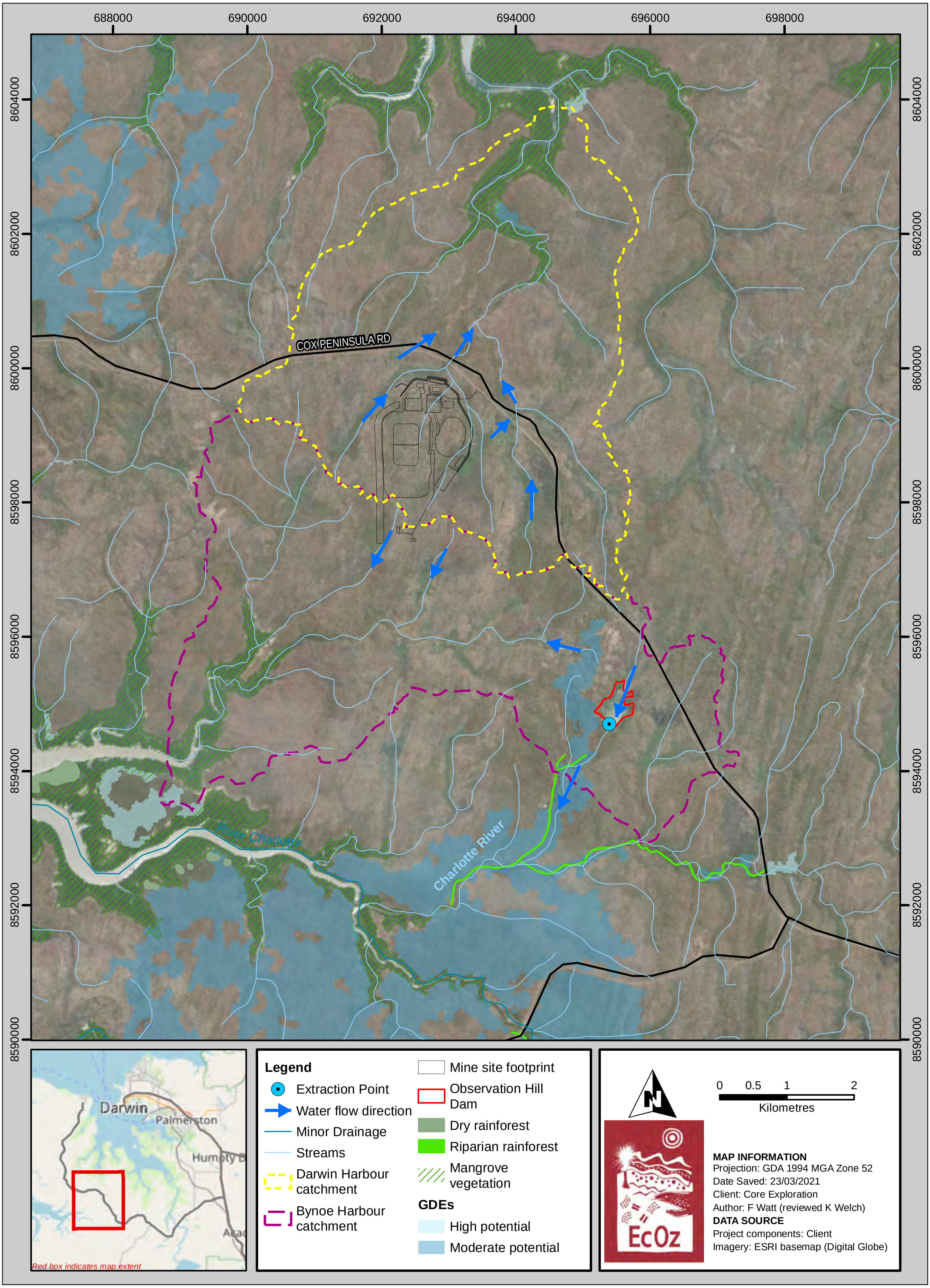


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Figure 2-1. Map of Finniss Lithium Project catchment areas

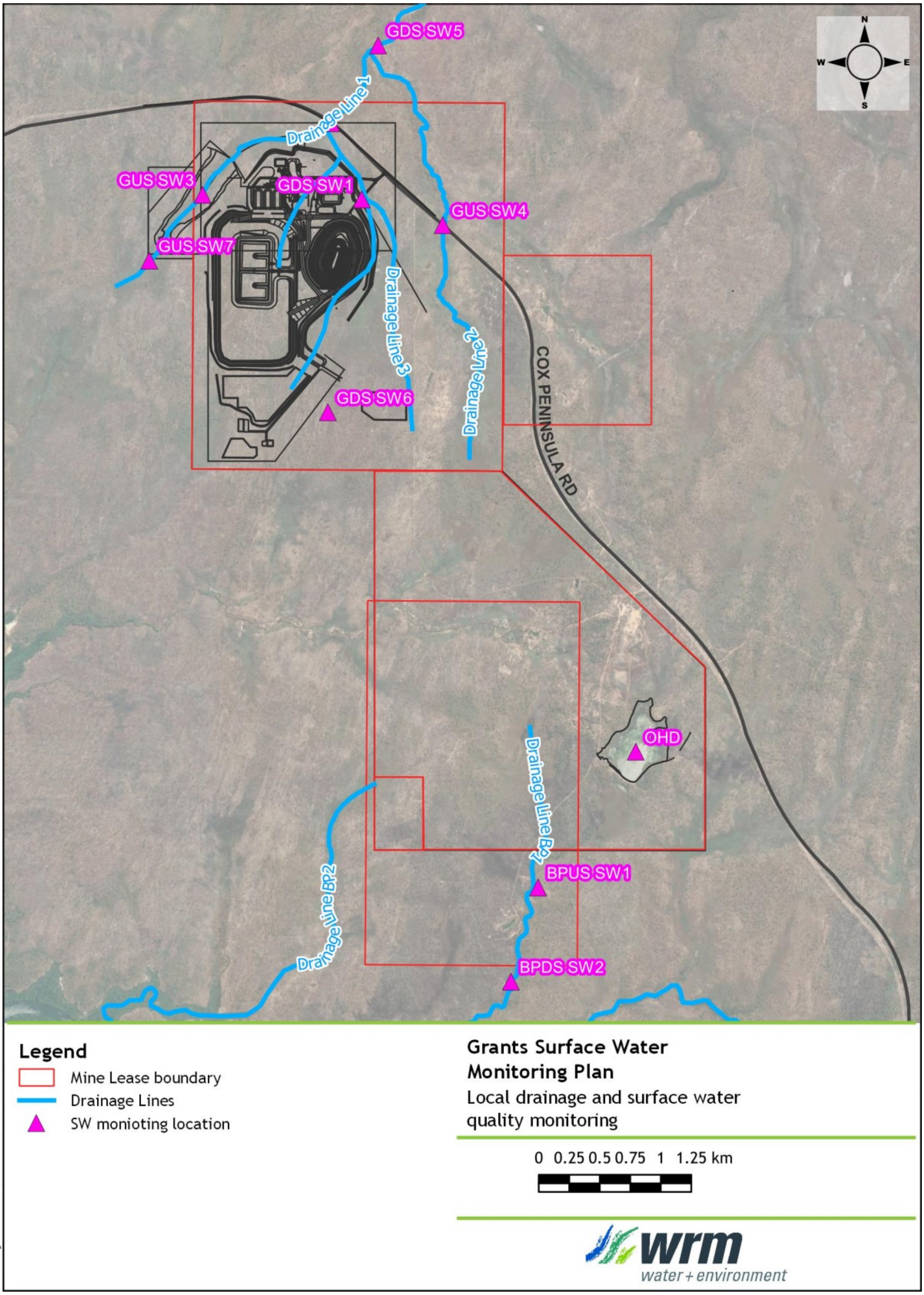


Figure 2-2. Map of local drainage features and surface water quality monitoring sites

2.2 Observation Hill Dam wall raise

The current estimated full storage volume for OHD is 364 ML. Core propose to raise the dam wall by approximately 1.5 m to increase storage capacity to around 620 ML. It is expected that the dam wall raise would be completed during the 2023 dry season.

The SWEL entitlements have been calculated based on the assumption that the dam wall raise will occur. The location of the proposed new embankment, and resulting enlarged inundation area, are shown on Figure 2-3. Refer to Appendix A for detail.

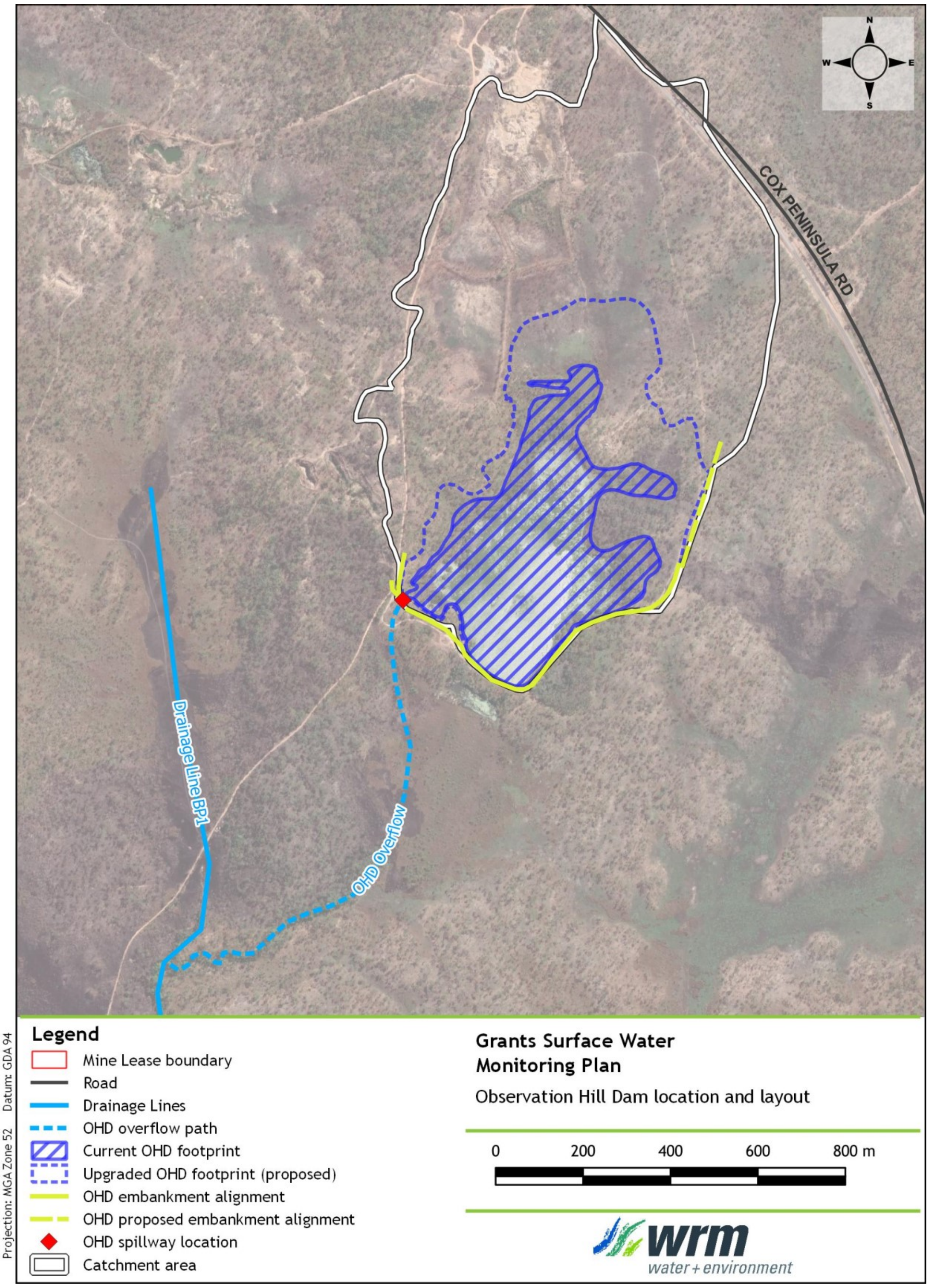


Figure 2-3. Map of Observation Hill Dam location and layout

2.3 Drainage Line BP1

Drainage Line BP1 has a catchment area of approximately 365 ha to the BPDS SW2 monitoring locations (Figure 2-2). Of this catchment area, 93.8 ha is impounded by OHD. The catchment is mostly natural with some grassed areas that were cleared by preliminary exploration activities. The channel is poorly defined, particularly in the upper section of the reach.

Two existing surface water quality monitoring sites are located along Drainage Line BP1; BPUS SW1 and BPDS SW2. BPDS SW2 will be monitored for surface water flows with a continuous water level logger, as outlined in Section 4.1.

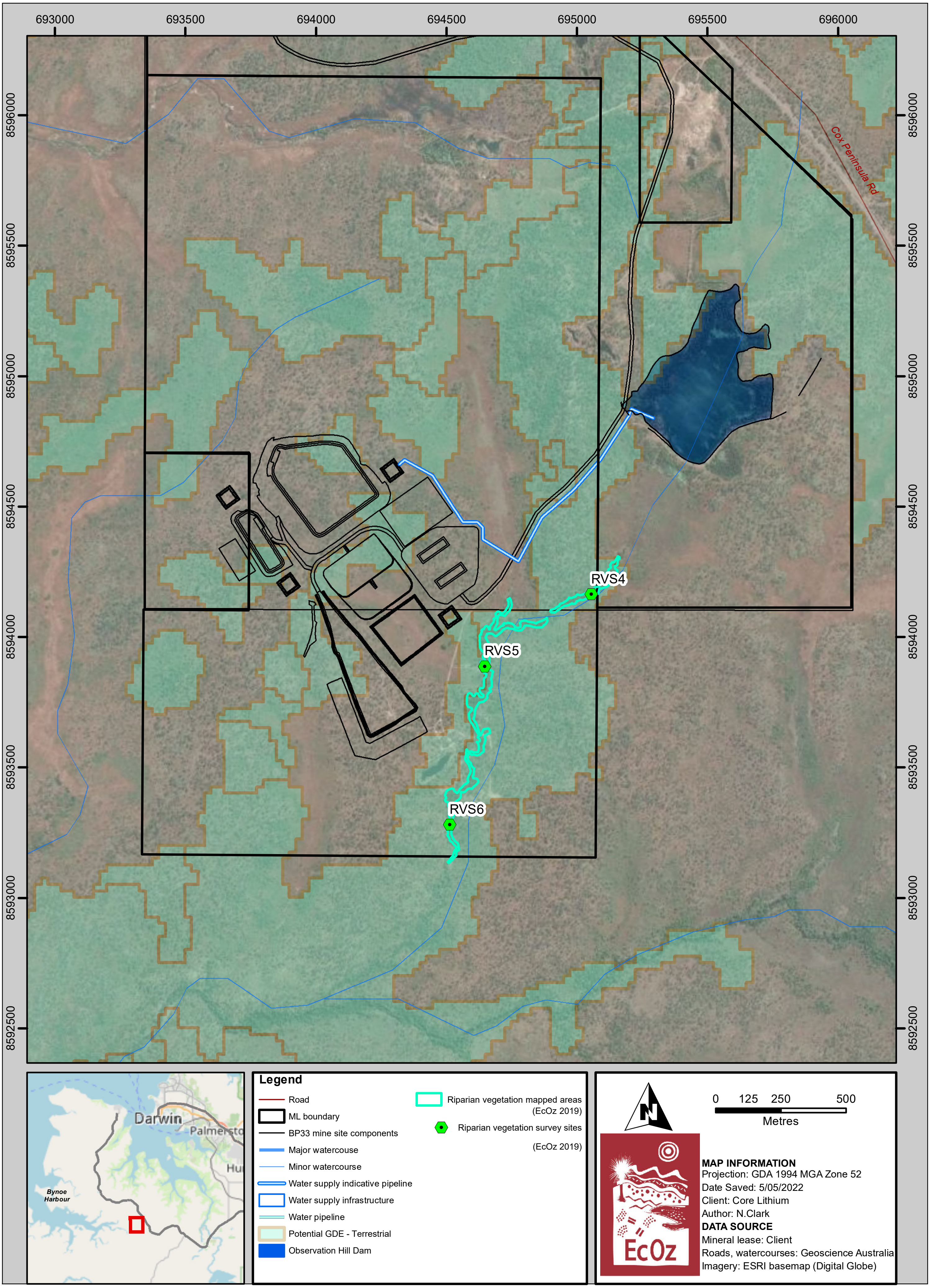
2.4 Riparian Vegetation

Previous surveys and assessments undertaken for the Grants Environmental Impact Statement (EIS) identified the presence of an ephemeral drainage line downstream of OHD which supports closed riparian vegetation identified as a potential Groundwater Dependent Ecosystem (GDEs) (Figure 2-4) based on desktop modelling. These riparian vegetation communities downstream of OHD could be susceptible to impacts associated with changes to surface water flows. The Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019) baseline study was undertaken to further assess the vegetation prior to mining activities commencing (refer Appendix B).

The intent of the baseline survey was to produce a vegetation map and record vegetation characteristics and condition of the sensitive vegetation communities downstream of OHD, which is now near the proposed BP33 underground mine.

Two types of baseline surveys were undertaken; an aerial drone survey to look at the overall riparian vegetation health and assist in mapping the riparian vegetation extent, and on-ground field survey to assess vegetation structure and composition within the mapped riparian vegetation extent.

Additional baseline surveys will be undertaken during 2022 to support implementation of this plan. Further details of additional baseline studies are provided in Section 2.4.1.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 2. Map of baseline studies for BP33 project area.mxd

Figure 2-4. Map of baseline riparian monitoring area and vegetation monitoring sites (EcOz, 2019)

2.4.1 Gaps in Riparian Vegetation Baseline Studies

Based on the existing information available, some gaps were identified in the baseline surveys and are proposed to be addressed as outlined below.

- The drone survey was only undertaken post wet-season. It is recommended to undertake additional drone flight for BP33 project area in the dry season to account for seasonality differences.
- The orthomosaic images obtained from drone mapping only used false colour imagery (i.e. green indicating to examine vegetation health). Further remote sensing analysis is required to quantify vegetation health and compare data between 2019 and 2022.
- No upstream of Charlotte's River riparian vegetation site assessments undertaken outside of the modelled groundwater drawdown (CloudGMS, 2021) for BP33 project area. A site will be established outside of the modelled 1m contour groundwater drawdown zone of influence (ZOI) to be used as a baseline reference site and assessed prior to significant water extraction from OHD and BP33 mining operations.
- No vegetation site assessment data was collected post-wet season. To account for seasonality differences, it is recommended to undertake biannual vegetation site assessment monitoring post-wet season for the 2022 baseline surveys. This data can be used for future reference if additional monitoring is required in accordance with the trigger action response plan (TARP) (Section 0).
- Though some data was obtained while undertaking vegetation site-based assessments post wet-season 2019, there was a lack of quantitative data collected - ground cover percentage, presence of recruitment, number of alive vs dead plants, erosion scoring etc. These attributes will assist in monitoring the condition of riparian vegetation and data comparison.
- Further investigation is required to determine the extent of the riparian vegetation within the identified ZOI of the BP33 predicted groundwater drawdown modelling. The ZOI has been defined by the one metre groundwater drawdown contour shown in Figure 4-2. It is assumed that drawdown of less than that would only affect water availability for a short period of time in the mid-late dry season when groundwater levels are naturally lowered. The ZOI encompasses a 4.5 km section of stream order one ephemeral watercourse.
- Additional baseline surveys will be conducted biannually during 2022 to address these gaps. A baseline assessment report will be developed to include outcomes of the 2019 monitoring and the 2022 monitoring and the RVMP revised as required.

3 ASSESSMENT OF POTENTIAL DOWNSTREAM IMPACTS

3.1 Potential Hydrological Impacts

3.1.1 Overview

An assessment of the maximum potential impacts due to water extraction from OHD was assessed as part of Grant's Mining Management Plan (Enviroconsult, 2019) for an average rainfall year. This study found that, over a full wet season of average rain (~1,652 mm), the reduction in average flows downstream of OHD due to an annual water extraction volume of 738 ML/year (daily average of 2.02 ML/d) would be 45% during the wet season. This is considered to be the maximum allowable impact on downstream flows due to water extraction for this climatic sequence per Special Condition 4.1(iii) of the WEL.

Note that:

- The maximum annual water entitlement is 620 ML, which is less than the modelled "worst-case" maximum based on a standard daily pump rate of 2.02 ML/day (i.e. modelling is conservative)
- 2.02 ML/day is the estimated peak water use, based on dry season demand for dust suppression, and actual water use will vary depending on seasonal conditions and mine operations and demand. Water use will be lower in the wet season when dust suppression is not required, or required infrequently.
- Once the mine is fully operational, water extraction from OHD will primarily be for the purpose of supplying potable water and addressing any water deficit that occurs due to changes in the availability of water from the other sources (e.g. groundwater inflows into Grants pit and rainfall).
- The current pump at OHD has an extraction rate of up to 4.00 ML/d, but pumped rates will be limited to ensure extracted volumes remain within entitlements as per Table 1 of SWEL 8151018.

An operational Trigger Action Response Plan (TARP) has been developed to continually monitor the pumped extraction volumes from OHD to ensure that the water extraction entitlements presented in Table 1 of SWEL 8151018 are not exceeded (refer to Appendix A).

3.1.2 Modelled Downstream Impacts for Varying Climatic Conditions

The WRM technical memorandum (Appendix A) presents potential downstream impacts of water extraction from OHD from a range of climatic conditions, based on previous water balances and modelling undertaken by Enviroconsult (2019) and a Goldsim model developed by WRM. Figure 4-1 in Appendix A shows the likely (i.e. taken as needed) and maximum downstream impacts (assessed immediately downstream of the OHD spillway) ranked according to the probability of exceedance. The figure shows that, if water is extracted from OHD as needed (assuming that the site water demand assumptions are correct), is it unlikely that the downstream impacts of OHD will exceed the maximum downstream impacts reported by Enviroconsult (2019). Taking water as need from OHD would result in a ~6% flow reduction downstream in an average climate year, and would only result in 100% flow reduction in the driest 2% of climatic conditions. Conversely, if OHD was pumped at a constant rate of 2.02 ML/d, there is a ~45% reduction in downstream flows in an average climate year; i.e. the maximum reduction in downstream flows assessed through the EIS process. Additionally, pumping at a constant rate may result in a downstream flow reduction of 100% (i.e. no overflows occurring during the wet season), for the driest 40% of climatic conditions. If the current maximum pump rate (4.00 ML/d) is maintained for extended periods, there would be a potential for the maximum allowable downstream impact to be exceeded.

WRM used the maximum allowable downstream flow reductions presented in Figure 4.1 of Appendix A to calculate the minimum OHD spill days, which are presented in Figure 3-1. The relationship between OHD spill days and wet season rainfall can be used as a tool to predict whether the extraction rates would cause an exceedance of the maximum allowable downstream impact, and has been used to inform the TARP for surface water flows presented in Section 4.2.

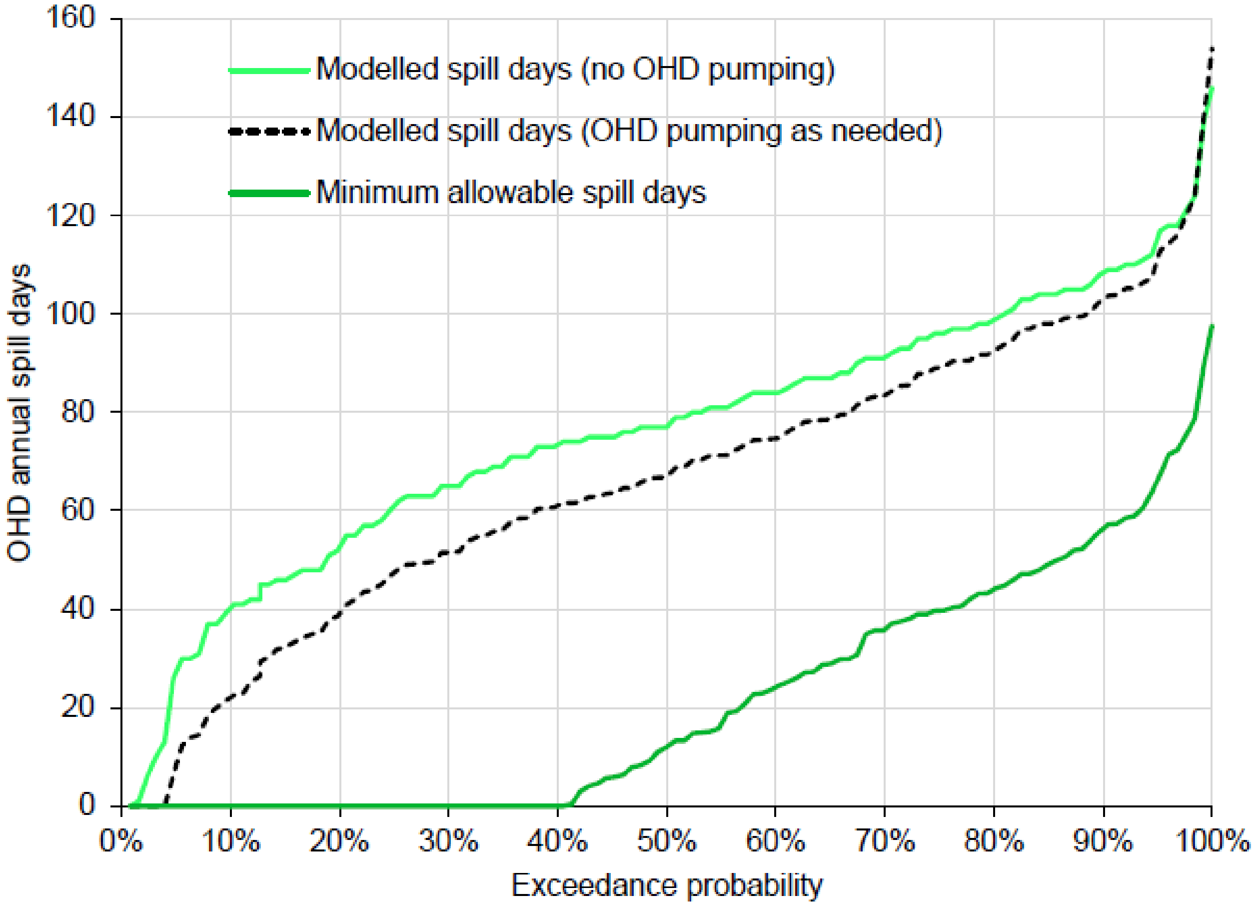


Figure 3-1. Minimum annual spill days required during OHD water extraction

3.2 Potential Riparian Vegetation Impacts

Healthy riparian zones are essential for maintaining healthy ecosystems and economic productivity along rivers (Dixon & Douglas 2015). When maintaining a riparian vegetation system, it is vital to retain a diverse vegetation cover to assist in maintaining the functions that a riparian vegetation community provides i.e. supporting aquatic habitats, shading the river and regulating the temperature, bank stabilisation, filtering of sediments and improving water quality of river by reducing contaminants (Dixon & Douglas 2015).

Riparian vegetation is able to access water multiple ways i.e. through the upper un-saturated zone as a result from recent rain events, the groundwater at depth via the capillary fringe above an unconfined aquifer, and through creek water (generally a combination of groundwater and rain water in the wet season, but may be predominantly groundwater in the dry season) (SKM 2012) (Figure 3-2). There are particular species that are more likely to be sensitive to declines in available ground water such as monsoon forest species that grow in areas where there is perennial water supply.

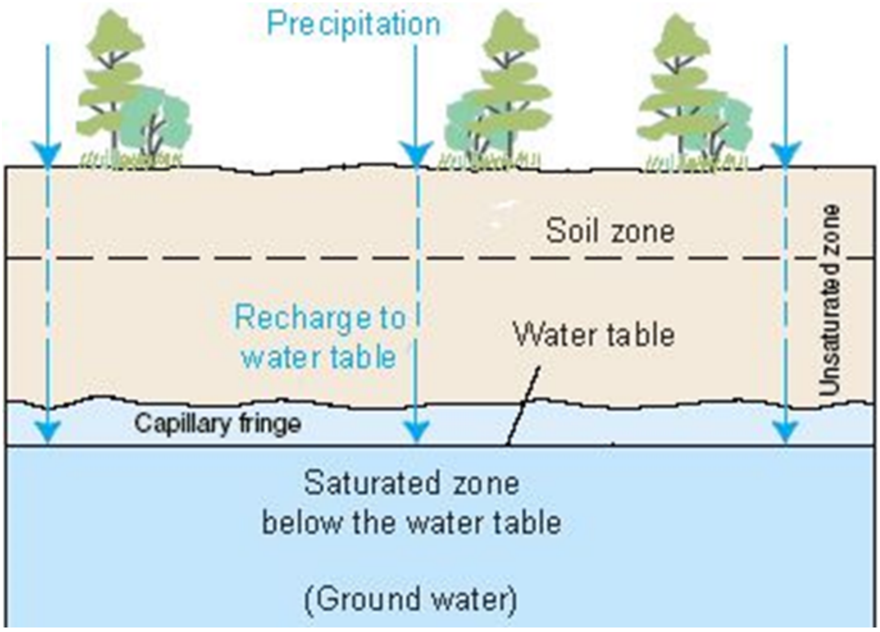


Figure 3-2. Diagram showing the capillary fringe (SKM 2012)

Riparian vegetation recruitment and germination depends on the level of surface water and ground water regimes as plants depend on predictable patterns in terms of structure and diversity according to water availability in the landscape (Eamus & Lamontagne 2006). Riparian tree recruitment typically occurs after large floods when viable plant material is transported onto point bars and the floodplains of naturally flowing rivers (Eamus, D., & Lamontagne 2006). If dry season flow is modified, or the water table recedes too quickly, new cohorts fail to recruit and the species composition may alter over time (Figure 3-3). Ultimately the intent of monitoring the riparian vegetation (Section 0) is to detect changes over time.

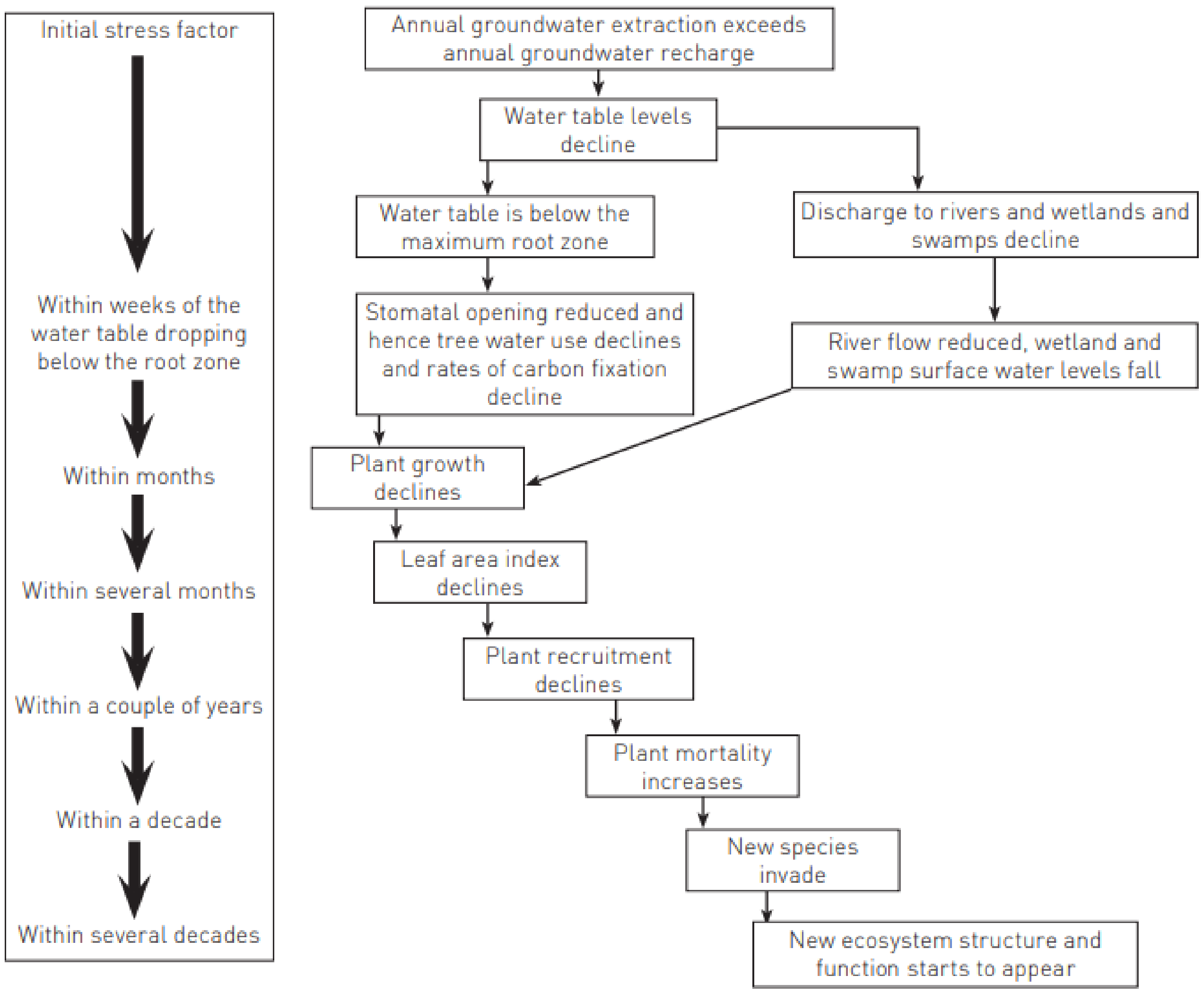


Figure 3-3. Diagram showing the potential consequences of groundwater drawdown affect (Eamus, D., & Lamontagne 2006)

4 MONITORING PROGRAMS

4.1 Surface Water Level Monitoring

Monitoring of surface water levels at and downstream of OHD will form a key component of the surface water management system and ensure compliance with SWEL 8151018. Monitoring of water levels will assist in demonstrating that the site water management system is effective in meeting its objective of minimal impact on downstream flows and will allow for early detection of any impacts and appropriate corrective action.

Water levels will be monitored at the OHD spillway (OHD DS), and at the downstream location BPDS SW2 on a continuous basis to:

- Inform the assessment of potential impacts on downstream flows, based on spillway data
- Monitor flows downstream to assess impact of extraction on flows in Drainage Line BP1
- Provide flow data to assist in interpretation of riparian vegetation monitoring data (discussed in Section 4.3.

Water levels at these sites will be recorded using a suitable continuous water level logger, and rating curves will be developed to relate recorded water levels to flows.

Additionally, water levels in OHD will be monitored via manual survey pickups of the water level on a weekly basis and as part of routine water quality monitoring to provide information on operational decisions and water supply volumes.

Rainfall data will be sourced from Bureau of Meteorology (BoM) Station 014264 located at the Territory Wildlife Park, to inform the assessment of potential impacts of surface water extraction as presented in Table 4-2.

The locations of the proposed surface water flow monitoring locations are shown in Figure 4-1 and summarised in Table 4-1.

Table 4-1. Surface water level monitoring locations

Name	Location	Coordinates (GDA 94 Zone 52)		Monitoring Measure	Sample Frequency	Sample Methodology	Site type
		Easting	Northing				
OHD DS	OHD Spillway	695 185	8 594 842	Water level / flow	Continuous	Logger	Compliance
BPDS SW2	Drainage Line BP1 D/S of OHD	694 461	8 593 025	Water level / flow	Continuous	Logger	Information
OHD	OHD	695 422	8 595 695	Water level / storage	Weekly	Manual survey pickup	Information

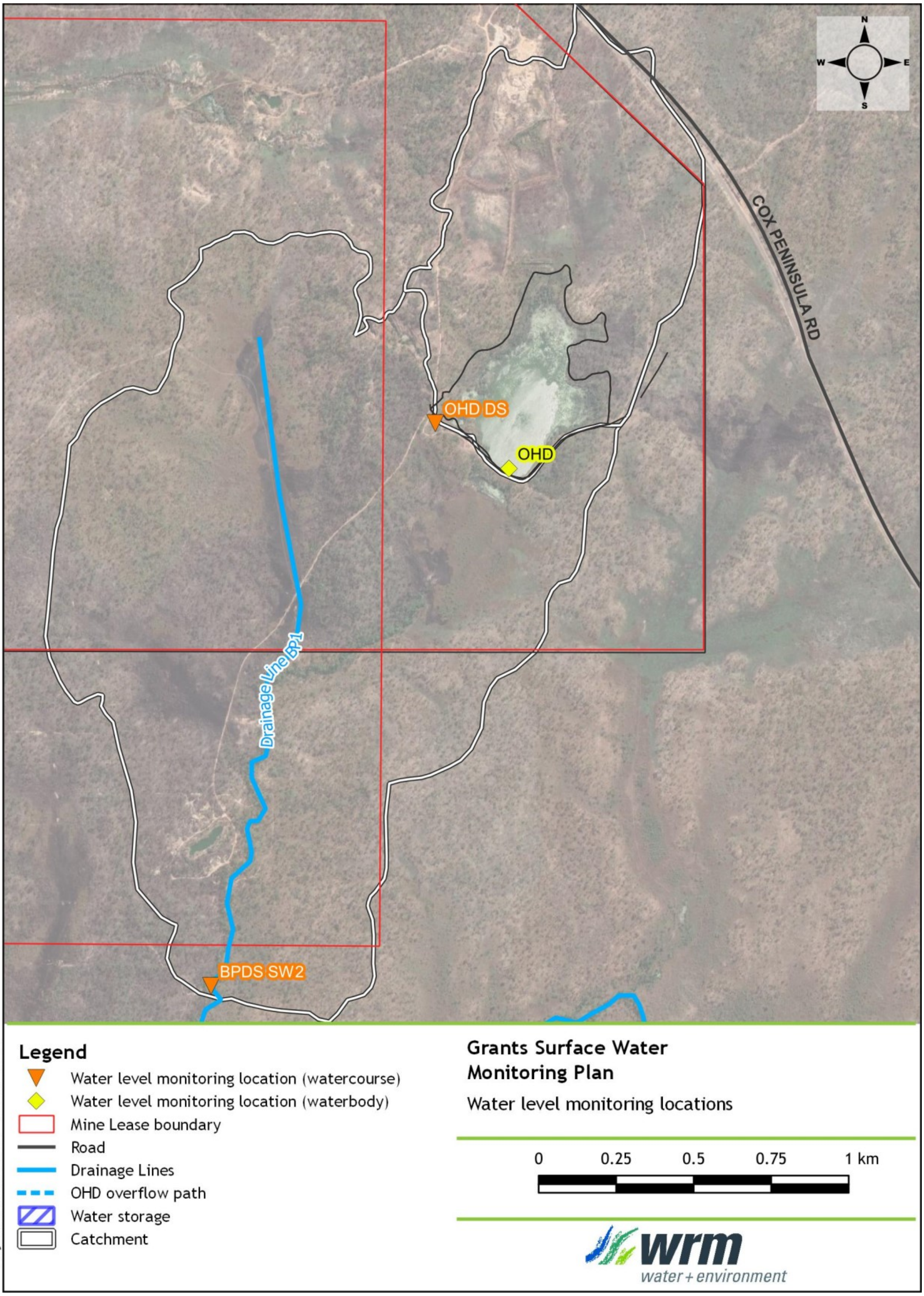


Figure 4-1. Surface water level monitoring locations

4.2 Surface Water Level Monitoring Performance Criteria

The performance criteria to be applied to the surface water level monitoring program is presented in Table 4-2.

The performance criteria assess the potential downstream risk based on the cumulative rainfall and spill days from OHD since the onset of the wet season (1 November of each year). As discussed in Section 3.1.2, the impact on flows downstream of OHD due to extraction of surface water would vary depending on the cumulative rainfall each wet season, recorded at BOM Station 014264. The potential impact category was informed by the relationship between spill days and rainfall derived from Figure 3-1, and range from Level 1 (likely no or minimum impact on the downstream flows) to Level 4 (potential for impact on the downstream environment, based on >45% reduction in flows).

The number of spill days will be informed by the level data from monitoring site OHD DS, and hence this site is considered the compliance site when assessing impacts to surface water flows. Rainfall and level data from OHD DS will be assessed against the performance criteria in Table 4-2 on a monthly basis during the wet season. The TARP which will be implemented based on the performance criteria as detailed in Table 4-4.

Table 4-2. Surface water level monitoring performance criteria

		Cumulative rainfall from 1 November*			
		<1,300mm	**1,300-1,500mm**	**1,500 – 1,700mm**	**>1,700mm**
Number of spill days from OHD from 1 November	**>60**	Level 1	Level 1	Level 1	Level 1
	51-60	Level 1	Level 1	Level 1	Level 2
	41-50	Level 1	Level 1	Level 1	Level 3
	31-40	Level 1	Level 1	Level 2	Level 4
	21-30	Level 1	Level 1	Level 3	Level 4
	5-20	Level 1	Level 2	Level 4	Level 4
	<5	Level 2	Level 3	Level 4	Level 4

*Recorded at BOM Station 014264

Table 4-3. Trigger Action Response Plan for Surface Water Level Monitoring

Level	Trigger*	Action	Response
Level 1 (normal)	Water level data from OHD DS indicates >60 spill days from OHD from 1 November, regardless of rainfall **OR** Cumulative rainfall and spill days in Table 4 2 indicate Level 1 risk (varies depending on rainfall)	• Continue to monitor water levels at OHD DS and BPDS SW2.	• No response required.
Level 2 (early warning)	Water level data from OHD DS indicates number of spill days since 1 November is: <5 spill days for <1,300 mm of rainfall **OR** <20 spill days for 1,300-1,500 mm of rainfall **OR** <40 spill days for 1,500-1,700mm of rainfall **OR** <60 for >1,700 mm of rainfall As per Table 4-2.	• Continue to monitor water levels at OHD DS and BPDS SW2. • Review the OHD operational rules for water extraction. • Review rainfall outlooks to determine if imminent rainfall will reduce risk to downstream flows.	• Amend operational rules for water extraction from OHD as required to minimise impacts on downstream flows.
Level 3 (imminent risk)	Water level data from OHD DS indicates number of spill days since 1 November is: <5 for 1,300-1,500 mm of rainfall **OR** <30 for 1,500-1,700mm of rainfall **OR** <50 for >1,700 mm of rainfall As per Table 4-2	• Continue to monitor water levels at OHD DS and BPDS SW2. • Review rainfall outlooks to determine if imminent rainfall will reduce risk to downstream flows. • Investigate and initiate options to reduce water use onsite, including options to recycle water. • Investigate and initiate options to source water from alternate locations. • Ensure that the site demands are being drawn from the mine water dams and sediment dams as a priority.	• Amend operational rules for water extraction from OHD as required to minimise impacts on downstream flows. • Investigate potential impacts on downstream environment including riparian vegetation. • Implement actions recommended from investigation.

Level	Trigger*	Action	Response
Level 4 (potential for downstream impacts)	Water level data from OHD DS indicates number of spill days since 1 November is <20 for 1,500-1,700 mm of rainfall **OR** <40 for >1,700mm of rainfall As per Table 4-2	• Cease water extraction from OHD. • Reduce non-essential water consumption as much as possible on site to limit operational impacts. • Ensure that the site demands are being drawn from the mine water dams and sediment dams as a priority. • Investigate options for potential additional water sources (including C5 Dam, bore water).	• Investigate potential impacts on downstream environment including riparian vegetation • Implement actions recommended from investigation.

*These figures will be reviewed following the 2022-2023 wet season and refined as required following collection of site specific flow data.

4.3 Riparian Vegetation Monitoring

4.3.1 Overview

Information obtained from the baseline studies and the identified information gaps have been used to develop the Riparian Vegetation Monitoring Program. The Monitoring Program outlines objectives and parameters that can be used to assess the riparian vegetation health during the drawdown and reduced surface flows from OHD as part of operations. For each monitoring type, the following headings have been used:

- Objective
- Survey method – these may include ongoing methods previously used in the baseline surveys or additional (new) methods
- Record keeping - maintenance of data for analysis
- Data analysis.

The following best practice and standards for vegetation monitoring been adopted and assisted in developing this RVMP:

- Brocklehurst et al 2007. *Northern Territory Guidelines and field methodology for vegetation survey and mapping*
- Dixon, I., & Douglas, M (2015). *A Field Guide to Assessing Australia's Tropical Riparian Zones*, Tropical Savannas Cooperative Research Centre for Tropical Savannas Management.
- Eamus, D., & Lamontagne (2006). Groundwater use by riparian vegetation in the wet-dry tropics of Northern Australia, Australian Journal of Botany.
- Florabank (1999-2000) Florabank guidelines and codes of practice www.florabank.org.au/ Greening Australia. Revised 2016. Accessed March 15, 2016
- Lloyd, J., & Cook, S (1996). NT Sampling and Processing Manual, Natural Resources Division, *Department of Lands, Planning and Environment*
- International Erosion Control Association (IECA) (2008). *Best Practice Erosion and Sediment Control.* Picton, NSW. Available at: https://www.austieca.com.au/documents/item/57
- Society for Ecological Restoration (SER) (2018). *National Standards for the Practice of Ecological Restoration in Australia*. 2nd edition, Australia.
- Han., Y., Jung, S., & Kwon, O (2017). *How to utilize vegetation survey using drone image and image analysis software*, Journal of Ecology and Environment 41:18.
- Ancin-Murguzur, F., & Munoz, L., Monz C., &. Hausne V. (2019). *Drones as a tool to monitor human impacts and vegetation changes in parks and protected areas,* Remote Sensing in Ecology and Conservation.
- Wegmann, M., Leutner, B., & Dech, S. (2017). Remote Sensing and GIS for Ecologists using Open Source Software, *Pelagic publishing*

4.3.2 Drone Survey

Objective

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey is to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover.

Methodology

- Create new drone flight path based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI. The new flight path will be an extension of the existing baseline survey

(EcOz 2019) to capture the riparian vegetation extent downstream of OHD to the 1m contour groundwater drawdown ZOI (see Figure 4-2 for indicative drone survey boundary). The indicative flight path will be field verified during 2022 baseline surveys prior to establishing a set flight path.

- Previously Drone Deploy (Software program) was used to design the flight path, however WebODM will be used for this monitoring. WebODM was selected as it contains the correct platform selected for to measure plant health.
- Drone will be flown in the middle of the day to avoid sun light interference i.e. shading. Observations will also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- When importing drone data to create the orthomasoaic, the same methods as per methods in baseline report outlined in section 3 (Appendix A) will be applied, except using WebODM.
- The boundary of the riparian vegetation will then be delineated using the orthomosaic imagery and remote sensing techniques.
- Drone data analysis will be undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.
- These values will be categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, will then be calculated.
- Investigate other environmental factors that may affect results i.e. amount of rainfall between October – April compared to rainfall amounts based on baseline studies to discern environmental factors.

Frequency

The drone survey will occur biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring during 2022, then the monitoring will be reduced to annual (in the late dry season only).

Record Keeping

- Vegetation monitoring database comprised of:
  - The riparian vegetation area size (ha) based on drone mapping for each drone survey.
  - VARI calculations for each survey conducted including varying colour bands and associated class intervals, the area (ha) that occurs within the class intervals and a percentage (%) of pixels that lie within these class intervals.
  - Additional observations that may need to be recorded if further on-ground investigation is require.
- Spatial data
  - All drone images captured during the drone surveys organised in folders.
  - A zip-file of all tiff files derived from drone surveys (both orthomosaic and plant health image).

Data Analysis

Before After/Control Impact (BACI) approach will be applied by performing statistical analysis (VARI) to test whether there is a significant difference between the baseline health data and the riparian vegetation health based on ongoing drone survey assessments.

4.3.3 Riparian Vegetation Site Assessments

Objective

Monitoring and evaluating riparian vegetation diversity and composition at established vegetation sites within ZOI, and an additional site established outside of the ZOI (reference site) to detect changes in riparian vegetation according to diagram presented in Figure 3-3 (Eamus, D., & Lamontagne 2006).

Methodology

Site Selection

- Two existing sites RVS4 and RVS5 will continue to be monitored using the updated monitoring method within this RVMP. Site RVS4 has been kept in the monitoring plan to detect immediate impacts from reduced SW flows downstream OHD. Existing site RVS5 has been retained as it is nearby a groundwater monitoring bore.
- Three new monitoring sites (RVS1, RVS2 and RVS3) will be established downstream of OHD within the ZOI (Figure 5). The location of these sites are suitable for monitoring as they lie within the potential GDE areas, align near existing bores for groundwater level monitoring (RVS3 and RVS2) and spatially correspond to immediate groundwater drawdown impacts (RVS3 located closest to the underground) and longer term potential impacts (RVS1 located near the 1m contour) (Figure 4-2).
- One new reference site upstream of Charlottes Creek (BP33 Control), in a similar riparian zone within the potential GDE area will be established with baseline monitoring commencing post-wet season 2022 (Figure 4-2). This site is outside of the predicted ZOI. The site was selected using various resources including up to date aerial imagery, mine components, and Land Units of the Greater Darwin Region (Fogarty et al. 1984).
- Sampling site locations for other BP33 project studies, such surface water, groundwater and biota monitoring have also been considered when selecting the new riparian vegetation monitoring sites. The precise locations will be verified in field during the 2022 post wet season survey.

Frequency

- Monitoring is to occur at all sites biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring, then monitoring will be reduced to annual (in the late dry season only).

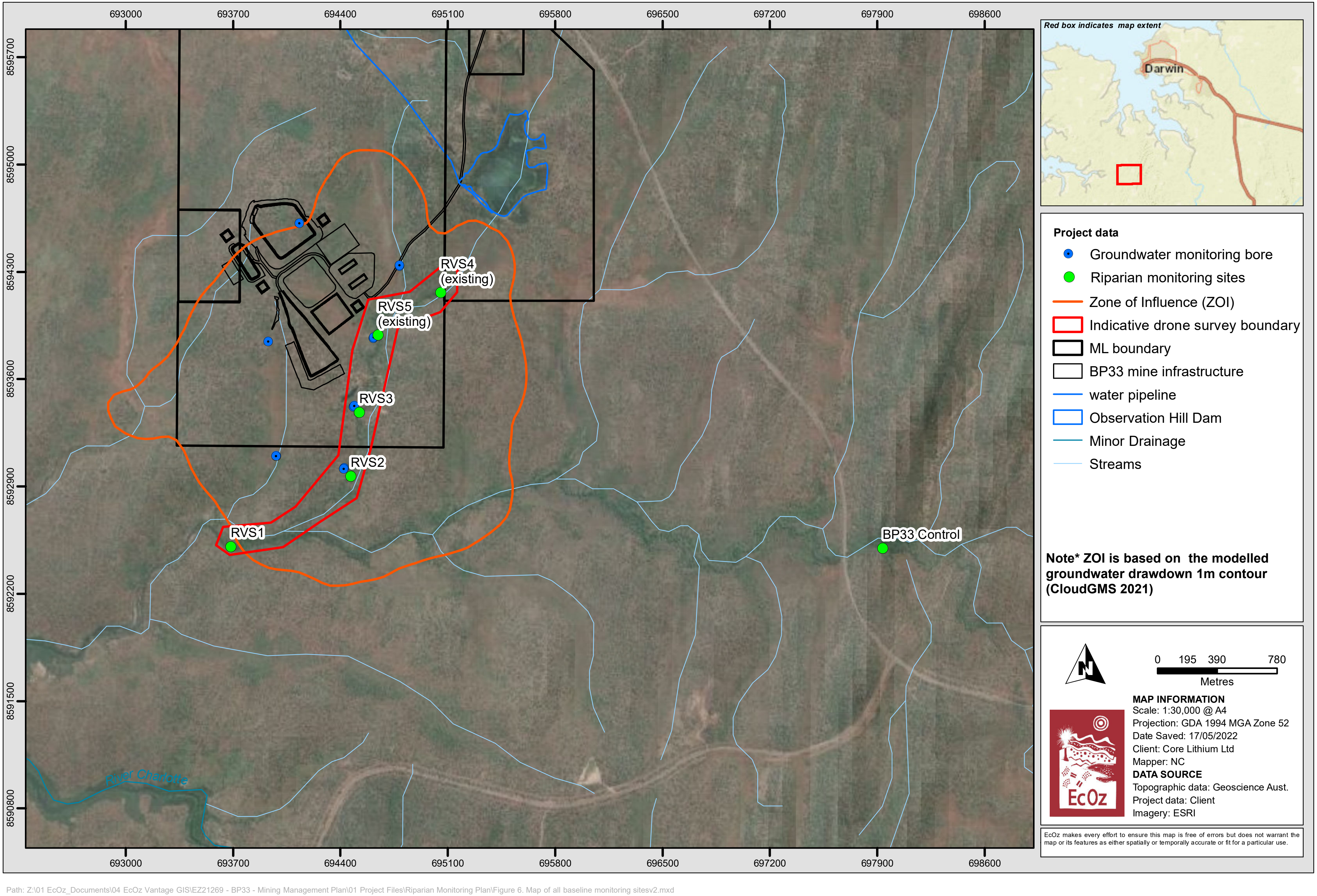


Figure 4-2. Map of riparian vegetation monitoring sites, indicative drone imagery boundary and modelled groundwater drawdown 1m contour

Vegetation Monitoring

Vegetation site assessment monitoring methods have been adopted utilising the potential consequences of the groundwater drawdown affect as presented in the diagram outlined Figure 3-3. As indicated, the effect may take several years before physical changes become apparent. Monitoring methods are outlined below:

- A plot size of 20 x 20m will be established at each new riparian monitoring site, using star pickets. Existing plots RVS4 and RVS5 will be re-monitored at established plots (existing star pickets present).
- In each plot the dominant layer/emergent layer species will be recorded; this includes all seedlings (woody plants under 1m in height), saplings (woody plants between 1m and 3m high and < 2cm diameter at breast height, or DBH) and trees (woody plants with stems ≥ 2cm DBH and greater than 3m high) will be identified (both native plants and invasive plants included). For each individual the height will be estimated and the % cover will be measured. All individual woody plants within the plot will also be marked alive or dead, whether the plant is fruiting/flowering. Note, deciduous trees will not be recorded as dead during the dry-season monitoring.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) will be tagged on hand held GPS for future ongoing measurements. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* (observed at RVS4, RVS5).
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) will be recorded. The results from this method will be used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation will be recorded to a standard that is equivalent to Level 5 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity will be monitored by traversing along a 100m transect from the middle monitoring site and visually estimate the canopy cover (or by using a densitometer) of the native vegetation to indicate how continuous the canopy cover is along the transect. Note, a break in the continuity must be at least 5 m between tree crowns and span the entire width of the transect (Figure 4-3). If one tree is missing within a wide riparian zone it will not be counted as a break in the canopy continuity because the break must span the entire width of the riparian zone.

Table 4-4 summarises monitoring methods and how they will be used to measure the potential consequences of the reduction in surface flows and/or groundwater drawdown.

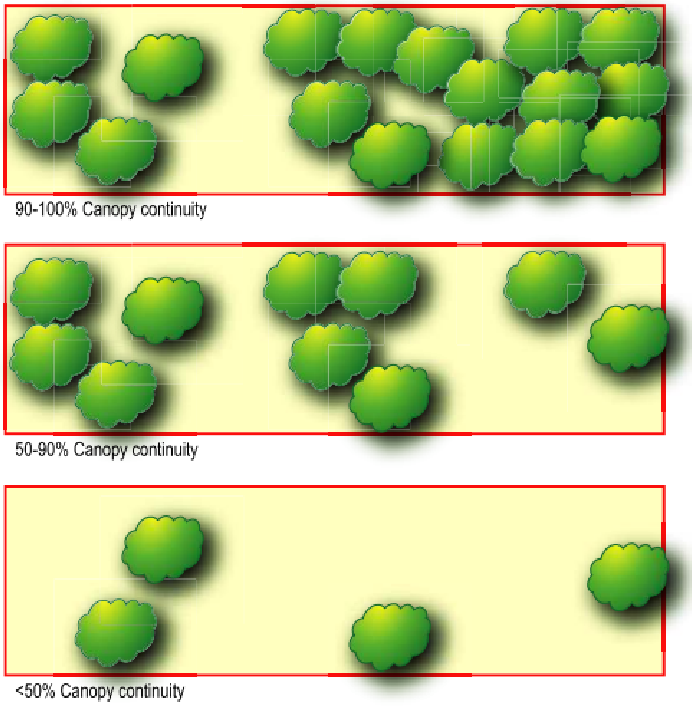


Figure 4-3. An example pictorial used for measuring canopy continuity (Dixon & Douglas 2015).

Table 4-4. Summary of monitoring methods that will be used to measure potential impacts of the reduction of surface water flows and groundwater drawdown

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree tagging	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 5 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

Photo point monitoring

- Four cardinal photo monitoring points (north, east, south, west) will be obtained within each plot.

Record keeping

- Vegetation monitoring database – comprised of seedling, sapling, and tree data for individual species and associated heights, DBH's and records of vegetation health e.g. % dead or sick plants.
- Ground cover data - percent cover and species richness.
- Photo monitoring point database.

Data analysis

The data collected based on monitoring methods outlined Table 4-4 will be statistically analysed using the Before After/Control Impact (BACI) approach. BACI will be applied by performing statistical analysis to test whether there is a significant difference between the baseline health data and riparian vegetation assessment data at the same sites, and riparian vegetation assessment data compared to reference site data.

Data captured for analysis includes:

- Species composition (%) using individual dominant/emergent plant data.
- Average heights of individual plants across riparian vegetation sites compared to reference site.
- Canopy cover (%) for each dominant, and emergent species across riparian vegetation assessment sites compared to reference site data.
- Plants alive or dead (%) across all riparian vegetation sites compared to reference site data.
- The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site.
- The ground cover percentages (vegetation type, soil, rock, litter).
- Type of ground cover percentages in the form of herbs/vines/grasses/ferns and sedges).

4.3.4 General Observations

Monitoring of other environmental factors is critical as they are contributing factors that can severely impact the health of riparian vegetation. Objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is discussed below.

Weeds

Weed data collection will be conducted in accordance with the Northern Territory Weed Management Branch (WMB 2015), Northern Territory Weed Data Collection Manual.

The percentage cover of weed species (declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat will be visually estimated for each weed species.

A GPS will be used to record locations of identified weed species, and will record the following information:

- Weed name
- Distribution - size (20, 50 or 100m diameter)
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1-5, 1 (absent) to 5 (>50%)
- Growth stage (seedling, juvenile, adult)
- Seeded (has the weed seeded?)
- Treatment (has the weed been treated and if so with what method of treatment)
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data will also be recorded outside of the plots to obtain surrounding data while traversing along the riparian area to visit each monitoring site.

Fire

<u>Broad scale</u>

Fire scar mapping and scoring will be determined by drone survey and mapped with NAFI each year to investigate frequencies and severity across the mapped riparian area.

<u>Site (plot) based</u>

At each plot an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and for recently burnt sites the severity will be scored from 1 to 4. Categories for characterisation of fire are:

- No evidence of fire
- Evidence of groundcover fire only
- Evidence of burnt saplings
- Evidence of fire in canopy layer.

Erosion

<u>Broad scale</u>

- Monitoring the presence of erosion (on a broader scale basis) may be more effective using remote sensing with the use of the drone imagery captured as per section 2.2. Monitoring erosion using monitoring plots can often mean that issue areas can be missed.
- It is recommended to flag any potential erosion issues identification with aerial imagery and follow-up with on-ground monitoring so that erosion risks are to be measured and remedial actions implemented.

<u>Site (plot) based</u>

At each plot note the presence or absence of erosion will be recorded, and if present the following characteristics will be recorded:

- Types of erosion i.e. gullying, sheet erosion etc
- The amount of bare ground above
- Tree root exposure – any roots exposed due to disturbance
- Slumping
- Fallen trees/woody debris
- Presence of surrounding erosion
- Width of riparian zone – measure or estimate the width of the riparian zone (facing downstream) for both sides of banks.

Aquatic life

Presence of aquatic life within the water will also be recorded. This will involve a record of aquatic fauna and flora at the nearest water access point from each of the vegetation monitoring plots.

Surface water flows

Presence of water flows at the time of surveying will be documented. Surface water flows will be assessed in accordance with the surface water flows monitoring plan (WRM 2022).

Sedimentation

Presence of sedimentation within the water and on the riparian vegetation.

Contamination

- Presence of potential contamination (foam/scum/oils) and odour will be documented.

Climatic conditions

Weather observation will be documented during the monitoring. The annual rainfall, evaporation and temperature will be recorded from the same station and discussed for survey data comparison.

The following monitoring will be undertaken in accordance with the Grants and BP33 water management plans:

- surface and groundwater quality
- sediment monitoring
- macroinvertebrate monitoring
- groundwater levels will be assessed in accordance with the GDE Management plan (Groundwater Enterprises and RDM Hydro 2022).

Record keeping

All observations and data captured will be uploaded after each monitoring event, mapped as required and all records maintained in excel database.

4.3.5 Summary of Riparian Vegetation Monitoring Requirements

Table 4-5 outlines the RVMP schedule, prior to any significant disturbance and for the duration of the OHD SWEL, BP33 life of mine and three years post operations when the groundwater levels are predicted to return to pre-mining conditions (CloudGMS 2021).

Table 4-5. Riparian vegetation monitoring schedule

Monitoring	When	Monitoring undertaken	Frequency of monitoring	Locations
Baseline drone survey	End of Wet season (May) and end of dry season (October) 2022	Drone flight path to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Baseline riparian vegetation site assessment survey	End of Wet season (May) and end of dry season (October) 2022	Site assessment at all identified locations to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Drone survey	End of dry season (October) 2023 onwards	Drone flight	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Riparian vegetation site assessment survey	End of dry season (October) 2023 onwards	Site assessments	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control

4.4 Riparian Monitoring Program Performance Criteria and TARP

A TARP relating to the results of the Riparian Vegetation Monitoring Program is presented in Table 4-6**.** The TARP incorporates triggers and responses from the surface water monitoring program (Section 4.1) and GDE Management Plan quantitative triggers and limits and/or adaptive management actions.

Table 4-6. Riparian vegetation monitoring program performance criteria and Trigger Action Response Plan

Level	Trigger	Performance Indicator		Action	Response
		Drone Survey	Riparian Vegetation Site Assessment		
Level 1 (normal)	No reduction in riparian vegetation extent and/or structure/ composition compared to baseline	Vegetation biomass using VARI analysis comparable to baseline mapping.	No change in in general vegetation health compared to reference sites i.e. no tree mortality or physical changes to health of plants through the use of on-ground assessment and photo monitoring points.	No action required	No response required
Level 2 (early warning)	10% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	There is no greater than a 10% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping	Vegetation structure and composition – there is no greater than 10% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites Groundcover – there is no greater than 10% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites Tree mortality – there is no greater than 10% tree mortality of tagged plants recorded compared to the representative reference sites General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 90% of the dominant species present within each strata) Tree canopy continuity – there is no greater than 10% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Continue to monitor in accordance with RVMP Investigate other potentially contributing environmental factors and likely reason for reduction in riparian vegetation extent. Conduct drone monitoring in GDE reference site Implement action in surface water flows monitoring program (Table 4-3) TARP Level 2. Investigate management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022).	Implement response in surface water flows monitoring program (Table 4-3) TARP Level 2. Report on the outcomes of the actions undertaken to the regulator.
Level 3a (elevated risk)	25% reduction in riparian vegetation extent	There is no greater than a 25% loss of the 3.6 ha vegetation biomass	Vegetation structure and composition – there is no greater than 25% reduction in the number of plants, saplings, and recorded within the plots of	Implement action in surface water flows monitoring program (Table 4-3) TARP	Implement response in surface water flows monitoring program (Table

Level	Trigger	Performance Indicator		Action	Response
	and/ or structure/ composition compared with baseline	using VARI analysis comparable to baseline mapping	that recorded at the representative reference sites Groundcover – there is no greater than 25% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites Tree mortality – there is no greater than 25% tree mortality of tagged plants recorded compared to the representative reference sites General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 75% of the dominant species present within each strata) Tree canopy continuity – there is no greater than 25% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Level 3. Further investigate extent of riparian vegetation reduction within ZOI, including assessment of the drainage line flowing east to west within the ZOI. Conduct biannual riparian vegetation site assessment (end of wet season and end of dry season) and compare seasonal variability to 2022 baseline data.	4-3) TAR Report on the outcomes of the investigation of riparian vegetation health within ZOI to regulator. Report on the outcomes of the seasonal variability (additional monitoring at end of wet season and dry season) to regulator. Report on outcomes of the investigation of management actions as outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) to the regulator.
Level 3b (imminent risk)	50% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	There is no greater than a 50% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping	Vegetation structure and composition – there is no greater than 50% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites Groundcover – there is no greater than 50% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites Tree mortality – there is no greater than 50% tree mortality of tagged plants recorded compared to the representative reference sites General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 50% of the dominant species present within each strata) Tree canopy continuity – there is no greater than 50% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Implement action in surface water flows monitoring program (Table 4-3) TARP Level 3. Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. Further investigate extent of riparian vegetation reduction outside 1m contour groundwater drawdown ZOI. Revise BP33 mine closure plan (MCP) and rehabilitation management plan (RMP) to include reinstatement of habitat values in the affected riparian areas and monitoring of ecosystem recovery and submit to Controller or Water Resources and NT EPA CEO	Implement response in surface water flows monitoring program (Table 4-3) TARP Level 3. Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Performance Indicator		Action	Response
				for approval	
Level 4 (exceedance of approved limits)	Loss of >3.6 ha of identified GDE vegetation extent and/or structure/ composition	There is no greater than a 100% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping.	Vegetation structure and composition – there is no greater than 100% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites Groundcover – there is no greater than 100% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites Tree mortality – there is no greater than 100% tree mortality of tagged plants recorded compared to the representative reference sites General vegetation description using NVIS level 5 does not align with the representative reference site descriptions (i.e. indicating new ecosystem structures and functions have appeared) Tree canopy continuity – there is no greater than 100% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Implement action in surface water flows monitoring program (Table 4-3) TARP Level 4. Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. Implement approved RMP. Notify NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.	Implement response in surface water flows monitoring program (Table 4-3) TARP Level 4. Report on the outcomes of the actions undertaken to the regulator.

5 REPORTING AND REVIEW

A monitoring report will be developed as per condition 4.2 of SWEL 8151018 and include data collected in accordance with the monitoring program under condition 4.1 for the previous water accounting year (1 May to 30 April). The report will:

- Include data collected on surface water flows and riparian vegetation monitoring, for the previous water accounting year.
- Outline management actions taken in response to quantitative triggers or limits, established in Section 4.2 and 4.4.
- Include a summary of updated surface water modelling using the most recent monitoring data.
- Discuss the measured and modelled impacts of water taken under the licence on downstream riparian vegetation and surface water flows.

A copy of the Monitoring Report will be published on Core's website such that it is publicly available.

This Monitoring Plan will be reviewed annually, based on the results of surface water flows and biannual riparian vegetation monitoring, to ensure continuous improvement of the monitoring program in accordance with Condition 4.1 of the SWEL (8151018). Data management and reporting is key to inform the review process. The triggers for surface water flows (presented in Table 4-3) will be refined in the next review of this Monitoring Plan once site specific data is obtained on surface water flows over the coming wet season.

Table 5-1. Data and report review schedule

Task	Timing	Responsibility
Review surface water flows data; assess performance against spill days and rainfall matrix	Monthly during wet season May (annually) after the water accounting year	Core Lithium Environmental Team
Review riparian vegetation monitoring data	Annually after late dry season monitoring event	
Monitoring Report	By 13 August each year	
Monitoring Plan review	August annually	

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APPENDIX A OBSERVATION HILL DAM SURFACE WATER MONITORING PROGRAM (TECHNICAL MEMORANDUM)

APPENDIX B MANGROVE AND RIPARIAN VEGETATION ASSESSMENT REPORT

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Observation Hill Dam Surface Water Extraction Licence Monitoring Report 2022

Finniss Lithium Project

Project details	
Surface Water Extraction Licence (SWEL) number:	8151018
Licence holder	Core Lithium Ltd.
Document Title	Observation Hill Dam Surface Water Extraction Licence Monitoring Report 2022
Reporting period	1 December 2021 to 30 April 2022
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1	Paul McHugh	Paul McHugh (Core)	Core Lithium and DEPWS	7 June 2022

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ACRONYMS

BACI	before after/control impact
BOM	Bureau of Meteorology
DEPWS	Department of Environment, Parks and Water Security (Northern Territory)
DRM	downstream risk matrix
GDE	groundwater dependant ecosystem
ML	Mineral Lease (granted)
NVIS	National Vegetation Information System
OHD	Observation Hill Dam
RVMP	Riparian Vegetation Monitoring Plan
RWD	Raw Water Dam
SILO	Scientific Information for Land Owners - online climate database
SWEL	surface water extraction licence
SWMP	Surface Water Monitoring Program
TARP	trigger action response plan
VARI	visible atmospherically resistant index

1 INTRODUCTION

1.1 Background

Core Lithium Limited (Core) was granted a surface water extraction licence (SWEL) 8151018 under section 45 of the *Water Act* 1992 (Northern Territory) in November 2021. The SWEL permits the use of surface water from the existing Observation Hill Dam (OHD) located on mineral lease (ML32074) for the beneficial use of mining on ML31726 and ML32074. The SWEL period is from 1 December 2021 until 30 April 2025 (3.5 years). The maximum licenced extraction volume is 620ML/year, with water entitlements per period as provided in Table 1-1.

Table 1-1. Licenced extraction volumes under SWEL 8151018

Entitlement	Period
310 ML	Commencement date (1/12/2021) to 30/04/2022
310 ML	1/05/2022 to 31/10/2022
61 ML	1/11/2022 to 30/04/2023
121 ML	1/05/2023 to 30/04/2024
121 ML	1/05/2024 to 30/04/2025

Condition 2.2 of the SWEL permits Core to apply for a change of the period which will allow an increase in entitlements for that period, however the total water extraction is not allowed to exceed the maximum water entitlement of 620 ML/year and the amended entitlement for that period.

Grants Lithium Project (Grants) commenced construction during quarter 4 2021. Water sourced from OHD for the Grants mine is pumped via a 6 km long buried pipeline (constructed and commissioned in Q4 2021) which traverses across both ML32074 and ML31726 from OHD to the Raw Water Dam (RWD) located at the Grants mine.

1.2 Scope and purpose

The purpose of this SWEL Monitoring Report is to fulfil the reporting requirements of SWEL 8151018 Condition 4.2, which stipulates that Core must provide a monitoring report to the Controller within 2 weeks of 30 June each year of the licence.

The monitoring report must:

> *(vi) include data collected in accordance with the monitoring program under 4.1 for the previous reporting year (1 May – 30 April);*
>
> *(vii) outline any management actions taken in response to the quantitative triggers or limits established under 4.1(iii);*
>
> *(viii) include a summary of the outputs from updated surface water modelling using the most recent monitoring data;*
>
> *(ix) discuss the measured and modelled impacts of water taken under this licence on the downstream riparian vegetation and surface water flows; and*
>
> *(x) publish a copy of the monitoring report on a website on the internet that is publicly accessible.*

As this is the first monitoring report for SWEL 8151018, the report provides background information and a reporting framework for future reporting of monitoring data where monitoring data is currently unavailable.

1.3 Reporting period

The monitoring report period is 1 December 2021 to 30 April 2022 (5 months).

2 SURFACE WATER EXTRACTION

2.1 Observation Hill Dam

OHD was originally constructed to supply water for tin and tantalite mining and ore processing that occurred in the 1980's and 1990's (Frater 2005).

2.1.1 Catchment and drainage

The existing OHD lies within the Charlotte River catchment and drains into Bynoe Harbour. The OHD receives runoff from a 93.9 ha catchment generally south of the Cox Peninsula Road (WRM 2022).

OHD is situated in the upper reaches of a north-south trending stream order 1 drainage line. The unnamed drainage line flows south for approximately 3 km to the confluence of a stream order 3 waterway and flows west for around 3 km to meet the tidal, mangrove-lined upper reaches of the Charlotte River.

Immediately downstream of OHD, there is a broad, open wet area with poorly defined drainage that supports wetland sedges and herbs during the wet season and early dry season, but mostly dries out later in the dry season. Approximately 1 km downstream of the dam wall the watercourse has a well-defined channel. Around 2 km downstream of the OHD wall the watercourse has well-developed riparian vegetation. A site inspection conducted by EcOz in late-dry season (October 2017), observed pools persisting around 2 km downstream of the OHD but no visible flows.

2.1.2 Capacity

The estimated dam volume when full is around 364 ML (EnviroConsult 2018) and dam yield is estimated to be 591 ML/year. To ensure water security for the project in the event of lower-than-average rainfall, the dam wall will be raised by 1.4 m at the embankment and 1.5 m at the spillway (to 31.4 m AHD) increasing the storage capacity from 364 to 620 ML. The wall raise is proposed to be constructed during the 2023 dry season.

2.2 Volume extracted this reporting period

During the reporting period, water extraction from OHD was within the entitlement limit for the period (Table 2-1). The OHD Surface Water Extraction Record is provided in Appendix A.

Table 2-1. Surface water extraction volume from Observation Hill Dam during the reporting period

Beneficial Use of Water Entitlement	Period	Maximum Water Entitlement (ML)	Water Usage (ML)
Mining activity: Construction / dust suppression	1/12/2021 to 30/04/2022	310	3.22

The water extraction volume for the reporting period is minimal as the Grants mine is in the construction and commencement of operations phase and requires water for dust suppression only. Dust suppression needs have been minimal during the wet season reporting period.

3 MONITORING PROGRAMS

The Riparian Vegetation Monitoring Plan (RVMP) and Observation Hill Dam Surface Water Monitoring Program (SWMP) were developed by EcOz (2022) and WRM (2022) respectively and submitted for approval to DEPWS in May 2022. The sections below provide a summary of the monitoring programs. Subsequent monitoring reports will include data collected in accordance with the approved monitoring programs.

3.1 Riparian vegetation

EcOz (2019) undertook an assessment of the riparian vegetation along the waterway downstream of OHD. Riparian vegetation boundaries were mapped using drone imagery captured in March 2019, and an on-ground survey describing the riparian vegetation community present and its condition was undertaken in June 2019. The survey identified the riparian community as *Xanthostemon eucalyptoides*, *Syzygium armstrongii* and *Erythrophleum chlorostachys* mid woodland over *Pandanus spiralis*, *Helicia australasica* and *Carallia brachiata* mid shrubland over *Eriachne triseta* mid tussock grassland. The community was found to be in good condition with no major weed populations or fire impacts.

The presence of this riparian vegetation indicates this waterway receives a proportion of groundwater inputs to sustain this freshwater-dependant community during the dry season. This is also supported by the observation of pools (but not flowing water) persisting along this waterway during site visits by EcOz during the mid to late dry season. The area is also mapped as a 'moderate' potential groundwater dependant ecosystem (GDE) in the national GDE Atlas (BoM 2021).

Riparian vegetation communities are not rare as such, but they are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DEPWS 2021).

The RVMP has been developed in accordance with Special Condition 4.1 of SWEL 8151018, and stipulates riparian vegetation monitoring methodologies, locations and frequency (refer to Appendix B).

Drone survey will be undertaken to capture imagery of riparian vegetation and allow for comparison over years to identify any retraction or change in coverage of riparian vegetation. An indicative location of the drone survey is presented in Figure 5 of the RVMP (Appendix B). Vegetation health will be analysed using Visible Atmospherically Resistant Index (VARI), with 'green' imagery representing healthy vegetation and red imagery representing bare ground (class intervals will be established to categorise how green an image is). Drone surveys will initially be undertaken biannually to establish a baseline; once at the end of the wet season and once at the end of the dry season, to account for seasonal variability. Once a baseline is established, drone surveys will be undertaken annually, in the late dry season only.

Riparian vegetation site assessments will also be undertaken at five sites located along the watercourse east and south of the mine site (tributaries of the Charlotte River), and one control (reference) site located upstream of Cox Peninsula Road, on a tributary of the Charlotte River. Site locations are presented in Figure 5 of the RVMP (Appendix B). Dominant layers, ground cover and species richness will be recorded, including presence of invasive species. Vegetation will be described and recorded to a standard that is equivalent to National Vegetation Information System (NVIS) Level 5, and in accordance with Brocklehurst et al. (2007). Riparian vegetation continuity will be measured along a transect, and canopy cover will be used to represent continuity. Data will be analysed using the Before After/Control Impact (BACI) method to assess change over time. As with the drone surveys, initially riparian vegetation site assessments will be undertaken biannually to establish a baseline (once at the end of the wet season and once at the end of the dry season), after which surveys will be undertaken annually at the end of the dry season.

A Trigger Action Response Plan (TARP) has been developed in the RVMP, which provides triggers for action and responses to be implemented, based on monitoring performance indicators. Refer to Table 4-1 of the Riparian Vegetation Management Plan (Appendix B).

3.1.1 Data

Further baseline data was recently collected in May 2022 to provide additional data for monitoring of reduced flows downstream of OHD. This data is considered baseline due to the limited surface water extraction volume to date during the 2021-2022 wet season (3.22 ML). A report will be prepared that combines the 2019 and 2022 baseline data and will be included in the subsequent monitoring report. No impact monitoring has been undertaken to date as no significant water extraction has occurred and plans yet to be approved by DEPWS. The first round of impact monitoring will be undertaken in the late dry season 2022, with results reported in the next monitoring report.

Riparian vegetation monitoring data will be entered into databases and compared to assessment criteria stipulated in the RVMP.

3.2 Surface water flows

The Finniss Lithium Project Observation Hill Dam Surface Water Monitoring Program (SWMP) outlines the flow monitoring that will be undertaken at OHD spillway and the downstream surface water site BPDS SW2 (see Appendix C). The SWMP has been developed in accordance with Special Condition 4.1 of SWEL 8151018. The monitoring will:

- provide information on the performance of the water management system
- ensure compliance with SWEL 8151018
- provide important flow data to inform analysis of riparian vegetation monitoring data
- facilitate adaptive management of water onsite.

Water levels will be monitored continuously within OHD to provide information on the volume of water stored and inform usage decisions. Additionally, stream gauges will be installed at OHD spillway and BPDS SW2 to provide continuous data on the impact of water extraction from OHD on flows over the spillway and downstream. The locations of proposed water level/flow monitoring sites are shown on Figure 5-1 of the SWMP (Appendix C).

Prior to the onset of the 2022 wet season, sensors will be installed within the OHD spillway and BPDS SW2 (drainage line downstream of OHD). The instruments will have capability to continuously measure water velocity and water level / depth. Additionally, the water level will be measured within the OHD.

Data remotely collected by loggers will be transmitted to the Grants site server. This will allow for continuous real time data collection and monitoring.

Rating curves will be developed for the OHD spillway and BPDS SW2 monitoring locations during 2022. See section 5 of the WRM (2022) SWMP (Appendix C) for further details.

A downstream risk matrix (DRM) has been developed which identifies the risk to the downstream environment based on spill days and cumulative rainfall scenarios (see Table 6-1 of Appendix C). Actions will be implemented in accordance with the TARP to minimise impacts on environmental flows. The TARP is based on the volume of water extracted from OHD and provides triggers depending on the volume extracted compared to the SWEL entitlement volume and period. Actions to be implemented to avoid over-extraction include (in order of priority):

- checking all monitoring equipment is calibrated and operating correctly
- ensuring all water infrastructure is operating correctly and efficiently (e.g. no leaks)
- investigate strategies to reduce water use
- ensuring water in mine site storages is used as a priority prior to extraction from OHD
- seeking approval for an increase to the water entitlement
- ceasing extraction if surface water entitlement is exceeded.

3.2.1 Data

No flow data has been captured to date. Gauging stations will be installed prior to the onset of the 2022 wet season, and data collected will be provided in the next monitoring report.

4 MANAGEMENT ACTIONS

This section will outline any management actions taken during the subsequent reporting periods in response to the quantitative triggers or limits established in the SWMP when surface water flows deviate significantly from the predictions (as per TARP in Appendix C).

5 SURFACE WATER MODELLING

Subsequent monitoring reports will provide a summary here-in of updated surface water modelling undertaken with future monitoring data collected as per the SWMP (Appendix C).

A summary of the baseline surface water modelling and potential impacts is provided in Section 6.2.

6 IMPACTS OF WATER EXTRACTION

This section provides the available measured and modelled impacts of water taken under SWEL 8151018 on the downstream riparian vegetation and surface water flows.

Potential environmental impacts to areas downstream of OHD were assessed as part of the Grants environmental approvals and Core's existing Mining Authorisation provides approval for raising of the dam wall and sourcing water from OHD, under a Water Extraction Licence. A summary of these impacts is provided below.

6.1 Riparian vegetation

6.1.1 Measured

There are currently no measured vegetation monitoring impacts for the reporting period. Future measured data collected will be compared with the 2019 and 2022 baseline data as described in section 2 of the RVMP (Appendix B).

6.1.2 Modelled

Potential impacts to riparian vegetation from surface water flow reduction is discussed below.

6.2 Surface water flows

6.2.1 Measured

There are currently no measured surface water flows impacts for the reporting period. Measured flows collected during the subsequent reporting period will be compared the modelled flows as discussed in section 6.2.2.

6.2.2 Modelled

Estimated peak operational water demand used for the Grants surface water modelling (EnviroConsult 2019) is 2.02 ML/day (approximately 63 ML/month), based on dry season water usage when dust suppression demand is greatest. Hydrological modelling was undertaken by EnviroConsult (2019) based on a standard daily extraction rate of 2.02 ML/day, i.e. a worst-case scenario. This is an overestimate as:

- It assumes consistent water extraction year-round, when in reality wet season dust suppression requirements will be minimal and peak water use (2.02 ML/day) may only occur in some dry season months.
- Other inputs will provide some mine water, including dewatered pit water and tailings dam decant water, reducing the need for extraction from OHD.

The outcomes of the EnviroConsult (2019) surface water modelling are considered to represent a worst-case scenario for downstream impacts due to water extraction from OHD. A summary of the influence of water extraction and OHD wall lift on downstream flows (EnviroConsult 2019) is provided below.

The modelled flow volumes based on the 24hr SILO rainfall data for an average year for the various scenarios at the spillway, Charlotte River catchment outlet and watershed outlet to Bynoe harbour is shown in Table 6-1 to Table 6-3 respectively.

Table 6-1. Flow volume (ML) at the OHD spillway (EnviroConsult 2019)

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr	Total
Natural catchment condition (no OHD, no pumping)	58	14	554	289	145	51	1111
Current OHD without pumping	0	0	323	253	108	28	**712**
Current OHD and 2.02 MLd-1 pumping applied	0	0	117	195	80	0	**392**
OHD spillway raised to 31.5 mAHD without pumping	0	0	78	240	98	26	442
OHD spillway raised to 31.5 mAHD and 2.02 MLd-1 pumping applied	0	0	0	42	79	0	121

Table 6-2. Flow volume (ML) at the catchment outlet to Charlotte River (EnviroConsult 2019)

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr	Total
Natural catchment condition (no OHD, no pumping)	100	28	2035	1097	612	177	4049
Current OHD without pumping	42	13	1803	1062	574	155	3649
Current OHD and 2.02 MLd-1 pumping applied	42	13	1598	1005	547	126	3331
OHD spillway raised to 31.5 mAHD without pumping	42	13	1588	1049	565	152	3409
OHD spillway raised to 31.5 mAHD and 2.02 MLd-1 pumping applied	42	13	1483	849	545	126	3058

Table 6-3. Flow volume (ML) at the watershed outlet to Bynoe Harbour (EnviroConsult 2019)

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr	Total
Natural catchment condition (no OHD, no pumping)	453	164	14920	8482	4896	1308	30223
Current OHD without pumping	396	148	14687	8448	4858	1286	29823
Current OHD and 2.02 MLd-1 pumping applied	396	148	14482	8390	4830	1258	29504
OHD spillway raised to 31.5 mAHD without pumping	396	148	14442	8434	4849	1284	29553
OHD spillway raised to 31.5 mAHD and 2.02 MLd-1 pumping applied	396	148	14369	8233	4829	1258	29233

EnviroConsult (2019) modelling showed that surface water flows will be reduced in the drainage line downstream of the OHD when water extraction occurs. The maximum reduction in monthly flow volumes, based on a worst-case scenario (extraction of 2.02 ML/day) is:

- 100% at the spillway
- 58.3% at the confluence of the Charlotte River (i.e. for the larger sub-catchment that contains the OHD)
- 12.6% at the discharge point to Bynoe Harbour (see Table 6-4).

Altered flow reductions only occur during the mid to late-wet season months of January, February, March and April. There is no change in flow regime for the early to mid-wet season (November, December) because the existing dam wall would have reduced flows during this time anyway. Raising the dam wall extends the time it takes for the dam to fill and spill.

Table 6-4 presents the modelled reduction in downstream flows at the OHD spillway, at the catchment outlet to Charlotte River and at the outlet to Bynoe Harbour. Each location shows the modelled outcomes of four scenarios of the OHD;

- previously existing condition (no raised spillway, no pumping)
- spillway raised to 31.5mAHD and no pumping
- current condition (no raise spillway and 2.02 MLd-1 pumping applied)
- spillway raised to 31.5mAHD and 2.02 MLd-1 pumping applied.

The difference between the previously existing condition (no raised spillway and no water extraction) and the current condition (no raised spillway, water extraction at 2.02ML/day) is shown in Table 6-4 as the OHD spillway is not proposed to be raised until the dry season of 2023, thus represents the scenario over the next 12 months. The largest difference in reduction is observed at the spillway during April (56%), however the reduction is significantly reduced 3 km downstream (16.1% in April) and less than 2.5% at the Charlotte River outlet to Bynoe Harbour, 4.5 km downstream.

Table 6-4. Modelled accumulated percentage reduction in downstream flows compared with natural catchment condition – no OHD for average rainfall year (EnviroConsult 2019).

Site Description	Conditions	Nov	Dec	Jan	Feb	Mar	Apr
Spillway	**Previously existing conditions (no raised spillway, no pumping)**	**100%**	**100%**	**41.8%**	**12.2%**	**25.6%**	**43.9%**
	Spillway raised to 31.5mAHD. No pumping	100%	100%	86.0%	17.0%	32.0%	48.0%
	Current conditions 2.02 MLd-1 pumping applied.	**100%**	**100%**	**78.8%**	**32.4%**	**44.6%**	**100%**
	Spillway when raised to 31.5mAHD. 2.02 MLd-1 pumping applied.	100%	100%	100%	85.6%	46.7%	100%
	Difference between previously existing conditions (no pumping) and current conditions (no raised wall, 2.02 MLd-1 pumping applied).	**0**	**0**	**37**	**20.2**	**19**	**56**
Approximately 3 km downstream. Catchment outlet to Charlotte River.	**Previously existing conditions (no raised spillway, no pumping)**	**58.3%**	**52.8%**	**11.4%**	**3.1%**	**6.1%**	**12.6%**
	Raised to 31.5mAHD. No pumping	58.3%	52.8%	23.5%	4.4%	7.7%	14.0%
	Current conditions. 2.02 MLd-1 pumping applied.	**58.3%**	**52.8%**	**21.5%**	**8.4%**	**10.6%**	**28.7%**
	Raised to 31.5mAHD. 2.02 MLd-1 pumping applied.	58.3%	52.8%	27.1%	22.6%	11.0%	28.7%
	Difference between previously existing conditions (no pumping) and Current conditions (no raised wall, 2.02 MLd-1 pumping applied).	**0**	**0**	**10.1**	**5.3**	**4.5**	**16.1**
Approximately 4.5 km downstream. Charlotte River outlet to Bynoe Harbour.	**Previously existing conditions (no raised spillway, no pumping)**	**12.6%**	**9.4%**	**1.6%**	**0.4%**	**0.8%**	**1.7%**
	Raised to 31.5mAHD. No pumping	12.6%	9.4%	3.2%	0.6%	1.0%	1.9%
	Current conditions. 2.02 MLd-1 pumping applied.	**12.6%**	**9.4%**	**3.9%**	**1.1%**	**1.3%**	**3.9%**
	Raised to 31.5mAHD. 2.02 MLd-1 pumping applied.	12.6%	9.4%	3.7%	2.9%	1.4%	3.9%
	Difference between previously existing conditions (no pumping) and Current conditions (no raised wall, 2.02 MLd-1 pumping applied).	**0**	**0**	**2.3**	**0.7**	**0.5**	**2.2**

It is possible that the riparian rainforest vegetation that occurs downstream of OHD could experience some changes in species composition and/or diversity as a result of reductions in surface flows. However, the community as a whole is expected to persist given it likely relies on groundwater to sustain it over the dry season and has persisted for over 20 years with the OHD in place. Any impact is expected to be limited to the 1 km section of watercourse upstream of the point of discharge to Charlotte River, because the modelling results indicate that further down the catchment in the Charlotte River, the reduction in flow is less than 3%

over January to April, and therefore the riverine environment and mangroves in Bynoe Harbour are unlikely to be impacted.

WRM (2022) further modelled the downstream impact of water extraction from OHD for varying climatic conditions, not only the average rainfall as presented by EnviroConsult (2019), and different water extraction volumes.

As outlined by WRM (2022) (Appendix C), Figure 6-1 shows the likely (i.e. taken as needed) and maximum downstream impacts (assessed immediately downstream of the OHD spillway) ranked according to the probability of exceedance. This figure shows the:

- Modelled pump rate (taken as needed): The black curve (generated based on the WRM 2022 Goldsim model) represents the potential downstream impacts of water extraction from OHD, taking the requirement for additional site water into consideration (assuming that the site water demand assumptions are correct).
- Constant pump rate (2.02 ML/d): The grey curve represents the methodology presented by Enviroconsult (2019). That is, the average wet season impact was calculated using a constant 2.02 ML/d extraction rate (regardless of the volume in OHD and the Grants water management system).
- The blue dots represent total wet season rainfalls (mm), plotted corresponding with the associated downstream impact.

EnviroConsult (2019) determined that, over a full wet season of average rain (~1,652 mm), the reduction in average flows at the OHD spillway outlet due to an annual water extraction volume of 738 ML/year (daily average of 2.02 ML/d) would be 45% reduction in downstream flows during the wet season (Table 6-1). This is considered to be the maximum impact on downstream flows due to water extraction for this climatic sequence.

The WRM (2022) Goldsim model determined that over a full wet season of average rain (~1,652 mm), the reduction in average flows downstream at the OHD spillway outlet due to an annual water extraction volume 'taken as needed' would be ~6% reduction in downstream flows during the wet season. Therefore, flow reduction is expected to be much lower than originally modelled by EnviroConsult (2019) and presented in Table 6-1 to Table 6-4 as water will be extracted on an as needed basis rather than a standard 2.02 ML/day rate.

See Appendix A of the WRM (2022) SWMP (Appendix C) for further details.

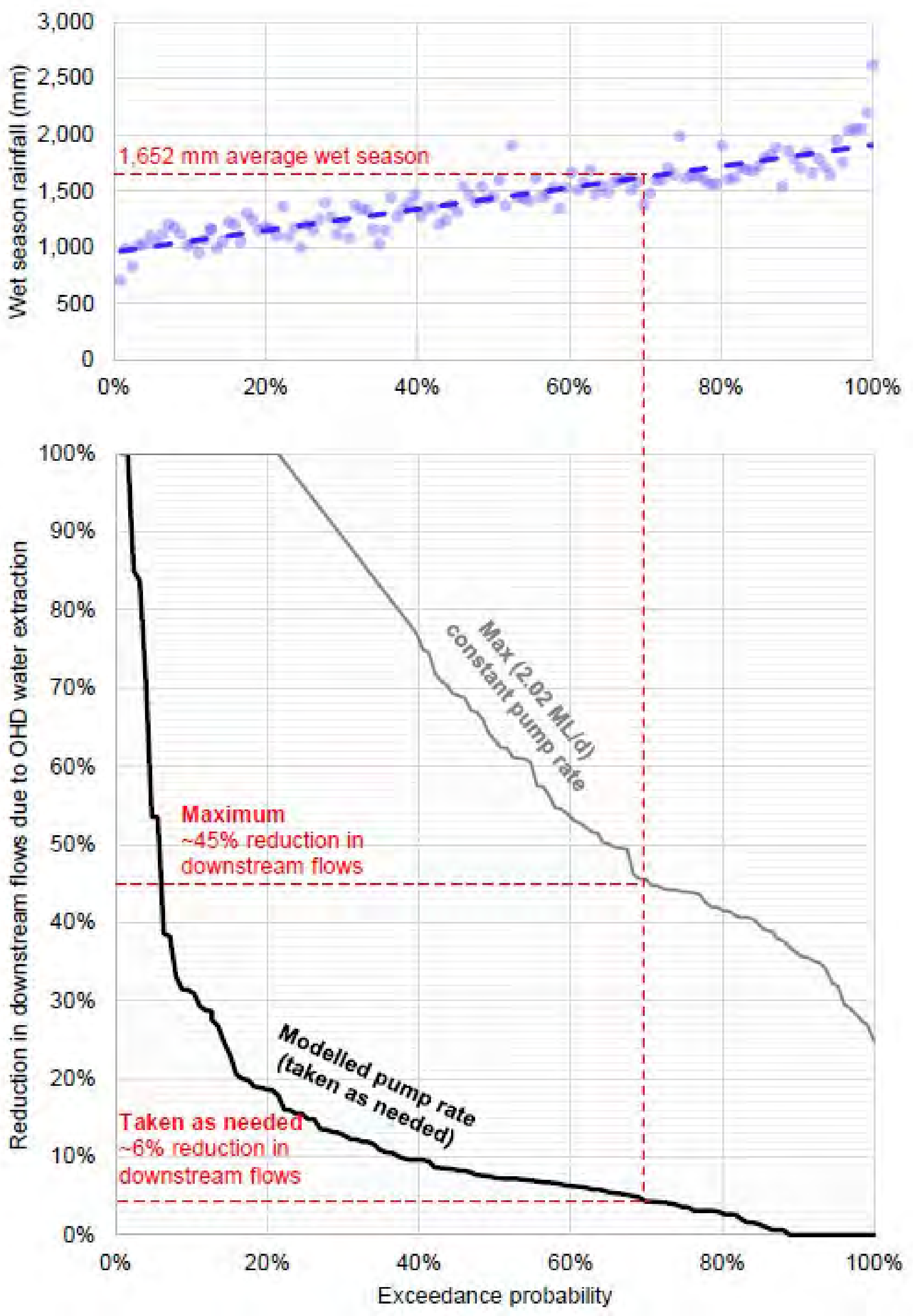

Figure 6-1. Potential impact of water extraction from OHD on downstream flow volumes (WRM 2022)

7 COMPLIANCE

Table 7-1 provides status and compliance of the SWEL 8151018 terms and conditions. There are no non-compliance issues to report.

Table 7-1. SWEL 8151018 Terms and conditions

Condition	Status / comments	Compliant (Y/N)
1. General Conditions		
1.1 The licence holder must comply with the provisions of the Act and all other laws in force in the Territory, including all regulations made under the Act.	Noted	Y
1.2 The licence holder can surrender or apply for modification of this licence at any time.	Noted	Y
1.4 Subject to Conditions 1.2 and 1.3, this licence is in force until the expiry date.	Noted	Y
1.5 If the licence holder wishes to apply for a renewal of this licence, the licence holder must make an application to the Controller in the prescribed form at least 6 months before the Expiry Date via email to water.regulation@nt.gov.au	Noted	Y
2. Water Extraction conditions		
2.1 Subject to Conditions 2.3 and 2.4, the licence holder must ensure that total extraction from the listed Waterway over the Periods specified below does not exceed the Entitlements	Noted	Y
2.2 The licence holder may seek approval from the Controller to change the Period, by completing an Application to amend the licence and submitting that application to water.regulation@nt.gov.au at least 20 business days prior to the start date of the relevant Period.	Noted	Y
2.3 The licence holder must have the amendment approved by the Controller in writing before the amendment takes effect.	Noted	Y
2.4 In each Period the licence holder must ensure that total extraction from the listed Waterway does not exceed the Entitlement.	Noted	Y
2.5 The Maximum Water Entitlement must be used for no purpose other than the specified beneficial use without the prior written approval of the Controller.	Noted	Y
2.6 The licence holder may only extract water under this licence for use on a property listed on this licence.	Noted	Y
3. Water Metering and Reporting Conditions		
3.1 Extraction from the listed Waterway must be recorded by a meter or meters supplied, installed and maintained by the licence holder in accordance with the Northern Territory Non-Urban Water Metering Code of Practice for Water Extraction Licences, as amended from time to time.	Noted	Y
3.2 Within two (2) weeks following the end of each Quarter of each year, the licence holder must supply the Controller with a record of total extraction from each of the listed extraction point(s) during that month.	Records supplied	Y
4. Special Conditions		
4.1 The licence holder must develop and submit for approval by the Controller a monitoring program to assess the impact of water taken under this licence on the riparian vegetation and surface water flows downstream of the Waterway. The monitoring program must: (i) be prepared by a suitably qualified professional; (ii) include the monitoring parameters, methodology and frequency for monitoring downstream impacts attributable to water taken under this licence on: (a) riparian vegetation; and	RVMP and SWMP submitted 18 May 2022 for approval by the Controller.	Y

Condition	Status / comments	Compliant (Y/N)
(b) surface water flows; (iii) include quantitative triggers and limits which can be used to initiate adaptive management actions when surface water flows deviate significantly from the predictions outlined in Core Exploration Ltd, Cox Peninsula Supplementary Report, Appendix H Surface Water Modelling, February 2019; (iv) include a review process to ensure continuous improvement of the monitoring program; and (v) be implemented immediately following the Controller's approval.		
4.2 The licence holder must provide a monitoring report to the Controller within 2 weeks of 30 June each year of the licence. The monitoring report must: (vi) include data collected in accordance with the monitoring program under 5.1 for the previous water accounting year (1 May - 30 April); (vii) outline any management actions taken in response to the quantitative triggers or limits established under 5.1(iii); (viii) include a summary of the outputs from updated surface water modelling using the most recent monitoring data; (ix) discuss the measured and modelled impacts of water taken under this licence on the downstream riparian vegetation and surface water flows; and (x) publish a copy of the monitoring report on a website on the internet that is publicly accessible.	2022 Monitoring Report submitted 7 June 2022	Y
4.3 The licence holder must immediately notify the department on becoming aware of non-compliance (or suspected non-compliance) with any condition of this licence. A notification under this condition must: 4.3.1 contain particulars of the non-compliance, including the identified or potential impacts associated with the non-compliance; 4.3.2 identify the steps that have or will be taken to minimise the impacts of the non- compliance; and 4.3.3 identify the steps that have or will be taken to prevent a reoccurrence or minimise the risk of further non-compliance.	Noted	Y
4.4 The licence holder must maintain a website on the internet that is publicly accessible. The licence holder must publish on the website, as soon as practicable: 4.4.1 this licence, any amendments to its conditions and information about this licence including any: 4.4.1.1 approved monitoring program (5.1); 4.4.1.2 monitoring report (5.2); 4.4.1.3 non-compliance with its conditions as reported (5.3); or 4.4.1.4 other documents related to this licence, or the activities conducted under it, as directed by the Controller.	In the process of being uploaded to the Core Lithium website (publicly available by 30 June 2022).	Y
4.5 The licence holder must have in place a Mining Management Plan to conduct Approved Mining Activities, approved by the Minister in accordance with the Mining Management Act 2001 throughout the Term of this licence. If the Mining Management Plan is revoked, the licence holder must notify the Controller within 7 days. The notification must be via email to water.regulation@nt.gov.au.	Noted	Y

8 REFERENCES

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WRM Water & Environment Pty Ltd (2022). Finniss Lithium Project Observation Hill Dam Surface Water Monitoring Program

APPENDIX A OHD SURFACE WATER EXTRACTION RECORD

Start Date	Start Time	Start (L)	Finish Date	Finish Time	Finish (L)	Volume Used (ML)	Culmulative Volume (ML)	Water Use	Comments
8/12/2021	12:00 PM	5171853.70	9/12/2021	2:30 PM	8174500.00	3.00265	3.00	Carlton Pit (CP) - Dust Suppression	Top up Carlton Pit.
14/12/2021	5:12 PM	8174500.00	14/12/2021	6:10 PM	8244500.00	0.07000	3.07	CP (0.045ML), Site WC (0.022ML)	
Start Date	**Start Time**	**Start (m^3)**	**Finish Date**	**Finish Time**	**Finish (m3)**	**Volume Used (ML)**	**Culmulative Volume (ML)**	**Water Use**	**Comments**
3/01/2022	10:15 AM	70829.82	3/01/2022	10:37 AM	70878.30	0.04848	3.12	Site WC Dust Suppression	New flow meter
6/01/2022	2:07 PM	70878.30	6/01/2022	2:53 PM	70975.64	0.09734	3.22	Site WC Dust Suppression	
19/04/2022	3:07 PM	70975.64	19/04/2022	3:25 PM	71641.39	0.00067	3.22	Charge pipeline	

APPENDIX B RIPARIAN VEGETATION MONITORING PLAN

Riparian Vegetation Monitoring Plan

Finniss Lithium Project

Core Lithium

www.ecoz.com.au

EcOz Environmental Consultants

DOCUMENT CONTROL RECORD

Job	EZ21269
Document ID	212326-94
Author(s)	Nicole Clark

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	Suz Barber	Suz Barber	Lithium Developments (Grants NT) Pty Ltd	18/05/2022

Recipients are responsible for eliminating all superseded documents in their possession.

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APPROVED COMPANY AS/NZS 4801 Occupational Health & Safety Management Systems — QMS Certification Services
APPROVED COMPANY ISO 9001 Quality Management Systems — QMS Certification Services
APPROVED COMPANY ISO 14001 Environmental Management Systems — QMS Certification Services

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1 INTRODUCTION

This plan documents the riparian vegetation monitoring program (RVMP) that will be implemented to monitor impacts associated with water extraction from Observation Hill Dam (OHD) under Surface Water Extraction Licence (SWEL) 8151018 and operation of the Finniss Lithium Project, BP33 underground mine located on the Cox Peninsula (Figure 1). Riparian vegetation health downstream of the mines could be affected by changes to:

- surface water flows associated with extraction of water from the OHD
- groundwater levels due to dewatering of BP33 underground mine.

Riparian vegetation monitoring is required as a condition of the following approvals and licences:

- Environmental Approval 2020/001-001 for BP33 underground lithium mine
- SWEL 8151018.

The RVMP will be implemented in conjunction with the surface water, groundwater, sediment and biota monitoring programs detailed in the Grants Water Management Plan and BP33 Water Management Plan.

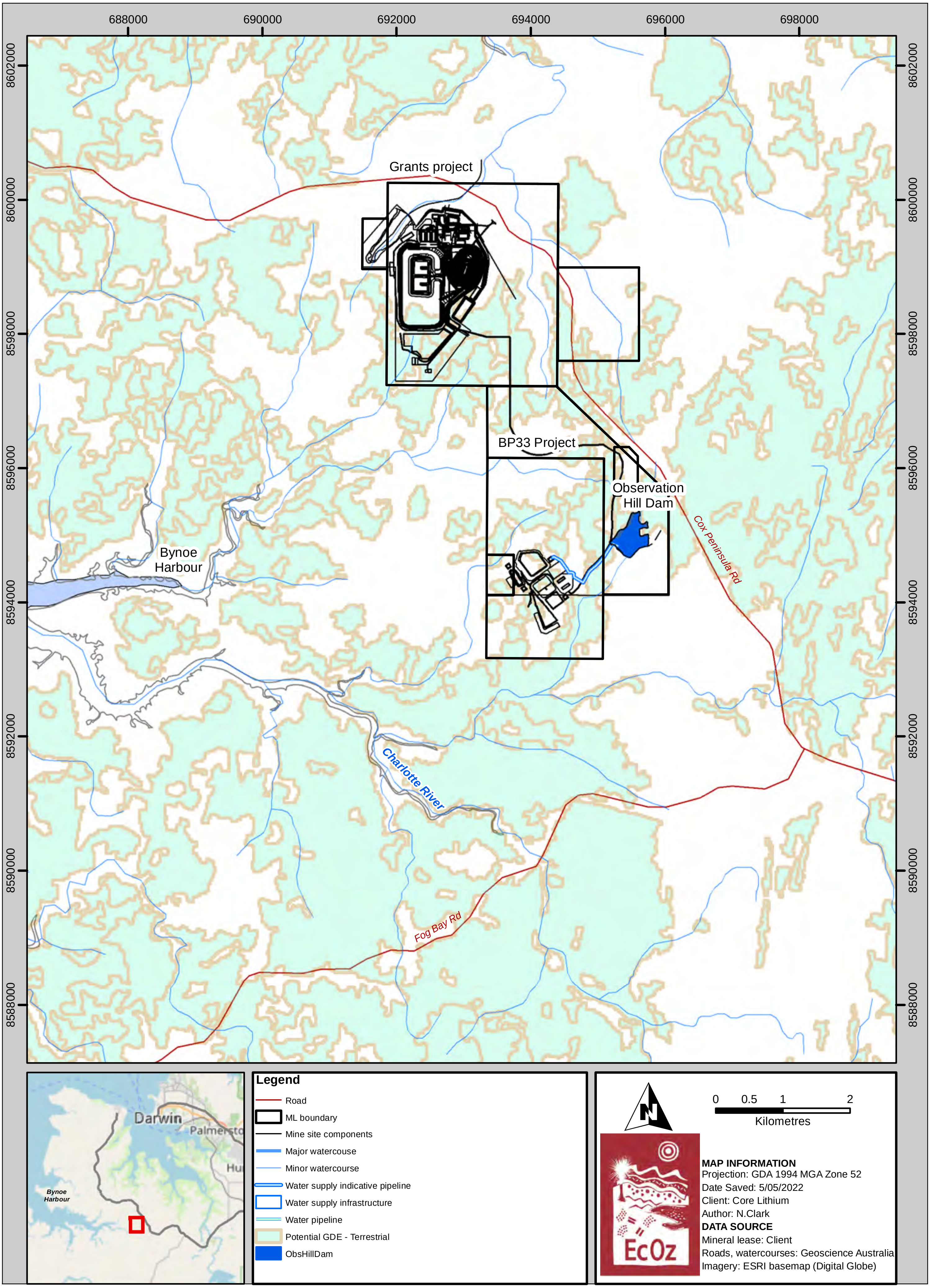
Riparian communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

The plan has been developed by EcOz botanist, Nicole Clark, whom is a suitable qualified professional. The plan includes:

- monitoring parameters, methods and frequency for monitoring downstream attributable to water under the SWEL on riparian vegetation
- a review process to ensure continuous improvement of the monitoring program.

To develop this RVMP, the following steps were undertaken:

- a desktop review of the existing baseline information available
- research of best practise methodologies in riparian monitoring including the monitoring of plant health
- addressing gaps in existing information to design a robust monitoring method.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 1. Map of the project location.mxd

Figure 1. Map of Finniss Lithium Project location

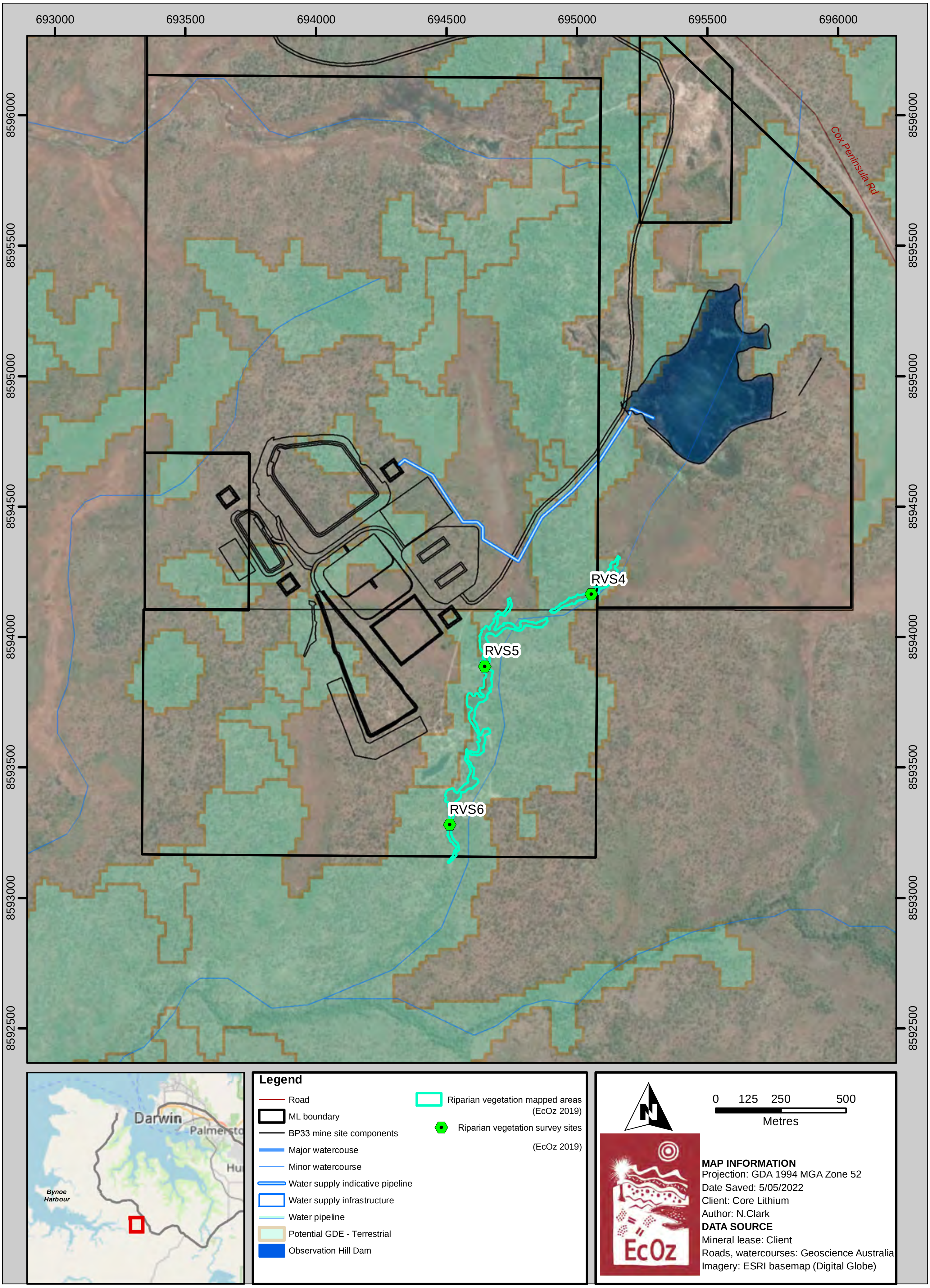
1.1 Summary of baseline surveys

Previous surveys and assessments undertaken for the Grants Environmental Impact Statement (EIS) identified presence of an ephemeral drainage line downstream of OHD which supports closed riparian vegetation identified as a potential Groundwater Dependent Ecosystem (GDEs) (see Figure 2) based on desktop modelling. These riparian vegetation communities downstream of the OHD water supply could be susceptible to impacts associated with changes to surface water flows. The Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019) baseline study (Appendix A) was undertaken to further assess the vegetation prior to mining activities commencing.

The intent of the baseline survey was to produce a vegetation map and record vegetation characteristics and condition of the sensitive vegetation communities downstream of OHD, which is now near the proposed BP33 underground mine.

Two types of baseline surveys were undertaken; an aerial drone survey to look at the overall riparian vegetation health and assist in mapping the riparian vegetation extent, and on-ground field survey to assess vegetation structure and composition within the mapped riparian vegetation extent. See Appendix A for the Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019).

Additional baseline surveys will be undertaken during 2022 to support implementation of this plan. Further details of additional baseline studies are provided in Section 1.1.1.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 2. Map of baseline studies for BP33 project area.mxd

Figure 2. Map of baseline riparian monitoring area and vegetation monitoring sites (EcOz 2019)

1.1.1 Gaps in baseline

Based on the existing information available, a few gaps were identified in the baseline surveys and are proposed to be addressed as outlined below.

- The drone survey was only undertaken post wet-season. It is recommended to undertake additional drone flight for BP33 project area in the dry season to account for seasonality differences.
- The orthomosaic images obtained from drone mapping only used false colour imagery (i.e. green indicating to examine vegetation health). Further remote sensing analysis is required to quantify vegetation health and compare data between 2019 and 2022.
- No upstream of Charlotte's River riparian vegetation site assessments undertaken outside of the modelled groundwater drawdown (CloudGMS 2021) for BP33 project area. A site will be established outside of the modelled 1m contour groundwater drawdown zone of influence (ZOI) to be used as a baseline reference site and assessed prior to significant water extraction from OHD and BP33 mining operations.
- No vegetation site assessment data was collected post-wet season. To account for seasonality differences, it is recommended to undertake biannual vegetation site assessment monitoring post-wet season for the 2022 baseline surveys. This data can be used for future reference if additional monitoring is required in accordance with the trigger action response plan (TARP) (see section 4).
- Though some data was obtained while undertaking vegetation site-based assessments post wet-season 2019, there was a lack of quantitative data collected - ground cover percentage, presence of recruitment, number of alive vs dead plants, erosion scoring etc. These attributes will assist in monitoring the condition of riparian vegetation and data comparison.
- Further investigation is required to determine the extent of the riparian vegetation within the identified ZOI of the BP33 predicted groundwater drawdown modelling. The ZOI has been defined by the one metre groundwater drawdown contour shown Figure 5. It is assumed that drawdown of less than that would only affect water availability for a short period of time in the mid-late dry season when groundwater levels are naturally lowered. The ZOI encompasses a 4.5 km section of stream order one ephemeral watercourse.
- Additional baseline surveys will be conducted biannually during 2022 to address these gaps. A baseline assessment report will be developed to include outcomes of the 2019 monitoring and the 2022 monitoring and the RVMP revised as required.

2 RIPARIAN VEGETATION MONITORING PLAN

Healthy riparian zones are essential for maintaining healthy ecosystems and economic productivity along rivers (Dixon & Douglas 2015). When maintaining a riparian vegetation system, it is vital to retain a diverse vegetation cover to assist in maintaining the functions that a riparian vegetation community provides i.e. supporting aquatic habitats, shading the river and regulating the temperature, bank stabilisation, filtering of sediments and improving water quality of river by reducing contaminants (Dixon & Douglas 2015).

Riparian vegetation are able to access water multiple ways i.e. through the upper un-saturated zone as a result from recent rain events, the groundwater at depth via the capillary fringe above an unconfined aquifer, and through creek water (generally a combination of groundwater and rain water in the wet season, but may be predominantly groundwater in the dry season) (SKM 2012) (see Figure 3). There are particular species that are more likely to be more sensitive to declines in available ground water such as monsoon forest species that grow in areas where there is perennial water supply.

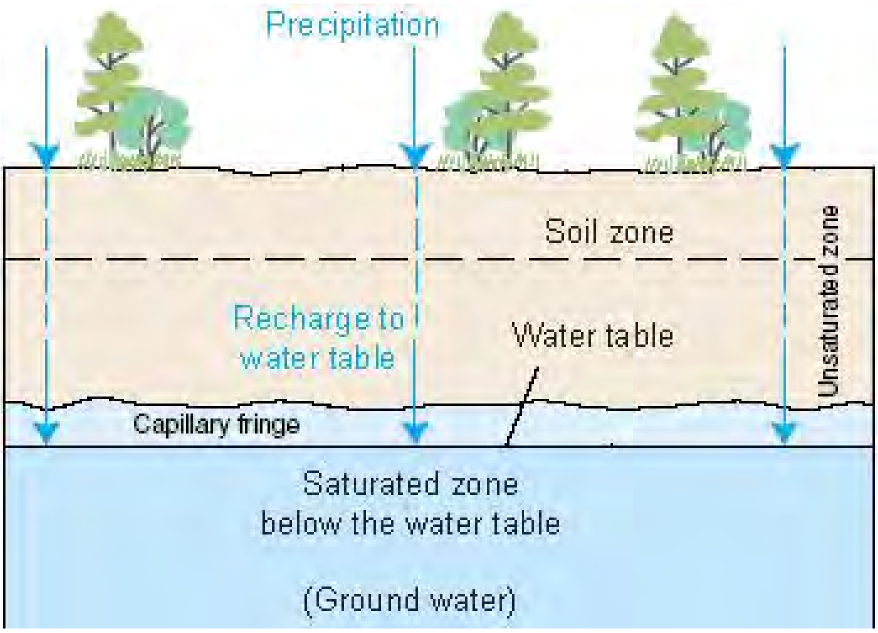


Figure 3. Diagram showing the capillary fringe (SKM 2012)

Riparian vegetation recruitment and germination heavily depends on the level of surface water and ground water regimes as plants depend on predictable patterns in terms of structure and diversity according to water availability in the landscape (Eamus & Lamontagne 2006). Riparian tree recruitment typically occurs after large floods when viable plant material is transported onto point bars and the floodplains of naturally flowing rivers (Eamus, D., & Lamontagne 2006). If dry season flow is modified, or the water table recedes too quickly, new cohorts fail to recruit and the species composition may alter over time (Figure 4). Ultimately the intent of monitoring the riparian vegetation a is to detect changes over time.

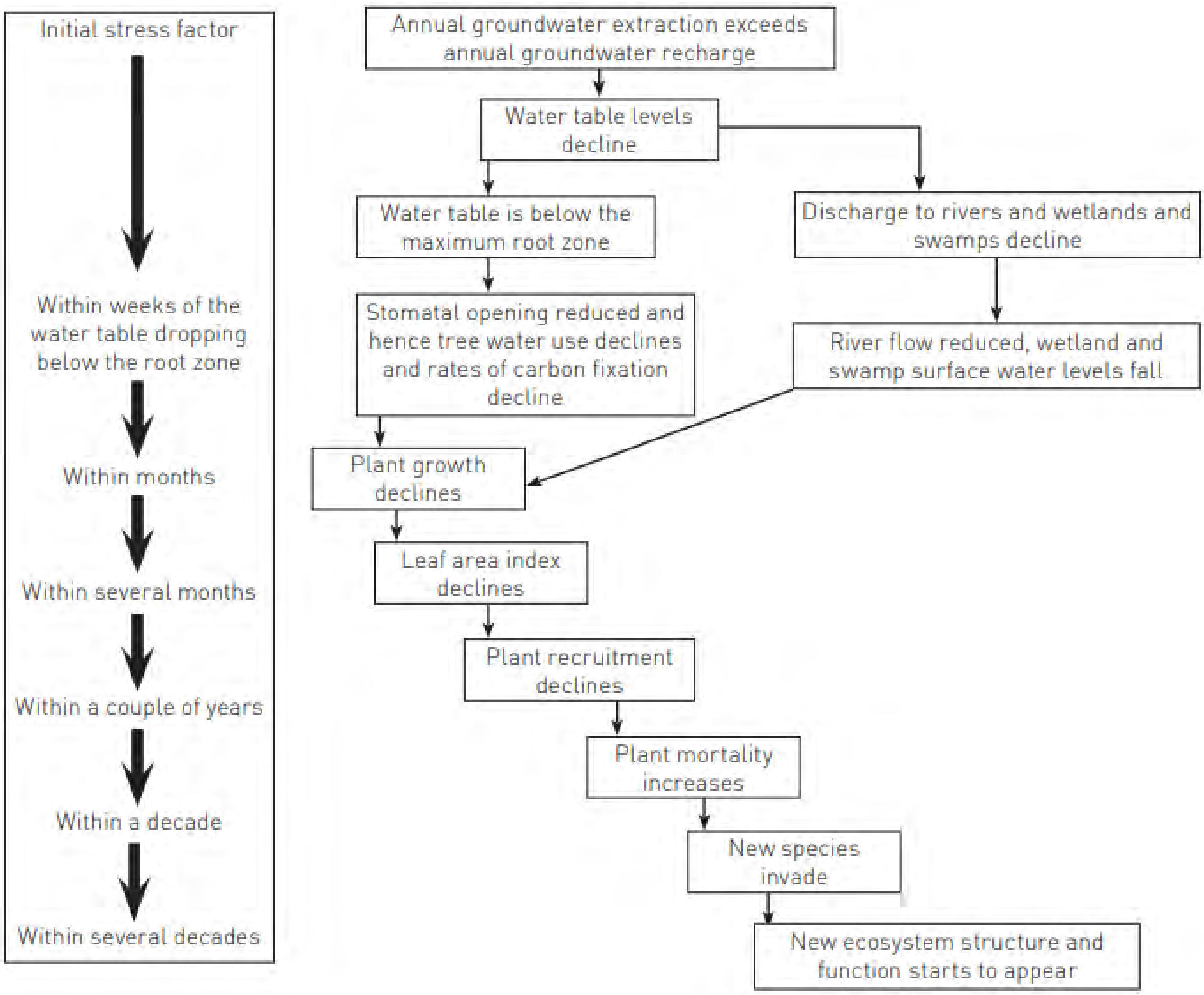


Figure 4. Diagram showing the potential consequences of groundwater drawdown affect (Eamus, D., & Lamontagne 2006)

Some of the information obtained from the baseline studies and the associated gaps identified have been used to develop this RVMP. The monitoring plan outlines objectives and parameters that can be used to assess the riparian vegetation health during the drawdown and reduced surface flows from OHD as part of operations. For each monitoring type, the following headings have been used:

- Objective
- Survey method – these may include ongoing methods previously used in the baseline surveys or additional (new) methods
- Record keeping - maintenance of data for analysis
- Data analysis.

2.1 Best practice and standards

The following best practice and standards for vegetation monitoring been adopted and assisted in developing this RVMP:

- Brocklehurst et al 2007. *Northern Territory Guidelines and field methodology for vegetation survey and mapping*
- Dixon, I., & Douglas, M (2015). *A Field Guide to Assessing Australia's Tropical Riparian Zones*, Tropical Savannas Cooperative Research Centre for Tropical Savannas Management.

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- Wegmann, M., Leutner, B., & Dech, S. (2017). Remote Sensing and GIS for Ecologists using Open Source Software, *Pelagic publishing*

2.2 Drone survey

2.2.1 Objective

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey is to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover.

2.2.1 Methodology

- Create new drone flight path based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI. The new flight path will be an extension of the existing baseline survey (EcOz 2019) to capture the riparian vegetation extent downstream of OHD to the 1m contour groundwater drawdown ZOI (see Figure 5 for indicative drone survey boundary). The indicative flight path will be field verified during 2022 baseline surveys prior to establishing a set flight path.
- Previously Drone Deploy (Software program) was used to design the flight path, however WebODM will be used for this monitoring. WebODM was selected as it contains the correct platform selected for to measure plant health.
- Drone will be flown in the middle of the day to avoid sun light interference i.e. shading. Observations will also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- When importing drone data to create the orthomasoaic, the same methods as per methods in baseline report outlined in section 3 (Appendix A) will be applied, except using WebODM.
- The boundary of the riparian vegetation will then be delineated using the orthomosaic imagery and remote sensing techniques.
- Drone data analysis will be undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.

- These values will be categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, will then be calculated.
- Investigate other environmental factors that may affect results i.e. amount of rainfall between October – April compared to rainfall amounts based on baseline studies to discern environmental factors.

Frequency

- The drone survey will occur biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring during 2022, then the monitoring will be reduced to annual (in the late dry season only).

2.2.2 Record keeping

- Vegetation monitoring database comprised of:
  - The riparian vegetation area size (ha) based on drone mapping for each drone survey.
  - VARI calculations for each survey conducted including varying colour bands and associated class intervals, the area (ha) that occurs within the class intervals and a percentage (%) of pixels that lie within these class intervals.
  - Additional observations that may need to be recorded if further on-ground investigation is require.
- Spatial data
  - All drone images captured during the drone surveys organised in folders.
  - A zip-file of all tiff files derived from drone surveys (both orthomosaic and plant health image).

2.2.3 Data analysis

Before After/Control Impact (BACI) approach will be applied by performing statistical analysis (VARI) to test whether there is a significant difference between the baseline health data and the riparian vegetation health based on ongoing drone survey assessments.

2.3 Riparian vegetation site assessments

2.3.1 Objective

Monitoring and evaluating riparian vegetation diversity and composition at established vegetation sites within ZOI, and an additional site established outside of the ZOI (reference site) to detect changes in riparian vegetation according to diagram presented in Figure 4 (Eamus, D., & Lamontagne 2006).

2.3.2 Methodology

Site selection

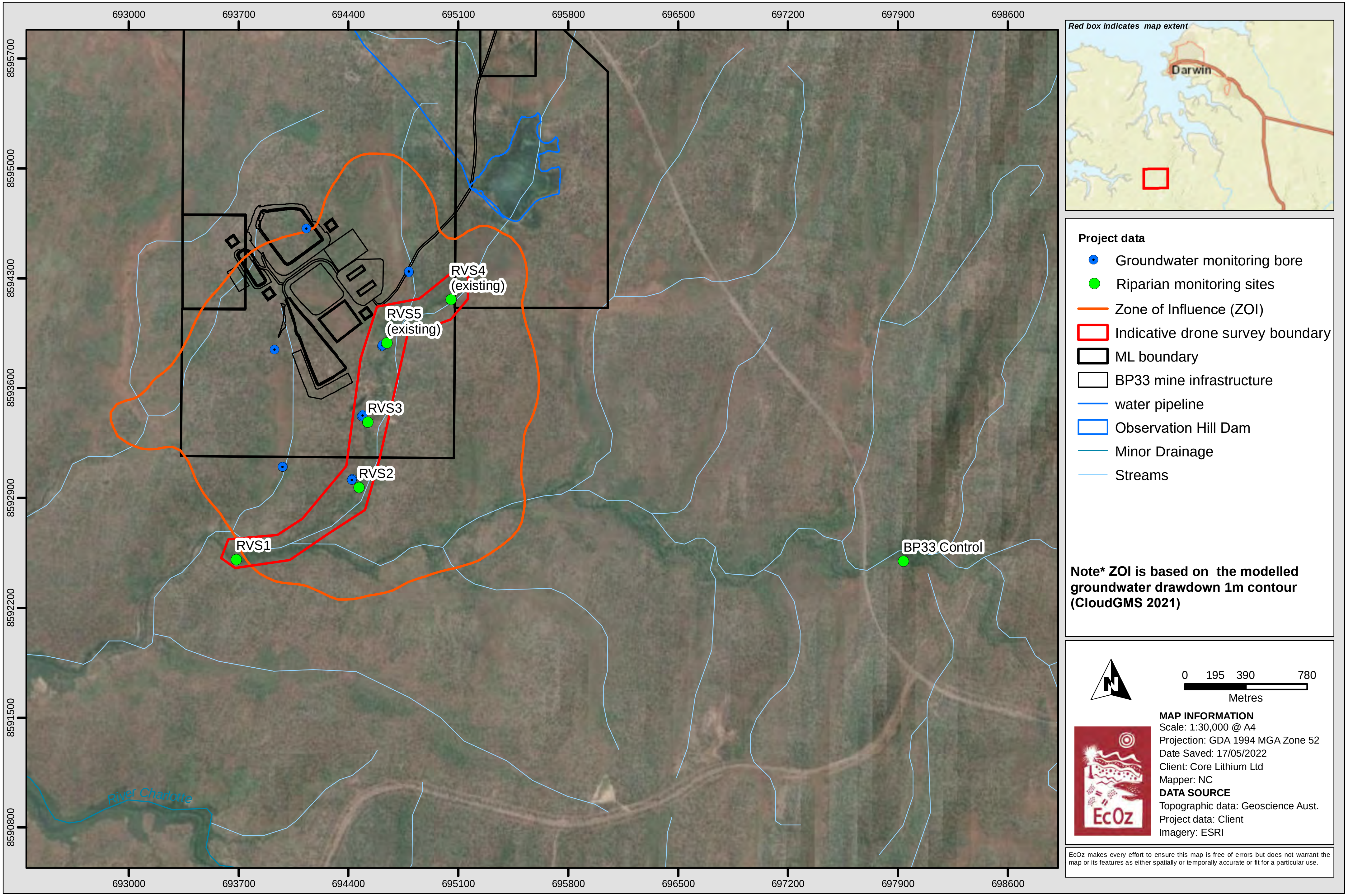
- Two existing sites RVS4 and RVS5 will continue to be monitored using the updated monitoring method within this RVMP. Site RVS4 has been kept in the monitoring plan to detect immediate

impacts from reduced SW flows downstream OHD. Existing site RVS5 has been retained as it is nearby a groundwater monitoring bore.

- Three new monitoring sites (RVS1, RVS2 and RVS3) will be established downstream of OHD within the ZOI (Figure 5). The location of these sites are suitable for monitoring as they lie within the potential GDE areas, align near existing bores for groundwater level monitoring (RVS3 and RVS2) and spatially correspond to immediate groundwater drawdown impacts (RVS3 located closest to the underground) and longer term potential impacts (RVS1 located near the 1m contour) (Figure 5).
- One new reference site upstream of Charlottes Creek (BP33 Control), in a similar riparian zone within the potential GDE area will be established with baseline monitoring commencing post-wet season 2022 (Figure 5). This site is outside of the predicted ZOI. The site was selected using various resources including up to date aerial imagery, mine components, and Land Units of the Greater Darwin Region (Fogarty et al. 1984).
- Sampling site locations for other BP33 project studies, such surface water, groundwater and biota monitoring have also been considered when selecting the new riparian vegetation monitoring sites. The precise locations will be verified in field during the 2022 post wet season survey.

Frequency

- Monitoring is to occur at all sites biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring, then monitoring will be reduced to annual (in the late dry season only).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 6. Map of all baseline monitoring sitesv2.mxd

Figure 5. Map of proposed riparian vegetation monitoring sites, indicative drone imagery boundary and modelled groundwater drawdown 1m contour

Vegetation monitoring

Vegetation site assessment monitoring methods have been adopted utilising the potential consequences of the groundwater drawdown affect as presented in the diagram outlined Figure 4. As indicated, the effect may take several years before physical changes become apparent. Monitoring methods are outlined below:

- A plot size of 20 x 20m will be established at each new riparian monitoring site, using star pickets. Existing plots RVS4 and RVS5 will be re-monitored at established plots (existing star pickets present).
- In each plot the dominant layer/emergent layer species will be recorded; this includes all seedlings (woody plants under 1m in height), saplings (woody plants between 1m and 3m high and < 2cm diameter at breast height, or DBH) and trees (woody plants with stems ≥ 2cm DBH and greater than 3m high) will be identified (both native plants and invasive plants included). For each individual the height will be estimated and the % cover will be measured. All individual woody plants within the plot will also be marked alive or dead, whether the plant is fruiting/flowering. Note, deciduous trees will not be recorded as dead during the dry-season monitoring.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) will be tagged on hand held GPS for future ongoing measurements. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* (observed at RVS4, RVS5).
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) will be recorded. The results from this method will be used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation will be recorded to a standard that is equivalent to Level 5 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity will be monitored by traversing along a 100m transect from the middle monitoring site and visually estimate the canopy cover (or by using a densitometer) of the native vegetation to indicate how continuous the canopy cover is along the transect. Note, a break in the continuity must be at least 5 m between tree crowns and span the entire width of the transect (Figure 6). If one tree is missing within a wide riparian zone it will not be counted as a break in the canopy continuity because the break must span the entire width of the riparian zone.

Table 2-1 summarises monitoring methods and how they will be used to measure the potential consequences of the reduction in surface flows and/or groundwater drawdown.

Table 2-1. Summary of monitoring methods that will be used to measure potential impacts of the reduction of surface water flows and groundwater drawdown

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree tagging	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 5 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

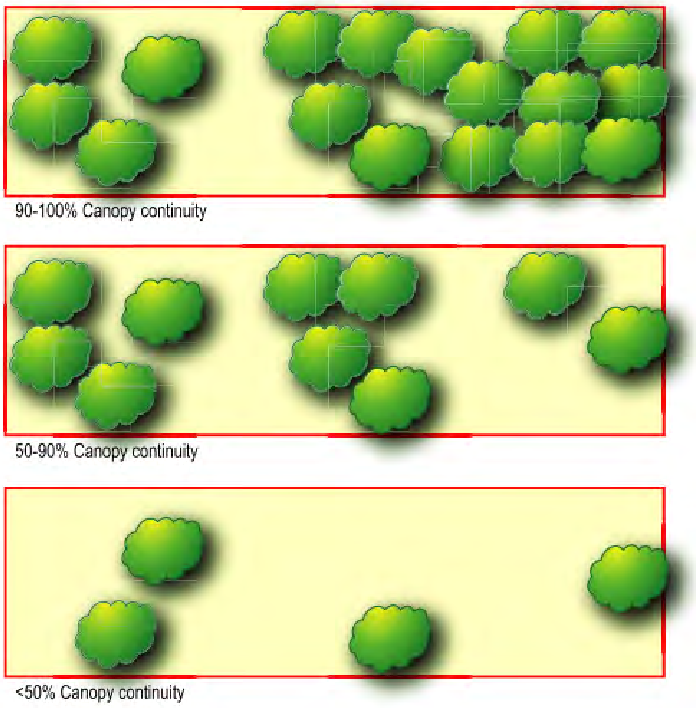


Figure 6. An example pictorial used for measuring canopy continuity (Dixon & Douglas 2015).

Photo point monitoring

- Four cardinal photo monitoring points (north, east, south, west) will be obtained within each plot.

2.3.3 Record keeping

- Vegetation monitoring database – comprised of seedling, sapling, and tree data for individual species and associated heights, DBH's and records of vegetation health e.g. % dead or sick plants.
- Ground cover data - percent cover and species richness.
- Photo monitoring point database.

2.3.4 Data analysis

The data collected based on monitoring methods outlined Table 2-1 will be statistically analysed using the Before After/Control Impact (BACI) approach. BACI will be applied by performing statistical analysis to test whether there is a significant difference between the baseline health data and riparian vegetation assessment data at the same sites, and riparian vegetation assessment data compared to reference site data.

Data captured for analysis includes:

- Species composition (%) using individual dominant/emergent plant data.
- Average heights of individual plants across riparian vegetation sites compared to reference site.
- Canopy cover (%) for each dominant, and emergent species across riparian vegetation assessment sites compared to reference site data.
- Plants alive or dead (%) across all riparian vegetation sites compared to reference site data.
- The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site.
- The ground cover percentages (vegetation type, soil, rock, litter).
- Type of ground cover percentages in the form of herbs/vines/grasses/ferns and sedges).

2.4 General observations

2.4.1 Objective

Monitoring of other environmental factors is critical as they are contributing factors that can severely impact the health of riparian vegetation. Objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is discussed below.

2.4.2 Other environmental factors

Weeds

Weed data collection will be conducted in accordance with the Northern Territory Weed Management Branch (WMB 2015), Northern Territory Weed Data Collection Manual.

The percentage cover of weed species (declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat will be visually estimated for each weed species.

A GPS will be used to record locations of identified weed species, and will record the following information:

- Weed name
- Distribution - size (20, 50 or 100m diameter)
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1-5, 1 (absent) to 5 (>50%)
- Growth stage (seedling, juvenile, adult)

- Seeded (has the weed seeded?)
- Treatment (has the weed been treated and if so with what method of treatment)
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data will also be recorded outside of the plots to obtain surrounding data while traversing along the riparian area to visit each monitoring site.

Fire - broad scale and site based monitoring

Broadscale

Fire scar mapping and scoring will be determined by drone survey and mapped with NAFI each year to investigate frequencies and severity across the mapped riparian area.

At each plot an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and for recently burnt sites the severity will be scored from 1 to 4. Categories for characterisation of fire are:

- No evidence of fire
- Evidence of groundcover fire only
- Evidence of burnt saplings
- Evidence of fire in canopy layer.

Erosion - broad scale and site based monitoring

Broadscale

- Monitoring the presence of erosion (on a broader scale basis) may be more effective using remote sensing with the use of the drone imagery captured as per section 2.2. Monitoring erosion using monitoring plots can often mean that issue areas can be missed.
- It is recommended to flag any potential erosion issues identification with aerial imagery and follow-up with on-ground monitoring so that erosion risks are to be measured and remedial actions implemented.

Site (plot) based

At each plot note the presence or absence of erosion will be recorded, and if present the following characteristics will be recorded:

- Types of erosion i.e. gullying, sheet erosion etc
- The amount of bare ground above
- Tree root exposure – any roots exposed due to disturbance
- Slumping
- Fallen trees/woody debris
- Presence of surrounding erosion
- Width of riparian zone – measure or estimate the width of the riparian zone (facing downstream) for both sides of banks.

Aquatic life

Presence of aquatic life within the water will also be recorded. This will involve a record of aquatic fauna and flora at the nearest water access point from each of the vegetation monitoring plots.

Surface water flows

Presence of water flows at the time of surveying will be documented. Surface water flows will be assessed in accordance with the surface water flows monitoring plan (WRM 2022).

Sedimentation

Presence of sedimentation within the water and on the riparian vegetation.

Contamination

- Presence of potential contamination (foam/scum/oils) and odour will be documented.

Climatic conditions

Weather observation will be documented during the monitoring. The annual rainfall, evaporation and temperature will be recorded from the same station and discussed for survey data comparison.

The following monitoring will be undertaken in accordance with the Grants and BP33 water management plans:

- surface and groundwater quality
- sediment monitoring
- macroinvertebrate monitoring
- groundwater levels will be assessed in accordance with the GDE Management plan (Groundwater Enterprises and RDM Hydro 2022).

2.4.3 Record keeping

All observations and data captured will be uploaded after each monitoring event, mapped as required and all records maintained in excel database.

3 MONITORING SCHEDULE

Table 3-1 outlines the RVMP schedule, prior to any significant disturbance and for the duration of the OHD SWEL, BP33 life of mine and three years post operations when the groundwater levels are predicted to return to pre-mining conditions (CloudGMS 2021).

Table 3-1. Riparian vegetation monitoring schedule

Monitoring	When	Monitoring undertaken	Frequency of monitoring	Locations
Baseline drone survey	End of Wet season (May) and end of dry season (October) 2022	Drone flight path to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Baseline riparian vegetation site assessment survey	End of Wet season (May) and end of dry season (October) 2022	Site assessment at all identified locations to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Drone survey	End of dry season (October) 2023 onwards	Drone flight	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Riparian vegetation site assessment survey	End of dry season (October) 2023 onwards	Site assessments	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control

4 PERFORMANCE INDICATORS AND TRIGGERS

A trigger action response plan (TARP) has been detailed in Table 4-1 below. The TARP incorporates triggers and responses from the surface water monitoring program (WRM 2022) and GDE Management Plan quantitative triggers and limits and/or adaptive management actions.

Table 4-1. Trigger action response plan

Level	Trigger	Monitoring Performance Indicator	Action	Response
Level 1 (normal)	No reduction in riparian vegetation extent and/or structure/ composition compared to baseline	Drone: • vegetation biomass using VARI analysis comparable to baseline mapping. Riparian vegetation site assessment: • No change in in general vegetation health compared to reference sites i.e. no tree mortality or physical changes to health of plants through the use of on-ground assessment and photo monitoring points	• No action required	• No response required
Level 2 (early warning)	10% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 10% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 10% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 10% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 10% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 90% of the dominant species present within each strata)	• Continue to monitor in accordance with RVMP • Investigate other potentially contributing environmental factors and likely reason for reduction in riparian vegetation extent. • Conduct drone monitoring in GDE reference site • Implement action in surface water flows monitoring program (WRM 2022) TARP Level 2. • Investigate management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022).	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 2. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		• Tree canopy continuity – there is no greater than 10% reduction in tree canopy cover (%) along transect compared to the representative reference sites		
Level 3a (elevated risk)	25% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 25% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 25% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 25% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 25% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 75% of the dominant species present within each strata) • Tree canopy continuity – there is no greater than 25% reduction in tree canopy cover (%) along transect compared to the representative reference sites	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Further investigate extent of riparian vegetation reduction within ZOI, including assessment of the drainage line flowing east to west within the ZOI. • Conduct biannual riparian vegetation site assessment (end of wet season and end of dry season) and compare seasonal variability to 2022 baseline data.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Report on the outcomes of the investigation of riparian vegetation health within ZOI to regulator. • Report on the outcomes of the seasonal variability (additional monitoring at end of wet season and dry season) to regulator. • Report on outcomes of the investigation of management actions as outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) to the regulator.
Level 3b (imminent Risk)	50% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 50% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 50% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 50% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Further investigate extent of riparian vegetation reduction outside 1m contour groundwater drawdown ZOI. • Revise BP33 mine closure plan (MCP) and rehabilitation management plan (RMP) to	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		representative reference sites • Tree mortality – there is no greater than 50% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 50% of the dominant species present within each strata) • Tree canopy continuity – there is no greater than 50% reduction in tree canopy cover (%) along transect compared to the representative reference sites	include reinstatement of habitat values in the affected riparian areas and monitoring of ecosystem recovery and submit to Controller or Water Resources and NT EPA CEO for approval.	
Level 4 (exceedance of approved limits)	Loss of >3.6 ha of identified GDE vegetation extent and/or structure/ composition	Drone: • There is no greater than a 100% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 100% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 100% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 100% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 does not align with the representative reference site descriptions (i.e. indicating new ecosystem structures and functions have appeared) • Tree canopy continuity – there is no greater than 100% reduction in tree canopy cover (%) along transect compared to the representative reference sites	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 4. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Implement approved RMP. • Notify NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 4. • Report on the outcomes of the actions undertaken to the regulator.

6 REVIEW PROCESS AND MANAGEMENT

A review process will be undertaken annually based on the biannual riparian vegetation monitoring to ensure continuous improvement of the monitoring program and in accordance with condition 4.1 of the SWEL (8151018) be implemented immediately following the DEPWS Water Resources Controller's approval. Data management and reporting is key to inform the review process.

The management during riparian monitoring is related to the management of water availability for the riparian vegetation/GDE's. Refer to management outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) and the Surface Water Management Plan (WRM 2022).

7 REPORTING

A monitoring reporting will be developed as per condition 4.2 of the SWEL (8151018) and include *data collected in accordance with the monitoring program under condition 4.1 for the previous water accounting year (1 May to 30 April)* and *discuss the measured and modelled impacts of water taken from SWEL (8151018) on the downstream riparian vegetation.*

In accordance with the NT EPA (2022), LDGNT will *notify the NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.*

The plan will be submitted to the:

- NT Department of Environment, Parks and Water Security (DEPWS) Controller of Water Resources Division as a Condition 4-1 of the SWEL (8151018)
- Chief Executive Officer (CEO) of the DEPWS for review and approval at least 3 months before substantial disturbance at BP33, as per condition 6-2 of the NT EPA BP33 Draft Environmental Approval (NT EPA 2022) as part of the GDE Management Plan.
- NT Department of Industry, Tourism and Trade (DITT) as appendices to BP33 Mine Management Plan (MMP).

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APPENDIX A RIPARIAN VEGETATION ASSESSMENT REPORT

Mangrove and Riparian Vegetation Assessment Grants Lithium Project

Core Lithium

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1 INTRODUCTION

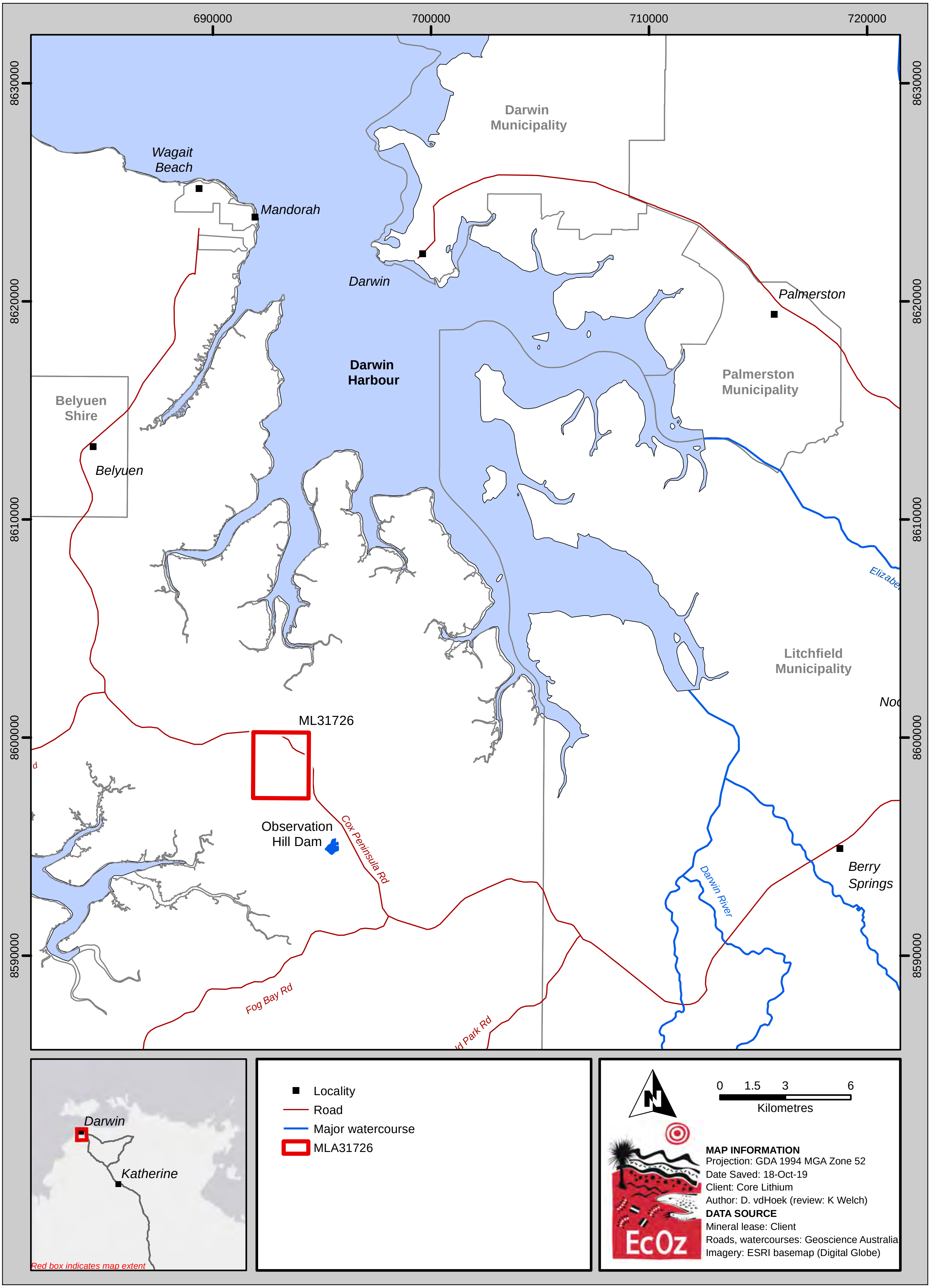
Core Lithium Ltd proposes to develop the Grants Lithium mine on the Cox Peninsula, approximately 90 km by road from Darwin CBD, or 25 km south as the crow flies, Northern Territory (Figure 1). The project area is located south of the Cox Peninsula Road, approximately 36 km west of the township of Berry Springs.

The proposal was assessed under the *Environmental Assessment Act* at the level of an Environmental Impact Statement (EIS). Surveys and assessments undertaken for the EIS process identified riparian mangrove communities downstream of the mine site and closed riparian vegetation communities downstream of the Observation Hill Dam (OHD) water supply that could be susceptible to impacts associated with changes to surface water flows. Both riparian and mangrove communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

To allow for future monitoring of impacts associated with mining activities on Core Lithium mineral leases, EcOz Environmental Consultants (EcOz) was engaged to map mangrove and riparian community boundaries and collect baseline information about community structure and condition prior to development. This report presents the survey methods and findings, including:

- Site selection.
- Methodology used to undertake drone aerial surveys and field surveys.
- Drone captured orthomosaic images (5cm/pixel) of the selected study sites
- Vegetation mapping at 1:500 scale of riparian vegetation boundaries
- Vegetation community descriptions for each mapped vegetation type

The baseline information documented in this report will allow future comparative assessments to detect any major changes in vegetation structure and composition because of project activities.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 1. Map of the project location.mxd

Figure 1. Map of the project location

2 SITE SELECTION

The objective of the baseline assessment was to record vegetation characteristics and condition of the sensitive vegetation communities downstream of the project area. The survey areas were determined with reference to the following spatial datasets:

- Proposed mine site components footprint (Core 2019)
- Digitalglobe aerial imagery (ArcGIS 10.6.1)
- Ground Water Dependant Ecosystem Atlas Dataset (BOM-GDE 2019)
- Land units of the Greater Darwin Area (Fogarty et al. 1984).

Assessment of the above datasets identified two riparian sites downstream of the project area. Mangrove communities associated with the West Arm of Darwin Harbour occur downstream of the proposed mine site. A closed riparian vegetation community occurs downstream of the OHD water supply, which based on community structure, is a potential Groundwater Dependent Ecosystem (GDE). The locations of the two selected study areas are shown in Figure 2.

2.1 Mangrove Ecosystem

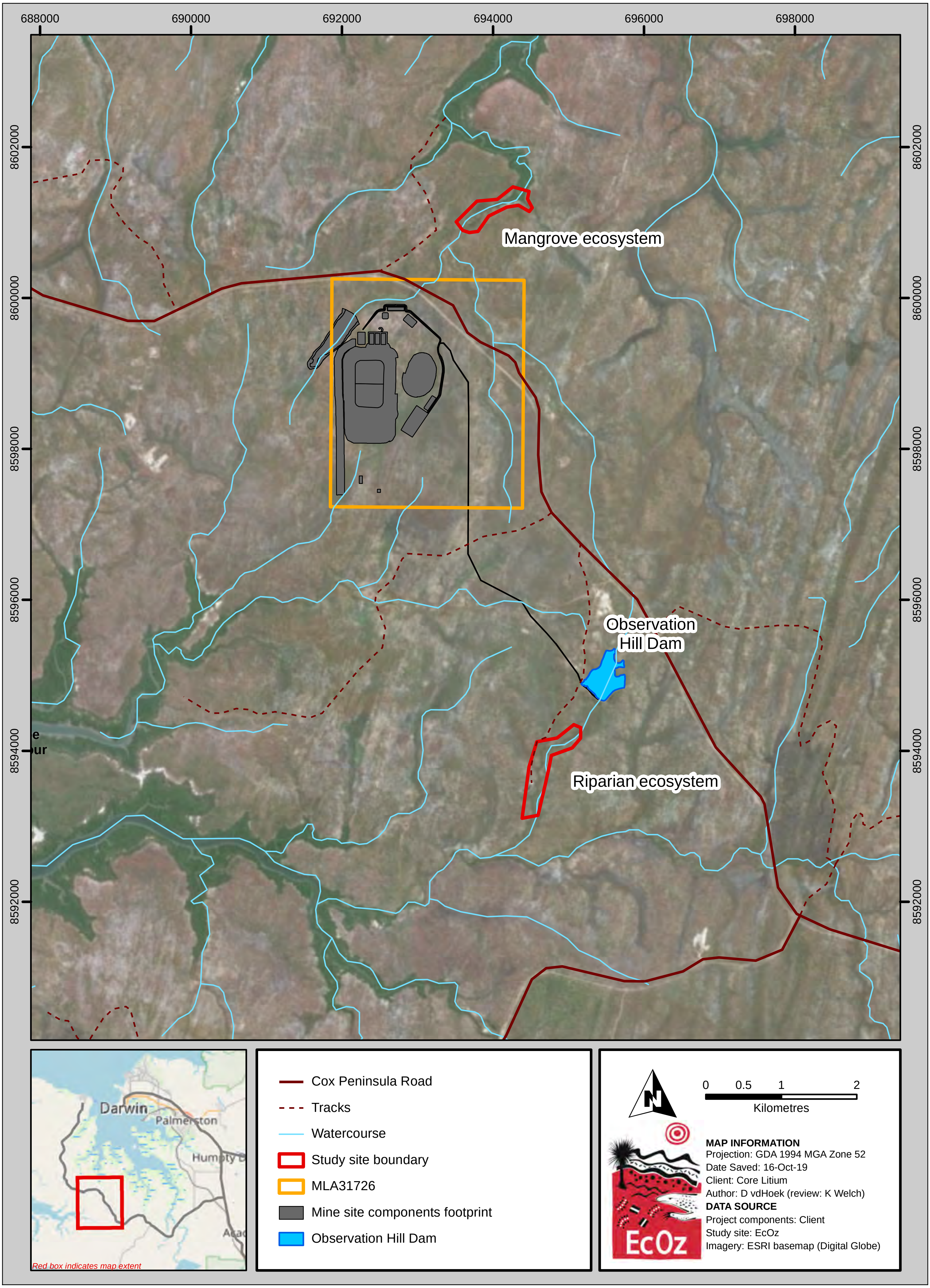
The proposed mine site and dam are located within the catchment of an ephemeral creek that flows into the West Arm of Darwin Harbour approximately 2.6 km to the north. Approximately 1.4 km north-east of the Mineral Lease (ML) boundary, the riparian zone of the creek supports mangrove vegetation. A baseline mangrove study site was established at this location.

Three vegetation survey plots were located within the mangrove study site, representing riparian, swamp and mangrove communities. The study site is located on two land units. The riparian and swamp survey sites are located within land unit 6b – Drainage System, and the mangrove survey site is in land unit 9b – Estuarine Fringes (Fogarty et al. 1984), see Figure 3.

2.2 Riparian Ground Water Dependant Ecosystem

The ephemeral drainage line downstream of OHD supports closed riparian vegetation identified as a potential GDE. The creek flows into the Charlotte River approximately 3 km downstream of the OHD wall, and discharges into Bynoe Harbour. The OHD is an artificial aquatic system that provides year round freshwater seepage into the downstream riparian system. Impacts to either the drainage system or the OHD can potentially result in impacts to downstream riparian vegetation communities.

One vegetation survey plot was located on the receiving channel of each surface water inflow to the riparian vegetation community allow future assessments to determine the potential upstream source of impact. A third survey plot was located downstream of both potential upstream inputs. The riparian study site is situated on land unit 5b1 – Drainage System. A neighbouring land unit 5a – Alluvial Plains is the source of surface water inflows into the study area (Fogarty et al. 1984), see Figure 4.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 2. The location of the riparian study sites.mxd

Figure 2. The location of riparian study sites in relation to the project infrastructure

3 METHODS

Assessment of the riparian vegetation was undertaken in two stages. Stage 1 involved an aerial drone survey to record an up to date orthomosaic photo of riparian vegetation boundaries. Stage 2 involved a ground field survey to assess vegetation structure and composition. A riparian vegetation map was created with reference to the drone orthomosaic image and mapped vegetation types were described with reference to the field vegetation assessments. The methods used for survey and mapping of the study sites are outlined in the sections below.

3.1 Drone survey

A drone survey was undertaken on the 13th of March, towards the end of the annual wet season. The timing of the survey was selected to record maximum vegetation growth within the survey area. Surveys were flown at both the Mangrove and Ri[arian Ground Water Dependant Ecosystem study sites. The drone survey was conducted by EcOz Chief Remote Pilot, David van den Hoek, according to the EcOz Remotely Piloted Aircraft Operations Manual. A DJI Phantom 4pro drone was used to capture images at a height of 75m (75% front overlap and 65% side overlap) using the DroneDeploy app. Images were then uploaded to the DroneDeploy website for processing and orthomosaic images were exported. Two 5cm pixel images were exported for each survey site, a colour orthomosaic and a plant health image, displayed in red, green and blue.

3.2 Vegetation mapping

Vegetation boundaries were delineated at a scale of 1:500 using the 5cm pixel orthomosaic aerial images captured during the drone survey. Individual trees, vegetation cover and soil colour was identified from the imagery to inform the mapping of vegetation boundaries. The following riparian vegetation types were mapped within each of the study sites:

Mangrove Ecosystem (downstream of mine site)

- Mangrove
- Riparian
- Swamp

Groundwater Dependant Ecosystem (downstream of OHD)

- Riparian

3.3 Field survey

Vegetation survey plots were located within each of the mapped riparian vegetation types. A baseline vegetation assessment was undertaken on the 5th of June 2019 by EcOz staff trained in botanical survey, Stephen Reynolds and Nicole Clark. Vegetation community assessments were undertaken based on the *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst et al. 2007).

Six vegetation survey plots, three in each study site, were surveyed to characterise vegetation types to a standard equivalent to NVIS Level V. Assessments were undertaken with a 20 m x 20 m quadrat and for each stratum (upper, mid and ground), three dominant species were recorded (but an attempt was made to record all species), cover was estimated and height values measured. Photographs were taken at the four cardinal directions for each site and NT declared weeds were recorded if present.

4 RESULTS

Vegetation maps were created to record the baseline boundary locations of riparian vegetation types situated within the study sites. The resulting maps and associated information is presented in the sections below.

4.1 Mangrove Ecosystem

The mangrove ecosystem study site records the ecotone between a freshwater creek and side swamp and a marine influenced mangrove community. The site is approximately 950 m long and 250 m wide, with an area of 23.2 ha. The boundaries of three riparian vegetation communities were delineated within the study site. Vegetation type descriptions and unit areas are provided below in Table 1. The vegetation map is presented in Figure 5. A table showing the results of field data collected at each survey site is present in Appendix A.

Incidental observations recorded during the survey noted that mangrove vegetation communities were generally in good condition. No major weed populations or fire impacts were observed within the mangrove and riparian communities. However, recent impacts were recorded within the landward swamp community where evidence of an off-road race track were observed. A number of weeds were also recorded within the swamp community, including Hyptis (*Hyptis suaveolens*), declared Class B – Spread to be controlled, under the Northern Territory *Weed Management Act* and environmental weeds including Annual mission grass (*Cenchrus pedicellatus*), Calopo (*Calopogonium mucunoides*) and Stinking passionfruit (*Passiflora foetida*).

Table 1. Mangrove Ecosystem - Riparian vegetation descriptions and unit areas

Vegetation Type	Vegetation Description	Survey site	Area (ha)
Mangrove	*Lumnitzera racemosa, Bruguiera exaristata, Avicennia marina* low open forest, over *Fimbristylis* sp. and *Xerochloa imberbis* mid sparse tussock grassland	MVS1	5.18
Riparian	*Melaleuca viridiflora* mid woodland over *Acacia plectocarpa* mid open shrubland over *Germainia grandiflora* mid tussock grassland	RVS2	0.76
Swamp	*Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa* mid woodland over *Lophostemon lactifluus* mid open shrubland over *Sorghum intrans* mid tussock grassland	SVS3	1.5

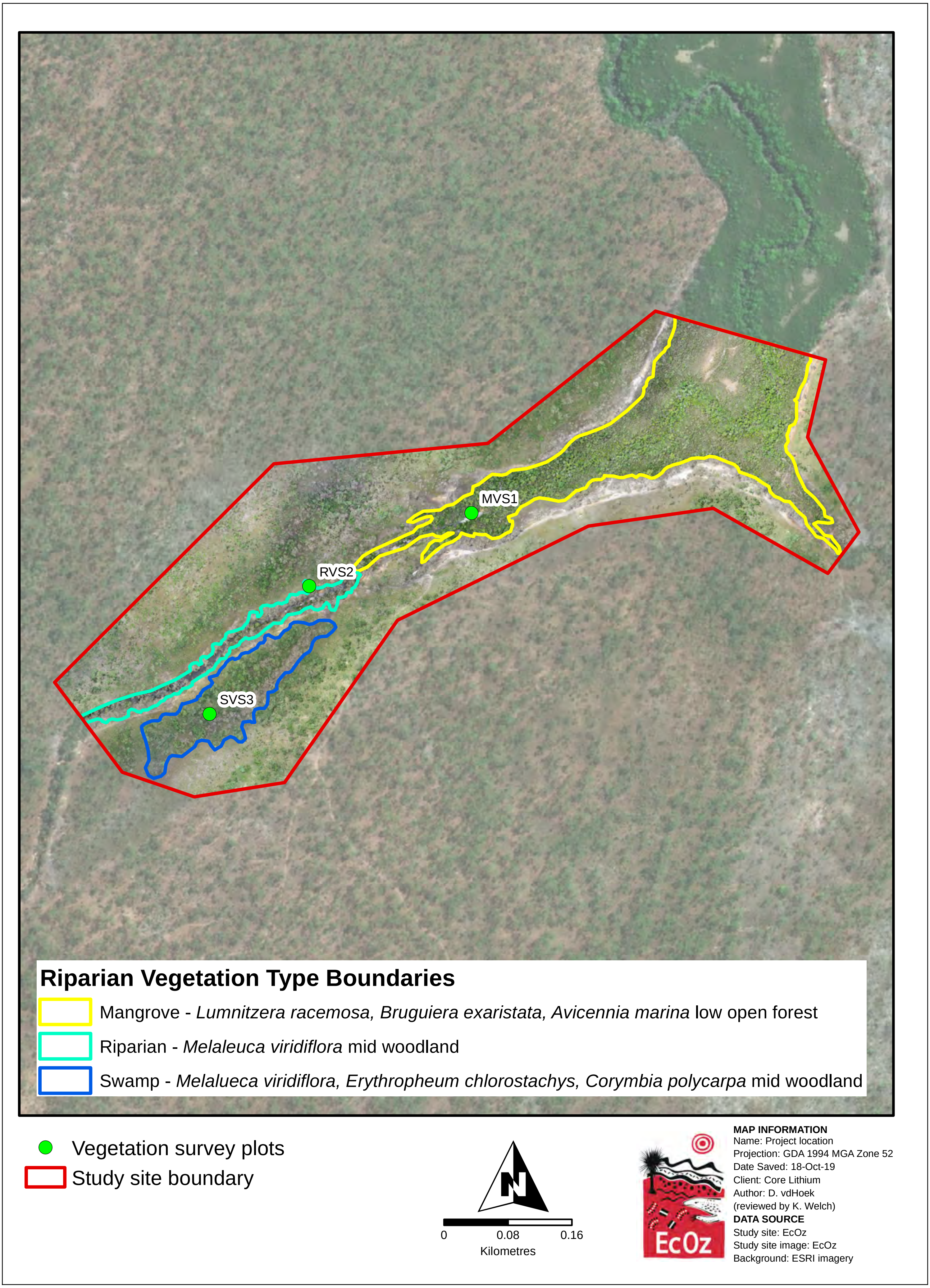
4.2 Riparian Groundwater Dependant Ecosystem

The riparian GDE study site is approximately 1.45 km long and 250 m wide, with an area of 33 ha. The boundary of one riparian vegetation community type was delineated within the study site. Vegetation type descriptions and unit areas are provided below in Table 2. A vegetation map is presented in Figure 6. A table showing the results of field data collected at each survey site is presented in Appendix A.

At the time of survey, riparian vegetation was observed to be in good condition. No major weed populations or fire impacts were recorded.

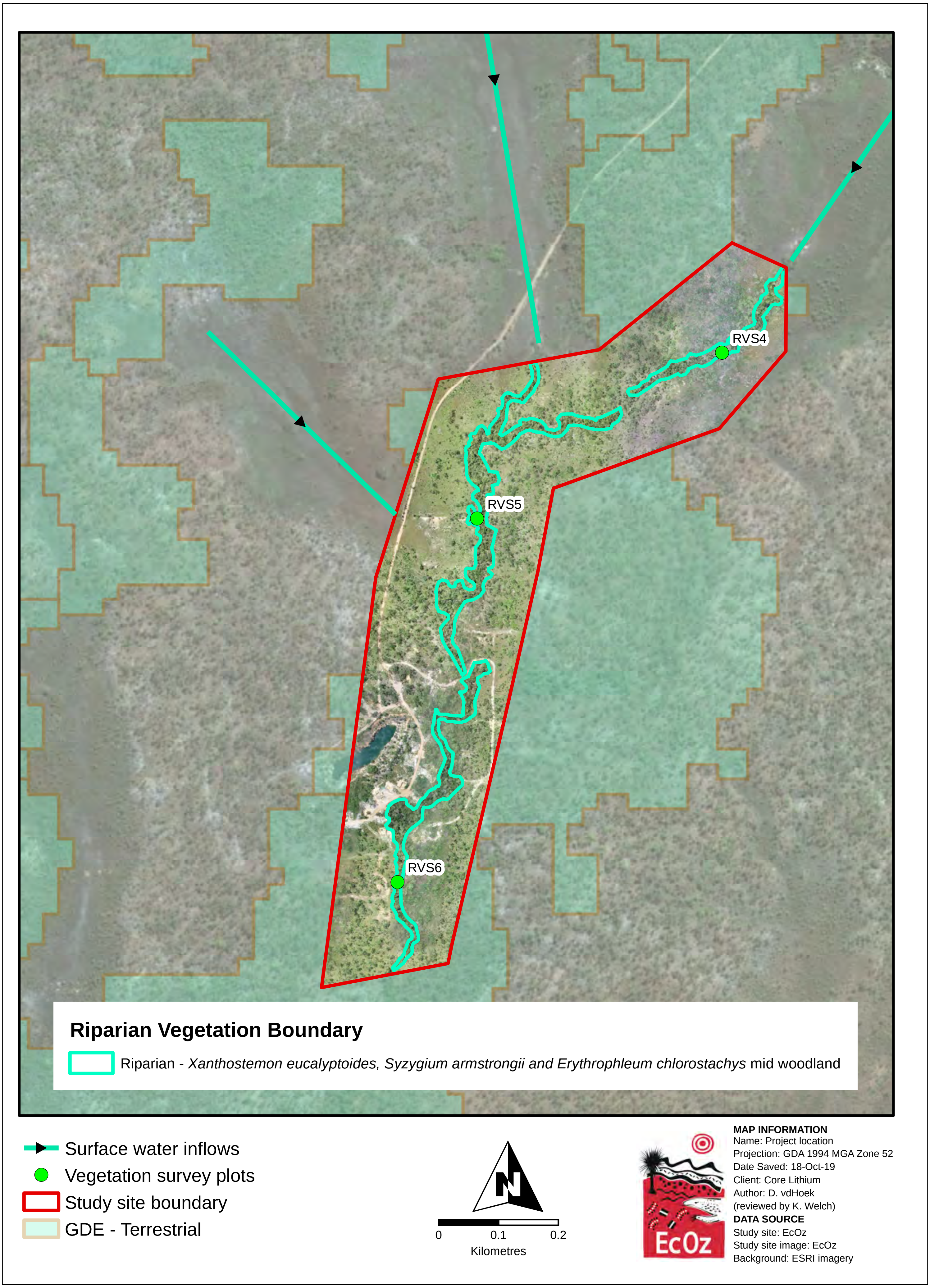
Table 2. Groundwater Dependant Ecosystem – Riparian vegetation descriptions and unit areas

Vegetation Type	Vegetation Description	Survey sites	Area (ha)
Riparian	*Xanthostemon eucalyptoides, Syzygium armstrongii* and *Erythrophleum chlorostachys* mid woodland over *Pandanus spiralis, Helicia australasica* and *Carallia brachiata* mid shrubland over *Eriachne triseta* mid tussock grassland	RVS4, RVS5, RVS6	3.62



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 3. Mangrove ecosystem vegetation boundaries.mxd

Figure 3. Mangrove ecosystem vegetation boundaries



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 4. GDE vegetation boundaries.mxd

Figure 4. Groundwater dependant ecosystem vegetation boundaries

5 CONCLUSION AND RECOMMENDATIONS

The assessment of vegetation boundaries presented within this report provides a baseline spatial dataset from which to monitor changes in riparian vegetation boundaries within the study sites. The baseline assessment indicates that vegetation communities within the study sites are in good condition, with limited pre-development disturbance. This is with the exception of the swamp community, which occurs downstream of the mine site in the West Arm catchment. Weeds and impacts from off-road racing tracks were observed within this vegetation community.

Future monitoring should repeat drone and vegetation surveys at the same time of the year that baseline surveys were conducted. This will allow for the capture of vegetation data in a similar seasonal state and enable more accurate analysis and interpretation of results.

When analysing the results of future drone survey against the baseline dataset, any significant retraction in riparian vegetation patch boundaries should trigger further assessment to determine the extent and potential cause of impact i.e. is the change confined to the impacted watercourse or occurring more broadly. This may require re-survey of vegetation plots to determine if there has been a change in vegetation structure and composition in response to vegetation boundary impacts.

Changes in vegetation structure and composition along the landward edge may indicate changes in surface and or groundwater flows entering those communities. However, further contextual assessment will be required as these changes could also occur because of bushfire and weed invasion unrelated to the project activities

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APPENDIX A FIELD VEGETATION PLOT DESCRIPTIONS

Site MVS1 – *Lumnitzera racemosa, Bruguiera exaristata, Avicennia marina* low open forest over *Fimbristylis* sp. and *Xerochloa imberbis* mid sparse tussock grassland
NVIS Code: T6c
Location (GDSA94, z52): 694035E, 8601220N
Upper 1: Mid open forest dominated by *Lumnitzera racemose* and *Avicennia marina*
Mid 1: *Bruguiera exaristata, Avicennia marina* with isolated *Excoecaria ovalis*
Ground 1: Sparse tussock grassland dominated by *Fimbristylis* sp. and *Xerochloa imberbis*
 
 
Other species **Upper stratum (U1):** - **Mid stratum (M1):** **Ground stratum (G1):** -
Land unit (Greater Darwin 25K) – 9b Marine
Landform: Mangrove flat near tidal creek
Soils: Brown sandy clay surface soils, some pebbles present ranging in size (2 – 6 cm)
Drainage: Very poorly drained
Fire history: No fire impact
Weeds: Absent
Disturbance: None
Hydrology: tidal, towards upper tide limit. Large pool located adjacent to vegetation assessment site – approximately 4 m wide.

Site RVS2 – *Melaleuca viridiflora* mid woodland over *Acacia plectocarpa* mid open shrubland over *Germainia grandiflora* mid tussock grassland
NVIS Code: T7i
Location (GDA94, z52): 693834E 8601132N
Upper 1: Mid woodland dominated by *Melaleuca viridiflora*
Mid 1: Mid open shrubland dominated by *Acacia plectocarpa, Lumnitzera racemosa* (on the edge of creek) and *Avicennia marina* (in creek channel)
Ground 1: Mid tussock grassland dominated by *Germainia grandiflora, Dapsilanthus* sp. and *Xerochloa imberbis*
 
 
Other species **Upper stratum (U1):** - **Mid stratum (M1):** *Thespesia populneoides* **Ground stratum (G1):** - *Asteraceae sp.*, *Wrightia saligna, Flagellaria indica, Acrostichum speciosum, Gymnanthera nitida, Lindernia lobelioides, Diospyros littorea*
Land unit (Greater Darwin 25K) – 6b Drainage system
Landform: Flat, adjacent to creek channel
Soils: Brown clay loam; rocks and pebbles common in channel adjacent to site
Drainage: Poorly drained
Fire history: 2+ years since last fire causing minimal impact
Weeds: None
Disturbance: Motorbike tracks nearby
Hydrology: Some pools nearby, inundated on large high tides and with freshwater during wet season

Site SVS3 – *Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa* mid woodland over *Lophostemon lactifluus* mid open shrubland over *Sorghum intrans* mid tussock grassland
NVIS Code: T7i
Location (GDA94, z52): 693708E, 8600969N
Upper 1: Mid woodland dominated by *Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa*
Mid 1: Mid open shrubland dominated by *Lophostemon lactifluus, Clerodendrum floribundum* and *Denhamia obscura*
Ground 1: Mid open tussock grassland dominated by *Sorghum intrans, Aristida* sp. and *Pandanus spiralis*
 
 
Other species **Upper stratum (U1):** - **Mid stratum (M1):** *Alphitonia excelsa, Grevillea decurrens* **Ground stratum (G1):** - *Germainia grandiflora, Acacia difficilis,* Fern sp., *Themeda* sp., *Wrightia saligna, Livistona humilis, Osbeckia australiana, Dianella odorata, Brachychiton megaphyllus, Fern sp.1, Antidesma ghesaembilla*
Land unit (Greater Darwin 25K) – 6b: Drainage system
Landform: Lower slope, flat open depression
Soils: Brown sandy loam. Some quartz present near creek
Drainage: Poorly drained – some wet season inundation
Fire history: Last year (relatively low impact fire)
Weeds: Annual mission grass scattered near site. Patches of *Hyptis suaveolens*, *Calopogonium mucunoides* and *Passiflora foetida* recorded nearby
Disturbance: None
Hydrology: Wet season inundation

Site RVS4 – *Syzygium armstrongii and Xanthostemon eucalyptoides* mid open woodland over *Pandanus spiralis* mid shrubland over *Scleria lingulata* mid open tussock grassland

NVIS Code: T7r

Location (GDA94, z52): 695055E 8594164N

Upper 1: Mid open woodland dominated by *Syzygium armstrongii* and *Xanthostemon eucalyptoides*

Mid 1: Mid shrubland dominated by *Pandanus spiralis, Flagellaria indica* and *Helicia australasica*

Ground 1: Mid open tussock grassland dominated by *Scleria lingulata***,** *Sorghum intrans* and *Eriachne triseta*



Other species

Upper stratum (U1): *Lophostemon lactifluus*

Mid stratum (M1): *Myrsine benthamiana*, *Melicope elleryana, Cyclophyllum schultzii, Carallia brachiata, Gmelina australis, Grevillea pluricaulis*

Ground stratum (G1): *Melastoma malabathricum* (*polyanthum), Themeda triandra, Eulalia mackinlayi, Osbeckia australiana, Dianella odorata, Cheilanthes* sp

Land unit (Greater Darwin 25K) – 5b1: Drainage System

Landform: Flat, adjacent to creek channel

Soils: Black clay in channel

Drainage: Poorly drained

Fire history: Very recent adjacent (other side of the creek) but 2+ years since last fire at the site

Weeds: None

Disturbance: Some pig damage

Hydrology: Site situated adjacent to large pool (approximately 8 m x 15 m) 40 cm ~ 1m deep, steep bank (0.5 m).

Site RVS5 – *Xanthostemon eucalyptoides* mid woodland over *Leptospermum madidum* mid open shrubland over *Eriachne triseta* mid tussock grassland
NVIS Code: T6d
Location (GDA94, z52): 694646E 8593887N
Upper 1: Mid woodland dominated by *Xanthostemon eucalyptoides; Syzygium armstrongii;* and *Melaleuca viridiflora*
Mid 1: Mid shrubland dominated by *Leptospermum madidum; Helicia australasica; Carallia brachiata* and *Cyclophyllum schultzii*
Ground 1: Mid tussock grassland dominated by *Eriachne triseta, , Fern sp.2* and *Mnesithea rottboellioides*
 
 
Other species **Upper stratum (U1):** - *Melaleuca viridiflora; Syzygium armstrongii; Corymbia polycarpa* **Mid stratum (M1): -** *Pandanus spiralis; Helicia australasica; Acacia 'pellita'; Carallia brachiate; Cyclophyllum schultzii; Carpentaria acuminata,* **Ground stratum (G1):** - *Livistona humilis; Grevillea pluricaulis; Osbeckia Australiana; Mnesithea rottboellioides; Dianella odorata; Eulalia mackinlayi; Heteropogon triticeus, Fern sp.2 Cyperus sp., Themeda triandra; Germainia grandiflora; Philydrum lanuginosum*
Land unit (Greater Darwin 25K) – 5b1: Drainage System
Landform: open depression (watercourse/gully)
Soils: Brown loam sand. Clay in channel
Drainage: Poorly-very poorly drained
Fire history: unburnt-fire nearby
Weeds: Absent
Disturbance: Some pig disturbance
Hydrology: Some pools nearby, inundated with freshwater during wet season

Site RVS6 – *Erythrophleum chlorostachys* mid woodland over *Xanthostemon eucalyptoides* mid open shrubland over *Eriachne triseta* mid tussock grassland

NVIS Code: T7i

Location (GDA94, z52): 694513E 8593280N

Upper 1: Mid woodland dominated by *Erythrophleum chlorostachys*

Mid 1: Mid open shrubland dominated by *Xanthostemon eucalyptoides; Melicope elleryana; Carallia brachiate; Lophostemon lactifluus; Pandanus spiralis*

Ground 1: Mid tussock grassland dominated by *Eriachne triseta;* Fern *sp1*; *Xanthostemon eucalyptoides*




Other species

Upper stratum (U1): - *Erythrophleum chlorostachys; Xanthostemon eucalyptoides; Corymbia polycarpa*

Mid stratum (M1): *Xanthostemon eucalyptoides; Melicope elleryana; Carallia brachiate; Lophostemon lactifluus; Pandanus spiralis*

Ground stratum (G1): - *Asteraceae sp., Wrightia saligna, Flagellaria indica, Acrostichum speciosum, Gymnanthera nitida, Lindernia lobelioides, Diospyros littorea; Mnesithea rottboellioides; Eulalia mackinlayi; Themeda triandra*

Land unit (Greater Darwin 25K) – 5b1: Drainage System

Landform: Lower slope adjacent to creek. Open depression from edge.

Soils: Brown clay loam

Drainage: Moderately well drained. Poorly drained FP. Very poorly drained channel seasonal creek.

Fire history: 2+ years since last fire causing minimal impact

Weeds: None

Disturbance: No visible impact

Hydrology: Seasonal freshwater in the creek during wet season

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APPENDIX C OBSERVATION HILL DAM SURFACE WATER MONITORING PROGRAM

Finniss Lithium Project

Observation Hill Dam Surface Water Monitoring Program

EcOz Environmental Consultants
1727-03-B2, 13 April 2022

Report Title	Finniss Lithium Project, Observation Hill Dam Surface Water Monitoring Program
Client	EcOz Environmental Consultants Level 1 70 Cavenagh Street, Darwin NT 0800
Report Number	1727-03-B2

Revision Number	Report Date	Report Author	Reviewer
1	9/03/2022	AMC	JDO
2	1/04/2022	AMC	JDO
3	13/04/2022	AMC	JDO

For and on behalf of WRM Water & Environment Pty Ltd
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Julian Orth

Principal Engineer

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1 Introduction

1.1 BACKGROUND

The Finniss Lithium Project (the Project) is located in the Northern Territory approximately 25 km southwest of Darwin. The product will be hauled to the East Arm Port for distribution. A locality plan of the Finniss Lithium Project is shown in Figure 1.1. The Project currently includes the approved Grants Lithium Project (Grants) and the proposed adjacent underground operation, BP33. The Finniss Lithium Project is managed by Core Lithium Ltd (Core).

WRM Water & Environment (WRM) have been commissioned by EcOz Environmental Consultants (EcOz) on the behalf of Core to develop an Observation Hill Dam (OHD) Surface Water Monitoring Program (SWMP) for the Project. This SWMP will address special conditions 4.1 and 4.2 of Core's Water Extraction Licence (WEL) (no. 8151018):

- measures to monitor impacts on surface water conditions (volumes and flows) downstream of the waterway;
- trigger values for changes in surface water which indicate that impacts to flows downstream of the waterway significantly vary from those predicted in Core Exploration Ltd, Cox Peninsula Supplementary Report prepared by EnviroConsult Pty Ltd dated February 2019 (relevant section/s provided in Appendix A of this report); and
- measures to undertake further assessment to characterise the nature of impacts to surface water conditions and riparian vegetation if the trigger values identified above are reached.

1.2 PROJECT DESCRIPTION

The targeted ore body is a near-vertical pegmatite intrusion, rich in the lithium-bearing mineral spodumene. The ore body will be mined via an open-cut (OC) pit using drill and blast methods, and processed on site by crushing, screening and water-based dense medium separation (DMS), to produce a concentrate for transport via road to Darwin Port for export. Waste rock from the pit will placed in an onsite waste rock dump (WRD), and waste from processing will be placed in a tailings storage facility (TSF) contained within the WRD. The Grants open cut mine life is expected to be two to three years. The proposed mine layout for Grants, including all major surface water infrastructure elements required during operations, is shown in Figure 1.2.

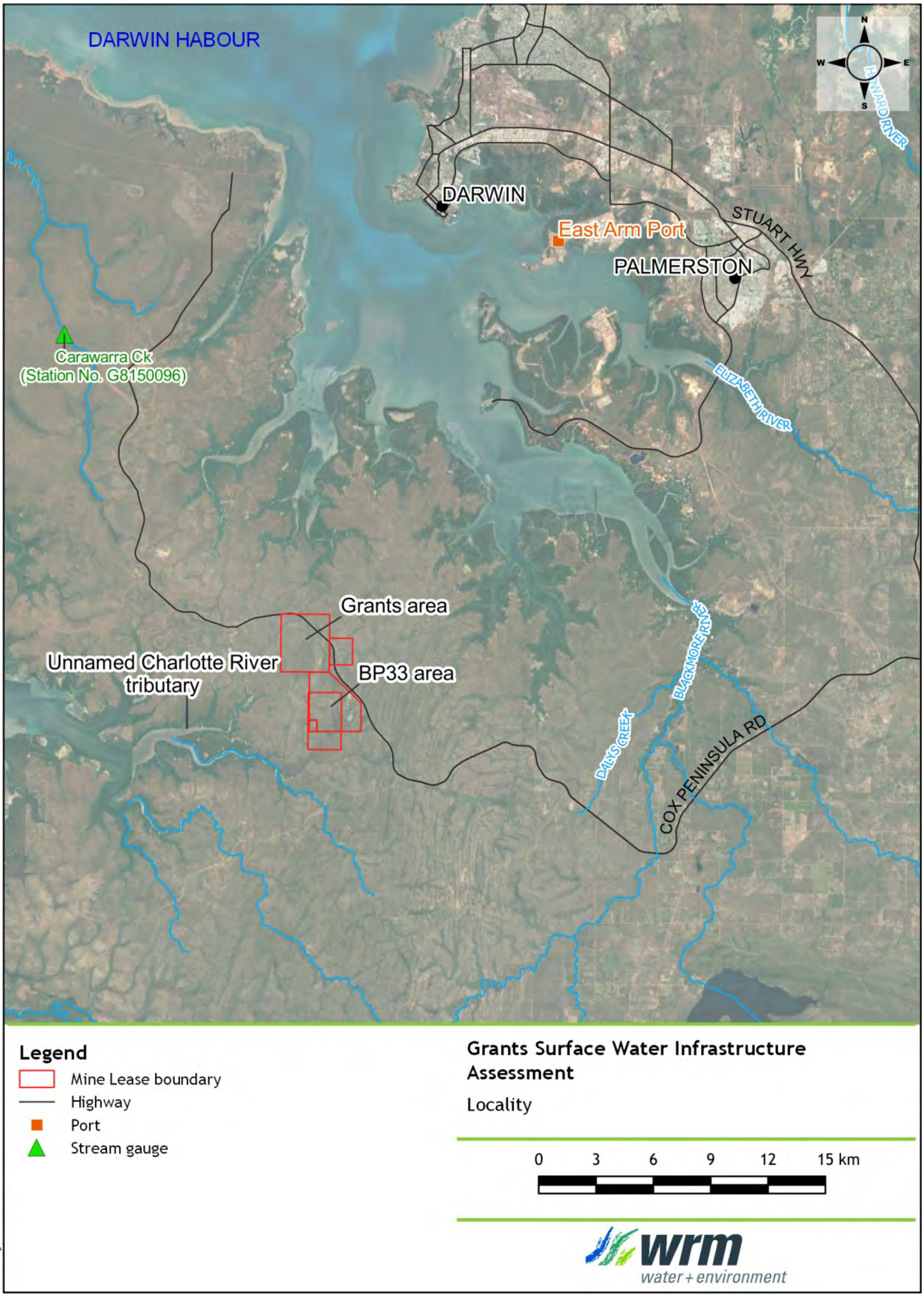


Figure 1.1 - Project locality

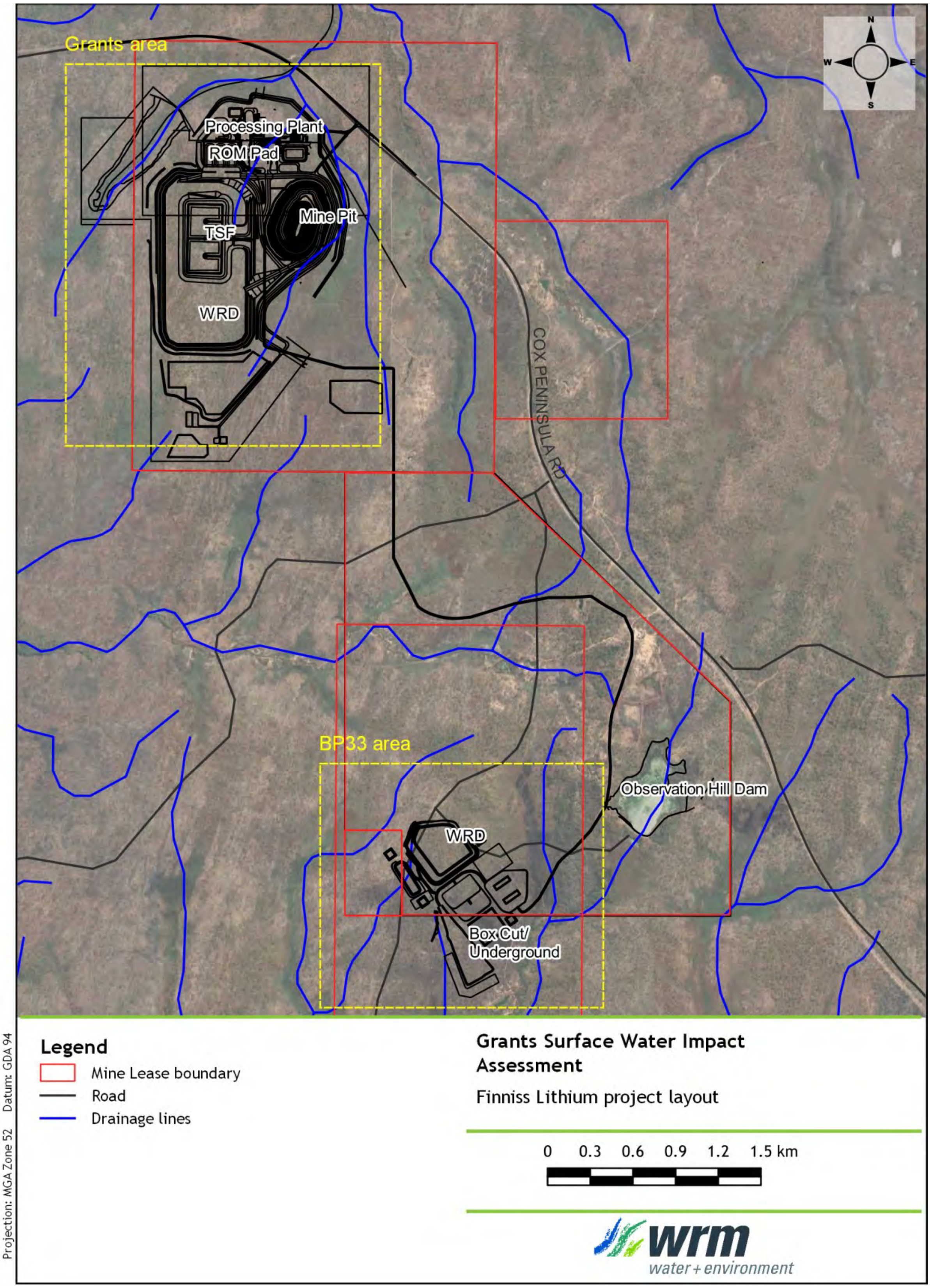


Figure 1.2 - Project layout

1.3 WATER EXTRACTION LICENCE

The Core WEL (8151018) commenced on 1 December 2021 and would allow for the extraction of up to 620 ML per annual period from OHD. The location of OHD is shown in Figure 1.2. Table 1 of WEL 8151018 (reproduced in Table 1.1) shows the total extraction volumes permitted from OHD over a set period. For each period specified in Table 1 of WEL 8151018, Core must ensure that the total extraction from OHD does not exceed the Entitlement.

The Core WEL also defines a security level of Low, Medium or High. The security level is the order in which announced allocations are applied to licences. The Core WEL security level is undefined.

Table 1.1 - Entitlement volumes for the Project, per the WEL (from Table 1 of WEL 8151018)

Entitlement (ML)	Period
310	Commencement date to 30 April 2022
310	1 May 2022 to 31 October 2022
61	1 November 2022 to 30 April 2023
121	1 May 2023 to 30 April 2024
121	1 May 2024 to 30 April 2025

1.4 REPORT STRUCTURE

This report is structured as follows:

- Section 2: A description of the current and proposed water management infrastructure at Grants.
- Section 3: A description of the existing surface water environment at Grants, including recorded water quality data.
- Section 4: An assessment of the potential downstream impacts of extraction from OHD.
- Section 5: A description of the proposed surface water monitoring plan.
- Section 6: The preliminary Downstream Risk Matrix for the operation of OHD.
- Section 7: The draft Trigger Action Response Plan for the WEL.
- Section 8: Review requirements of the SWMP.
- Section 9: Limitations of the information used to prepare the SWMP.
- Section 10: Provides a list of references.

2 Observation Hill Dam characteristics

2.1 OVERVIEW

The project plans to utilise the existing OHD as a makeup water supply storage. Water from OHD would be transferred to RWD via a 6 km underground pipeline, if required to meet onsite demands. This dam was constructed to supply water for tin and tantalite mining and ore processing that occurred in the 1980's and 1990's.

2.2 CATCHMENT AREA

OHD receives a runoff from a 93.9 ha catchment generally south of Cox Peninsula Road, as pictured in Figure 2.2. This catchment is based on the LiDAR collected by Core in 2021.

2.3 EMBANKMENT

The location of the existing OHD embankment is shown in Figure 2.2. The minimum embankment crest level is currently at 31.5 mAHD.

Foundations under the OHD existing embankment were found to be low to very low strength clays and silts, up to 9 m below the embankment. Phyllite and/or metasandstone was encountered below the low strength foundations.

2.4 STORAGE CAPACITY

The current estimated FSV for OHD is 364 ML. Core propose to raise the dam wall by approximately 1.5 m to increase storage capacity to around 620 ML. It is expected that the dam wall raise would be completed by the 2022 dry season.

The stage-storage curve developed by GHD (2021) for OHD (including the raised capacity) is presented in Figure 2.1.

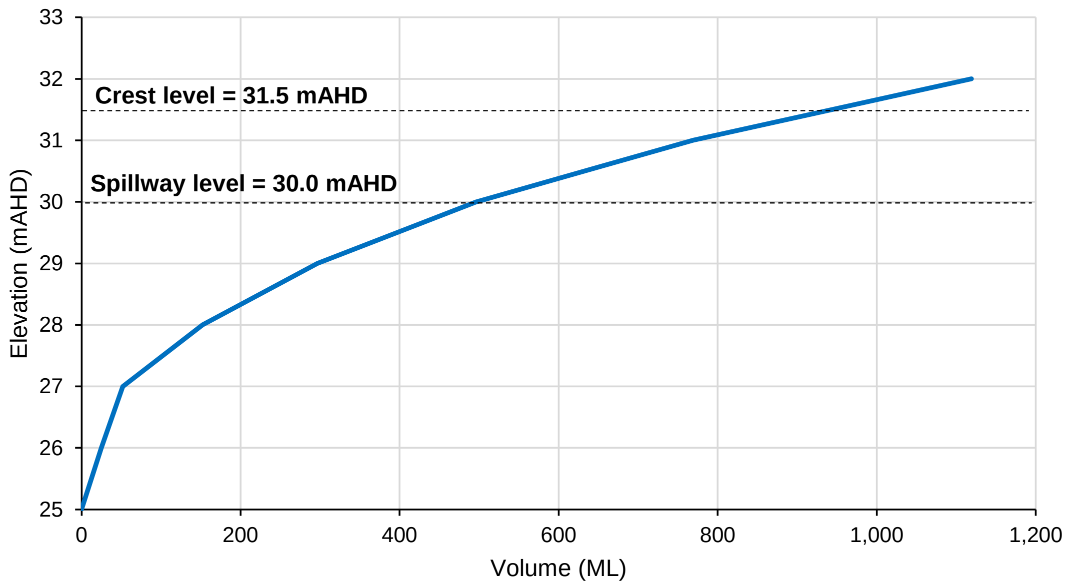
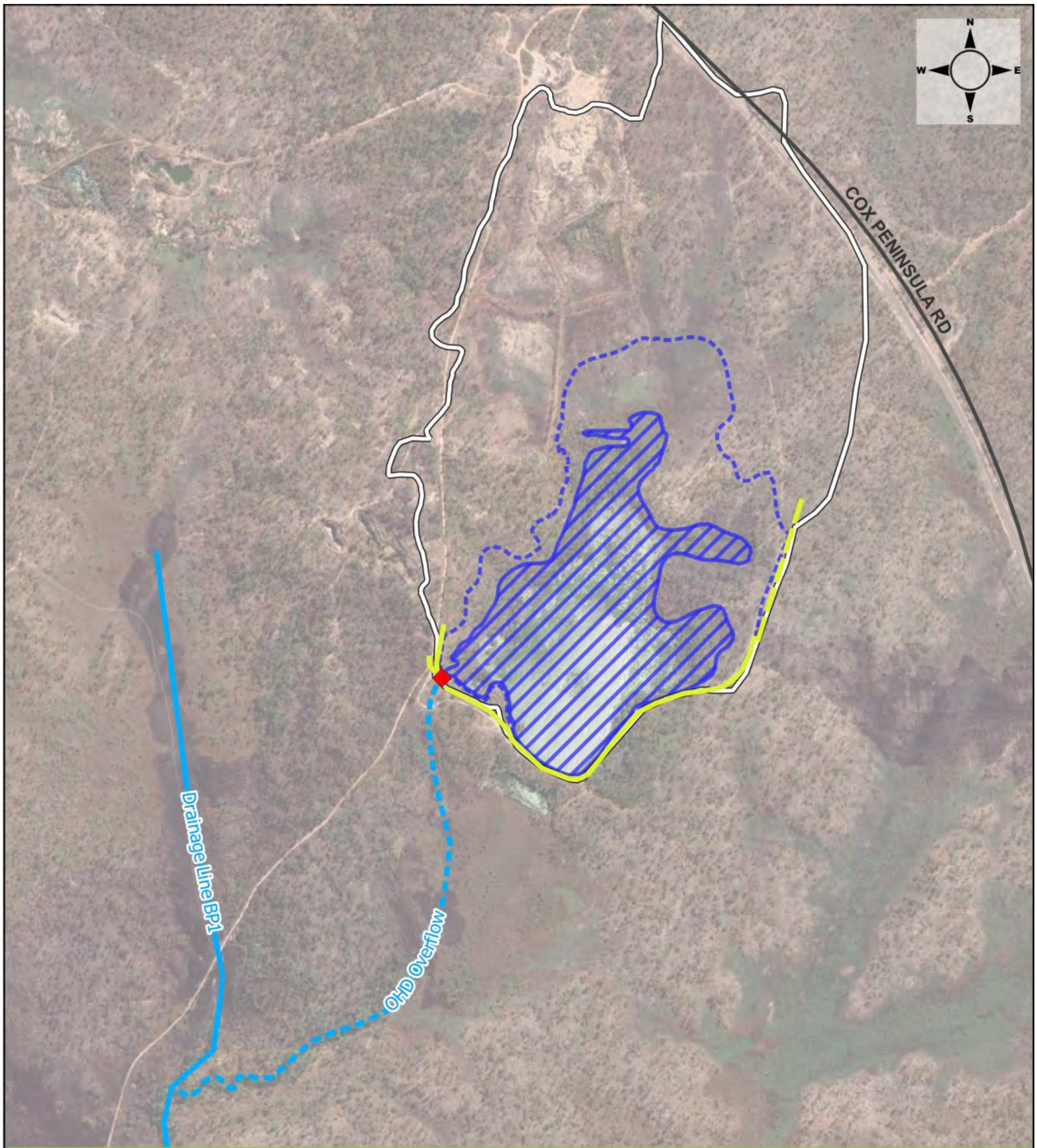


Figure 2.1 - Observation Hill Dam stage-storage curve (GHD, 2021)



Projection: MGA Zone 52 Datum: GDA 94

Legend

- Mine Lease boundary
- Road
- Drainage Lines
- OHD overflow path
- Current OHD footprint
- Upgraded OHD footprint (proposed)
- OHD embankment alignment
- OHD proposed embankment alignment
- OHD spillway location
- Catchment area

Grants Surface Water Monitoring Plan

Observation Hill Dam location and layout

0 200 400 600 800 m

wrm water + environment

Figure 2.2 - OHD location and catchment area

2.5 SPILLWAY

The existing OHD spillway is located on the north western edge of the dam embankment (see Figure 2.2) and would direct flows into Drainage Line BP1. The spillway has an elevation of approximately 30 mAHD and a width of approximately 5 m. Figure 2.2 also shows the maximum OHD footprint, based on the current spillway level.

2.6 DAM WALL RAISING

In order to increase the storage capacity of OHD, and hence the volume of water available to supply site demands, Core propose to raise the OHD embankment and spillway. The embankment would be raised by 1.4 m and the spillway would be raised by 1.5 m, increasing the total capacity from 364 ML to 620 ML. The upgraded OHD spillway would be designed to have a 1% AEP capacity, based on a 'Low' Dam Failure Consequence Category (GHD, 2021; ANCOLD, 2012). The proposed OHD upgraded spillway and embankment design is presented in

Table 2.1. A typical section of the proposed raise is shown in Figure 2.3

Table 2.1 - Summary of OHD upgrade specifications

Parameter	Value
Storage type	Valley Dam
Embankment type	Zoned earthfill
Crest level	RL 32.9 mAHD
Height (max)	11.2 m
Crest width	6 m
Upstream batter slope (H:V)	3:1
Downstream batter	4:1

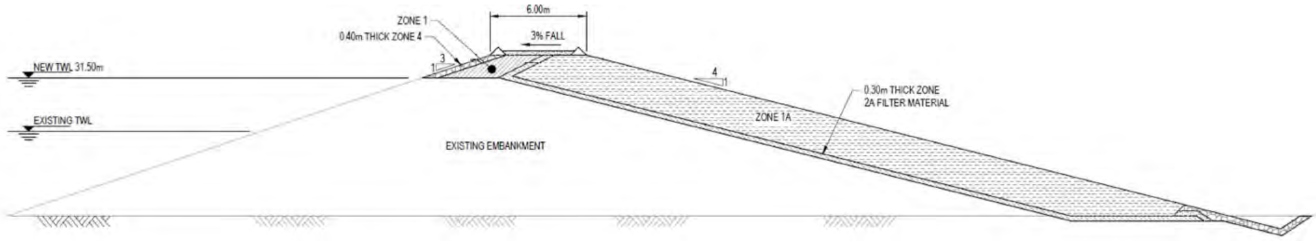


Figure 2.3 - OHD upgrade typical section (GHD, 2021)

The majority of the proposed raise consists of a general earthfill zone back sloping from the existing embankment, which would likely be sourced from previously disturbed mining areas adjacent to the storage. The embankment would be overlain with an erosion protection layer.

A sand filter would also be included on the downstream side of the existing embankment, tying into a blanket filter on the new foundations before reporting to the downstream rock toe. The purpose of the sand filter would be to reduce the risk of piping failure.

3 Catchment hydrology and environmental values

3.1 GENERAL

This section describes the drainage characteristics in the vicinity of the Project and the key water storages. The environmental values as defined by the NT Water Act, Environmental Protection Policies (EPPs), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) and regulations of these waterways are also described.

3.2 CATCHMENT HYDROLOGY

3.2.1 Project

Figure 3.6 shows the local drainage features within the vicinity of Grants. Drainage features that cross the Project area eventually drain to the Timor Sea. The tributaries connecting with the Timor Sea which intersect the Grants area include (Figure 3.6):

- Drainage Line 1;
- Drainage Line 2;
- Drainage Line 3;
- Drainage Line BP1; and
- Drainage Line BP2.

3.2.2 OHD

OHD is located adjacent to the proposed BP33 area and receives runoff from a largely undisturbed catchment area of 94 ha. There are no defined drainage lines in the upper OHD catchment. The upper catchment has a slope between 1% to 2%. Figure 3.1 shows the upper OHD catchment area, which appears to be well vegetated.

Figure 3.2 shows the OHD water surface and surrounding vegetation. This photograph shows that the area around OHD is well vegetated.

OHD would overflow via its spillway, during wet weather events, into Drainage Line BP1.

Figure 3.1 - OHD upper catchment

Figure 3.2 - OHD water surface

3.2.3 Drainage Line BP1

Drainage Line BP1 has a catchment area of approximately 298 ha and 365 ha to the BPUS SW1 and BPDS SW2 monitoring locations respectively (shown in Figure 3.6). Of this catchment area, 93.8 ha would be impounded by OHD. The catchment is mostly natural with some grassed areas that were cleared by preliminary exploration activities. The channel is poorly defined, particularly in the upper section of the reach. The channel banks are vegetated with grasses, shrubs and small trees, as shown in Figure 3.4.

There is a small exploration pit void adjacent to the Drainage Line BP1 channel, downstream of BPUS SW1 (shown in Figure 3.5). The void has filled with water. The void is surrounded by an embankment approximately 1 m high, which may constrict flows in this location.

Cross-sections taken across the Drainage Line BP1 channel are shown in Figure 3.3 and are based on available LiDAR ground survey. The cross sections show the following regarding the Drainage Line BP1 channel:

- Drainage Line BP1 is a broad overland flowpath with no defined channel at DL2XS1.
- At DL2XS2, DL2XS3 and DL2XS4, the channel has the following characteristics:
  - 4-5 m channel base width; and
  - 1V:4H to 1V:6H channel side slopes.

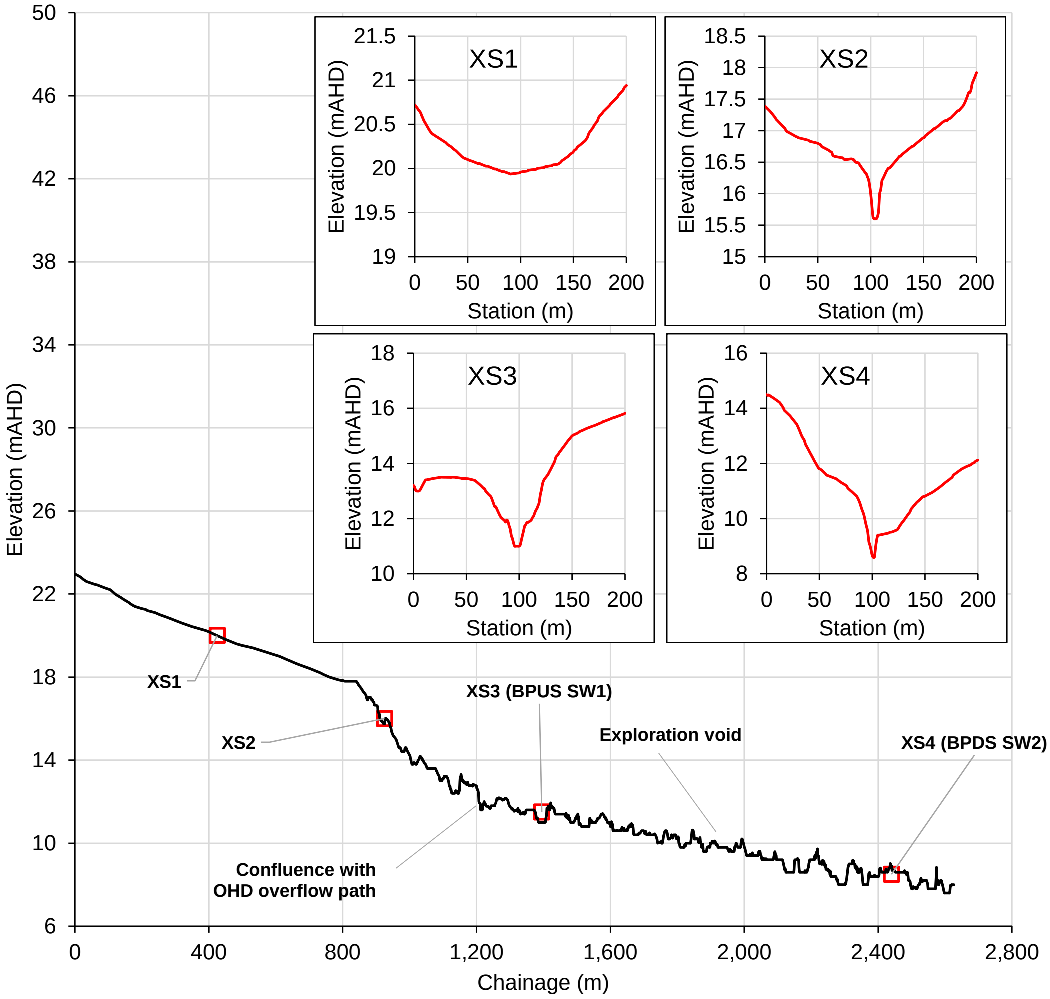


Figure 3.3 - Drainage Line 2 representative cross sections

Figure 3.4 - Drainage Line BP1 channel

Figure 3.5 - Drainage Line BP1 exploration void

3.3 WATER QUALITY

EcOz undertook surface water quality sampling during 2016 and 2017 at the monitoring locations presented in Figure 3.6. Core personnel collected water quality samples between 2017 and 2021. A statistical analysis of the water quality sampling results for key analytes is presented in Table 3.1. The following is of note regarding the water quality sampling results:

- OHD generally exhibited low concentrations of metals, however nutrients (nitrogen and phosphorus) were slightly elevated. The elevated nutrient concentrations are likely the result of biological processes (i.e. algal blooms);
- The receiving water locations generally tend to have lower pH level (slightly acidic);
- The dissolved metal concentration in the receiving water locations is generally low, with some exceptions for aluminium and iron; and
- Overall, the water quality in OHD and at the receiving water locations is generally similar.

Table 3.1 - Surface water quality monitoring results

Parameter	Units	OHD				BPUS SW1				BPDS SW2			
		count	20%ile	50%ile	80%ile	count	20%ile	50%ile	80%ile	count	20%ile	50%ile	80%ile
pH	pH unit	13	5.9	6.6	6.9	13	5.1	5.5	7.3	13	5.3	5.5	7.3
EC	µS/cm	13	15	19.5	23.4	13	14.6	18.2	26.6	13	15.9	17.7	25.9
DO	%sat	13	56.1	79.2	89.7	13	59.3	75.2	83.5	13	51.1	74.9	83.2
Turbidity	NTU	12	1.8	4.5	9.7	12	3	4.6	11.8	13	3	5.6	21
Aluminium	mg/L	12	0.01	0.01	0.012	13	0.02	0.06	0.146	13	0.02	0.04	0.116
Arsenic	mg/L	12	0.002	0.003	0.0042	13	<0.001	<0.001	0.002	13	<0.001	<0.001	0.0022
Cadmium	mg/L	13	<0.0001	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0001
Chromium	mg/L	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Copper	mg/L	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Lead	mg/L	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Nickel	mg/L	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Selenium	mg/L	9	<0.01	<0.01	<0.01	10	<0.01	<0.01	<0.01	10	<0.01	<0.01	<0.01
Zinc	mg/L	13	<0.005	<0.005	<0.005	13	<0.005	<0.005	<0.005	13	<0.005	<0.005	<0.005
Lithium	mg/L	13	<0.001	<0.001	0.0022	11	<0.001	0.003	0.0072	11	<0.001	0.003	0.0068
Iron	mg/L	12	0.05	0.06	0.182	13	0.09	0.17	0.306	13	0.094	0.16	0.428
Mercury	mg/L	13	<0.0001	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0001
Ammonia as N	mg/L	13	<0.01	0.02	0.07	13	<0.01	0.03	0.074	13	<0.01	0.02	0.096
NOx as N	mg/L	13	<0.01	0.02	0.04	13	<0.01	<0.01	0.03	13	<0.01	<0.01	0.03
TN as N	mg/L	13	0.2	0.3	0.5	13	<0.1	0.2	0.22	13	<0.1	0.2	0.34
TP as P	mg/L	13	<0.01	<0.01	0.02	13	<0.01	<0.01	0.016	13	<0.01	<0.01	0.022
TRP as P	mg/L	12	<0.001	0.002	0.0052	13	0.001	0.003	0.01	13	<0.001	0.003	<0.01

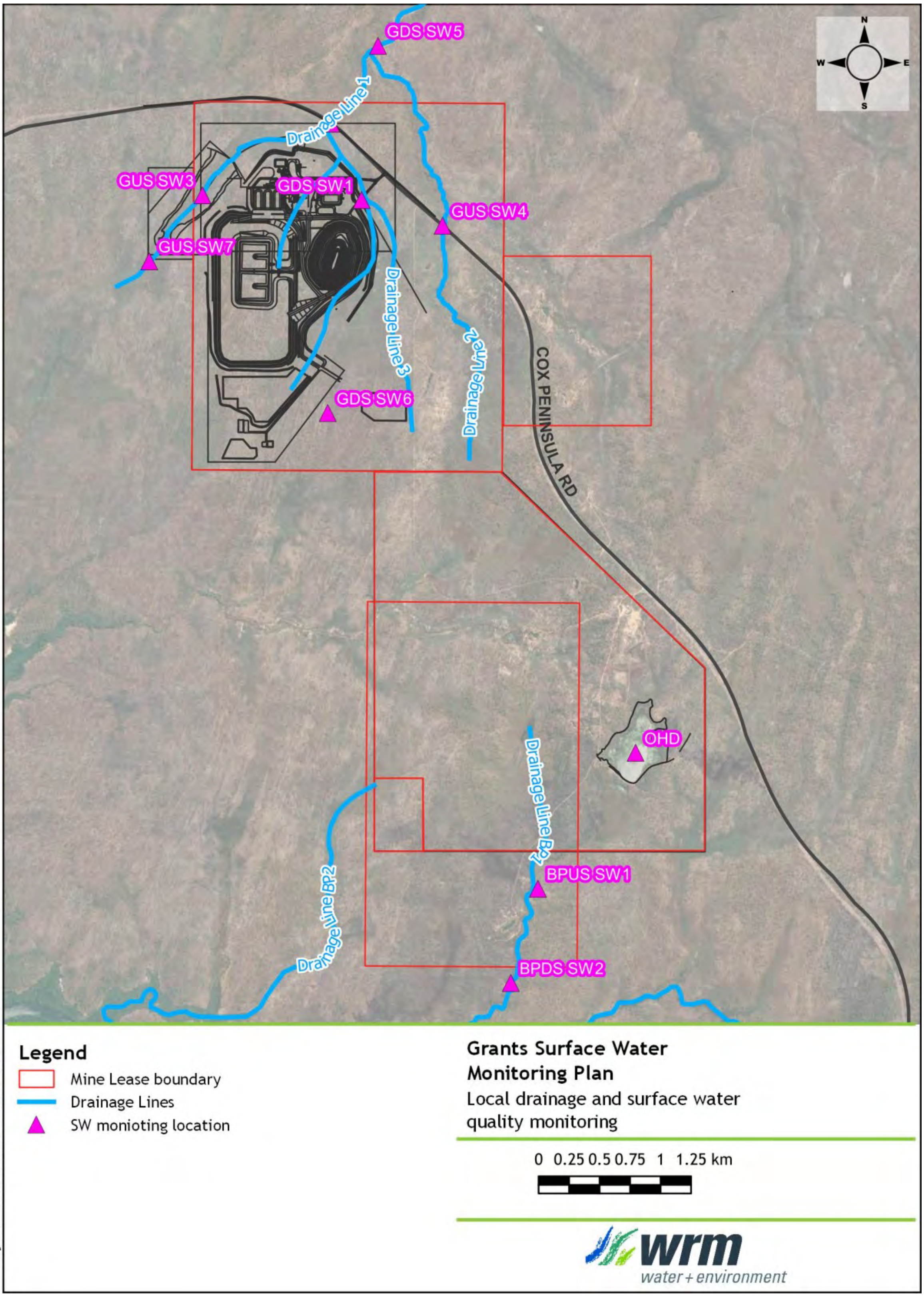


Figure 3.6 - Surface water quality monitoring location

4 Assessment of potential downstream impacts

4.1 OVERVIEW

An assessment of the maximum potential impacts due to water extraction from OHD was assessed as part of Grant's Mining Management Plan (Enviroconsult, 2019) for an average rainfall year. This study found that, over a full wet season of average rain (~1,652 mm), the reduction in average flows downstream of OHD due to an annual water extraction volume of 738 ML/year (daily average of 2.02 ML/d) would be 45% during the wet season. This is considered to be the maximum impact on downstream flows due to water extraction for this climatic sequence per Special Condition 4.1(iii) of the WEL. Note that the current pump at OHD has an extraction rate of up to 4.00 ML/d.

The outcomes of the Enviroconsult (2019) assessment would be considered as the baseline limit for downstream impacts due to water extraction from OHD.

4.2 MODELLED DOWNSTREAM IMPACTS FOR VARYING CLIMATIC CONDITIONS

The Enviroconsult (2019) assessment only presented potential downstream impacts for the average wet season. However, it is important to consider the full range of climatic conditions that Grants may experience to determine the limits to potential downstream impacts. For example, water extraction during drier years would likely result in greater downstream impact, compared to the average downstream impact. Whereas, during wetter years, the downstream impact would likely less than average conditions.

The Project GoldSim water balance model was used to estimate the potential downstream impacts of water extraction from OHD for a range of climatic conditions. The model also considered water requirements on site (i.e. water was only taken from OHD as needed). The development of the GoldSim model is documented in WRM (2022).

Note that the OHD extraction volumes would be sensitive to the water balance assumptions including (but not limited to):

- Groundwater inflow rates into the Mining Pit;
- Actual production rates and DMS plant process demands;
- Haul road dust suppression demands; and
- Catchment runoff volumes collected by the site.

Figure 4.1 shows the likely (i.e. taken as needed) and maximum downstream impacts (assessed immediately downstream of the OHD spillway) ranked according to the probability of exceedance. This figure shows the following:

- The black curve represents the potential downstream impacts of water extraction from OHD, taking the requirement for additional site water into consideration (i.e. taken as needed). This curve was generated based on the Goldsim model.
- The dashed grey curve represents the methodology presented in the Enviroconsult (2019) assessment. That is, the average wet season impact was calculated using a constant 2.02 ML/d extraction rate (regardless of the volume in OHD and the Grants water management system).
- The blue dots represent total wet season rainfalls (in mm), plotted corresponding with the associated downstream impact.

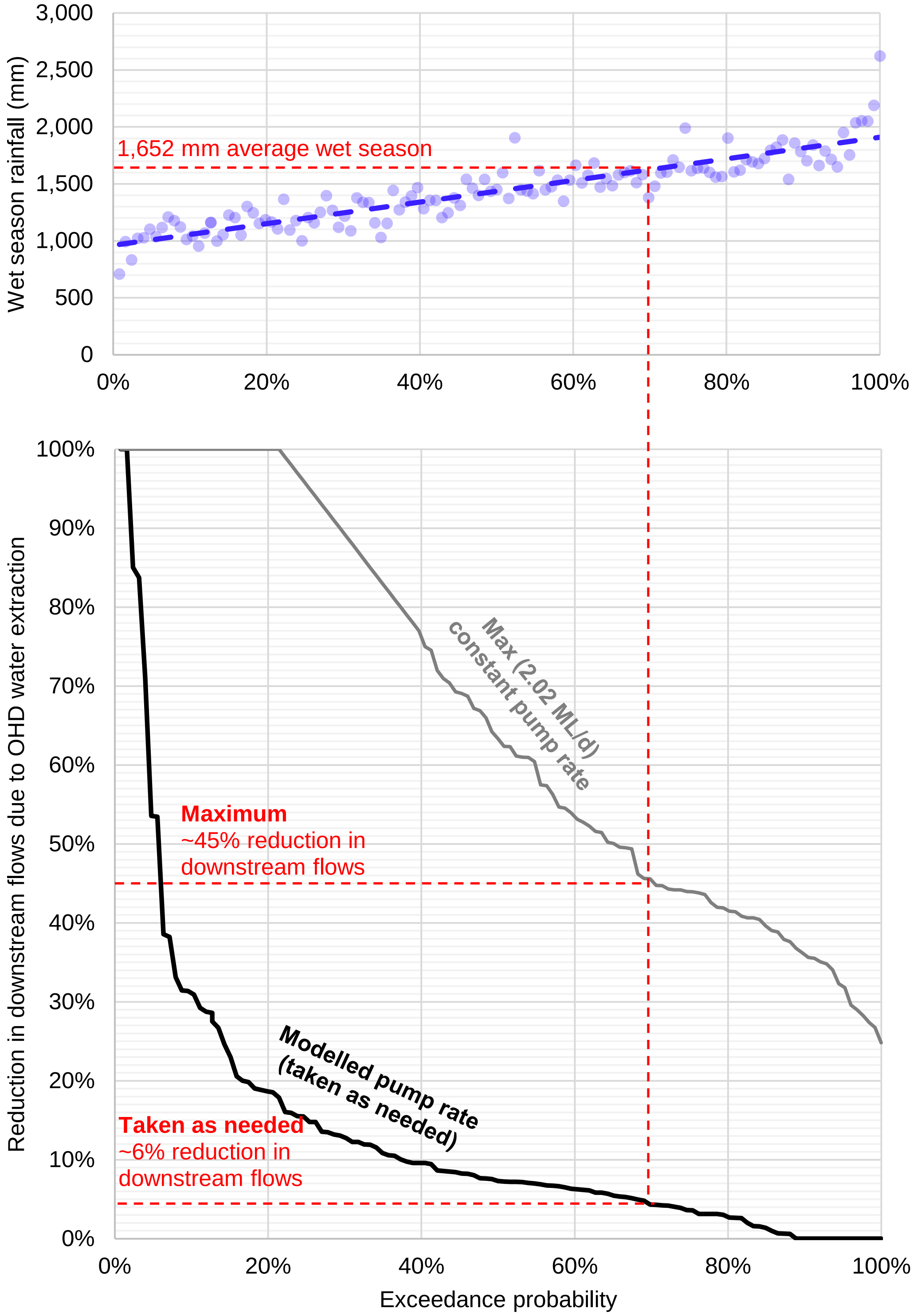


Figure 4.1 - Potential impact of water extraction from OHD on downstream flow volumes

The following is of note regarding this figure:

- For conservativism, it was assumed that OHD would be empty at the beginning of the wet season.
- If water is extracted from OHD as needed (assumed that the site water demand assumptions are correct), is it not likely that the downstream impacts of OHD will exceed the maximum downstream impacts reported by Enviroconsult (2019).
- If OHD is pumped out at a constant rate of 2.02 ML/d, this may result in a downstream flow reduction of 100% (i.e. no overflows occurring during the wet season), for the driest 40% of climatic conditions. Taking water as need from OHD would only result in 100% flow reduction in the driest 2% of climatic conditions.
- If the current maximum pump rate (4.00 ML/d) is maintained for extended periods, there would be a potential for the maximum allowable downstream impact to be exceeded.

Based on the maximum allowable downstream flow reductions presented Figure 4.1, the minimum required annual OHD spill days have been determined. The annual spill days (considering no OHD pumping) were estimated using the Project GoldSim model. The minimum allowable annual spill days are presented in Figure 4.2.

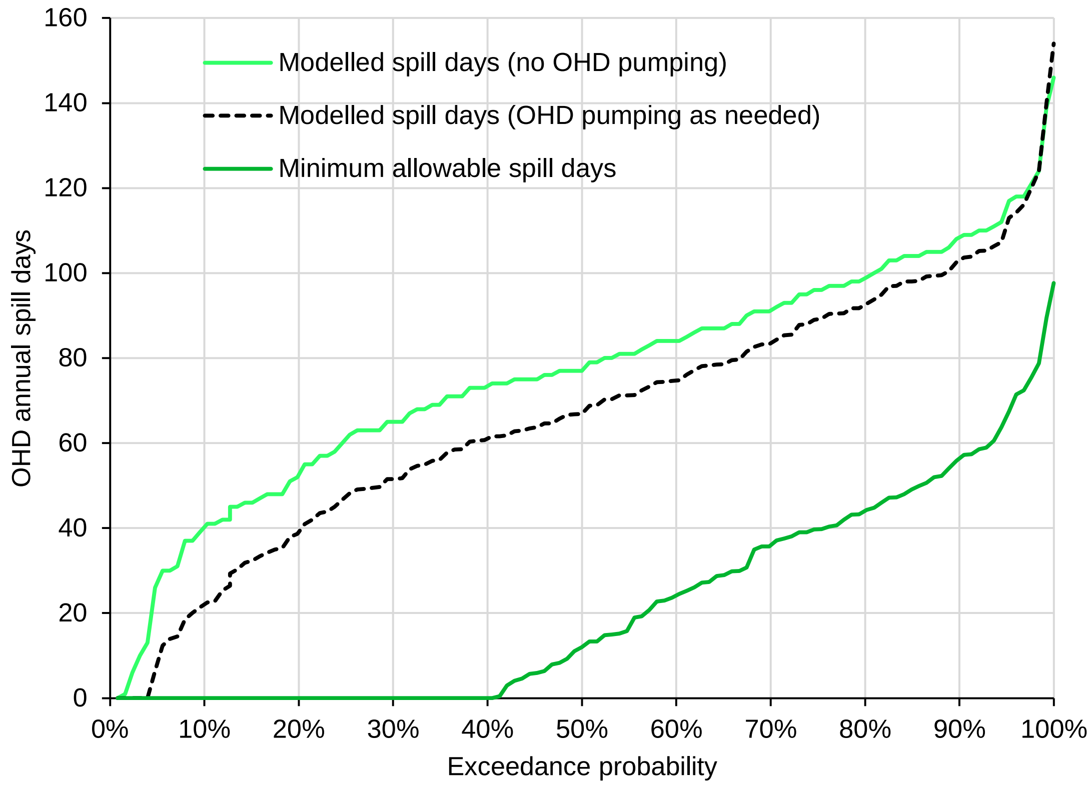


Figure 4.2 - Minimum annual spill days required during OHD water extraction

4.3 APPLICATIONS

The relationship between the maximum downstream impacts and wet season rainfall can be used as an early warning tool, to predict whether the current extraction rate would cause an exceedance of the maximum allowable downstream impacts. The potential downstream impacts from OHD would be managed using two plans: Surface Water Monitoring Plan and Downstream Risk Matrix. The details of these plans are discussed in the following sections.

5 Proposed surface water monitoring plan

5.1 OVERVIEW

Monitoring of surface water levels downstream of OHD will form a key component of the surface water management system. Monitoring of water levels will assist in demonstrating that the site water management system is effective in meeting its objective of minimal impact on downstream flows and will allow for early detection of any impacts and appropriate corrective action.

The surface water monitoring protocols will:

- ensure compliance with the Project Waste Discharge Licence (WDL) and Water Extraction Licence (WEL);
- provide valuable information on the performance of the water management system; and
- facilitate adaptive management of water resources on the site.

5.2 WATER LEVEL MONITORING LOCATIONS

Water levels downstream of OHD should be monitored on a continuous basis to determine the potential impact of water extraction on downstream flow volumes. Water levels would be monitored at the OHD spillway and at the downstream location BPDS SW2. It is recommended that a water level logger is installed in these locations.

Additionally, water levels in OHD should also be monitored. This could be done by collecting a surveyed water level on a weekly basis and as part of routine water quality monitoring.

Locations of the proposed surface water monitoring locations are shown in Figure 5.1 and summarised in Table 5.1.

Table 5.1 - Water level monitoring locations

Name	Location	Easting (m)	Northing (m)	Sampling frequency
OHD DS	OHD spillway	695,185	8,594,842	Continuous
BPDS SW2	Drainage Line BP1 D/S of OHD	694,461	8,593,025	Continuous
OHD	OHD	695,422	8,595,695	Continuous

5.3 RATING CURVE DEVELOPMENT

Rating curves should be developed for the OHD spillway and BPDS SW2 water level monitoring locations, to relate recorded water levels to flows. It is recommended that these rating curves are developed prior to the implementation of this SWMP.

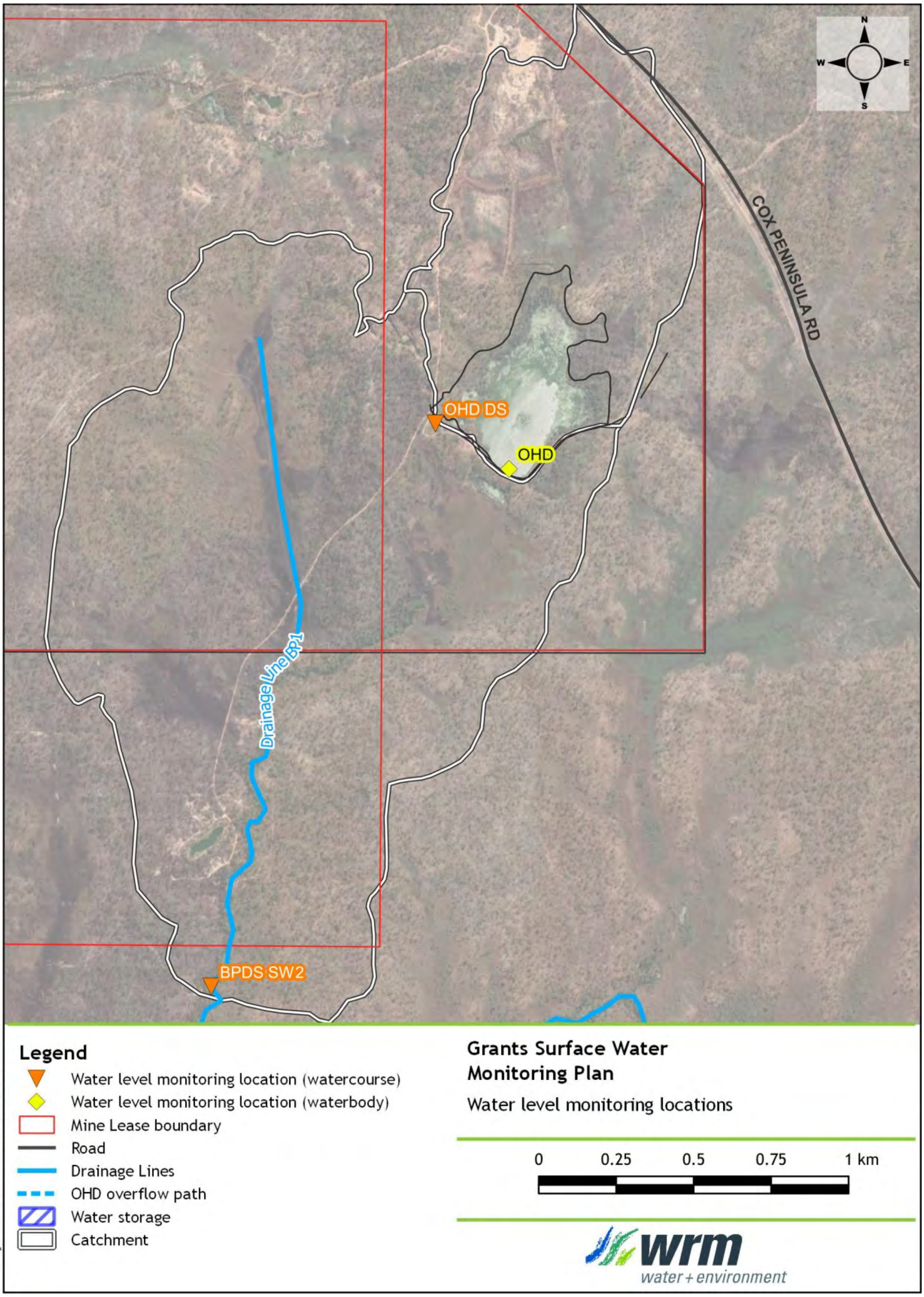


Figure 5.1 - Surface water monitoring locations

6 Downstream Risk Matrix

6.1 GENERAL

This section presents a preliminary Downstream risk matrix (DRM) to manage and minimise the risk of exceeding the allowable downstream streamflow impacts due to the operation of OHD.

6.2 OHD OPERATIONAL RULES

Water would be drawn from OHD during operations to meet site demands, including DMS plant process water makeup and haul road dust suppression. Water would only be drawn from OHD if the following conditions are met:

- The volume in RWD is less than its low alarm volume of 20 ML. This would ensure that excessive volumes are not drawn from OHD, which would then require management in the Grants WMS.
- The volume in OHD is not less than the assumed dead storage (10 ML), to provide a storage buffer to preserve water quality and ecological values.

Water will be transferred to RWD via a 300 mm HDPE pipeline, at a maximum rate of 4.00 ML/d, when required.

6.3 DOWNSTREAM RISK MATRIX

Table 6.1 shows the preliminary DRM table. This table assessed the potential downstream risk based on the cumulative rainfall and spill days from OHD since the onset of the wet season (1 November of each year). As shown in Figure 4.1, the allowable downstream risk would vary based on the severity of the wet season. The range of spill days for each rainfall range were derived from Figure 4.2.

The risks presented in the DRM table range from LEVEL 1 (no or minimum impact on the downstream flows) to LEVEL 4 (potentially significant impact on the downstream flows). The downstream risk during the wet season should be assessed on a regular basis (i.e. weekly) until the end of the wet season (30 April), so that the potential downstream risk can be tracked over the wet season.

Table 6.2 shows the recommended actions for each of the DRM levels. These actions would ensure that the potential downstream impacts are managed throughout the wet season.

It is recommended that the DRM assessment is undertaken on an annual basis as part of the Environmental Monitoring Report, per condition 4.2 of the WEL.

Table 6.1 - Preliminary downstream risk matrix for OHD

		Cumulative rainfall from 1 Nov			
		<1,300 mm	1,300 - 1,500 mm	1,500 - 1,700 mm	>1,700 mm
Number of spill days from 1 Nov	>60	LEVEL 1	LEVEL 1	LEVEL 1	LEVEL 1
	51-60	LEVEL 1	LEVEL 1	LEVEL 1	LEVEL 2
	41-50	LEVEL 1	LEVEL 1	LEVEL 1	LEVEL 3
	31-40	LEVEL 1	LEVEL 1	LEVEL 2	LEVEL 4
	21-30	LEVEL 1	LEVEL 1	LEVEL 3	LEVEL 4
	5-20	LEVEL 1	LEVEL 2	LEVEL 4	LEVEL 4
	<5	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 4

Table 6.2 - Recommended DRM actions

Risk	Action
LEVEL 1	• Continue to monitor the downstream environment.
LEVEL 2	• Continue to monitor the downstream environment. • Review the OHD operational rules.
LEVEL 3	• Continue to monitor the downstream environment. • Investigate and initiate options to source water from alternate locations. • Investigate and initiate options reduce water use and onsite, including options to recycle water.
LEVEL 4	• Undertake an assessment to characterise the nature of impacts to surface water conditions and riparian vegetation. • Initiate investigation into reasons for system failure, including assessment of environmental harm. • Investigate options for potential additional water sources (including C5 Dam, bore water). • Take actions recommended by investigation to prevent recurrence.

7 Trigger Action Response Plan

An operational Trigger Action Response Plan (TARP) has been developed to continually monitor the pumped extraction volumes from OHD to ensure that the WEL entitlements presented in Table 1 of the WEL 8151018 (reproduced in Table 1.1). The TARP recommends actions to minimise the risk of exceeding the entitlement.

Table 7.1 shows the recommended operational TARP for OHD water extraction.

Table 7.1 - Recommended OHD wet season water extraction TARP

Level	Triggers	Action	Response
Level 1 (Normal)	Pumped extraction from OHD is less than 50% of the entitlement.	• No action required.	• No response required.
Level 2 (Early warning)	Pumped extraction from OHD is greater than 50% and less than 80% of the entitlement. *and* *More* than half of the entitlement period has passed.	• Ensure monitoring equipment is calibrated and operating correctly. • Review water use and seek approval from the regulator to increase the entitlement if required.	• Post-event review to confirm event was well managed with appropriate resources in place.
Level 3A (Elevated Risk)	Pumped extraction from OHD is greater than 50% and less than 80% of the entitlement. *and* *Less* than half of the entitlement period has passed.	• Ensure that the pipeline is operating correctly and efficiently. • Investigate strategies to reduce OHD water use (without impeding on operations). • Seek approval from the regulator to increase the entitlement if required.	• Post-event review to confirm suitability of water transfer infrastructure & operational rules. • Update operational rules if required. • Prepare recommendations for modifications or upgrades to reduce OHD water use.
Level 3B (Imminent Risk)	Pumped extraction from OHD is greater than 80% and less than 100% of the entitlement.	• Investigate strategies to reduce OHD water use (without impeding on operations). • Ensure that the site demands are being drawn from the mine water dams and sediment dams as a priority, rather than OHD where possible. • Seek approval from the regulator to increase the entitlement if possible.	
Level 4 (Exceedance of entitlement)	Pumped extraction from OHD is greater than 100% of the entitlement.	• Cease water extraction from OHD. • Reduce non-essential water consumption as much as possible on site to limit operational impacts. • Ensure that the site demands are being drawn from the mine water dams and sediment dams as a priority. • Seek approval from the regulator to increase the entitlement if possible.	• Initiate investigation into reasons for system failure, including assessment of environmental harm. • Investigate options for potential additional water sources. • Take actions recommended by investigation to prevent recurrence • Notify the regulator per Condition 4.3 of the WEL

8 Review of this document

Special condition 4.1(iv) stipulates that the SWMP should include a review process to ensure the continual improvement of the monitoring program.

The results given in this report have been prepared based on the best available data and information at the time of preparing the report. The data and information used have been obtained from a validated mine Goldsim water balance model, reports prepared and modelling undertaken by other consultants, and verbal and written advice received from Core staff and other consultants.

The key assumptions adopted in this assessment include:

- The capacity of OHD (noting the tentative plans to raise the spillway level in the 2022 dry season);
- The seepage loss from OHD is negligible;
- The maximum extraction rate (pump capacity) from OHD; and
- The catchment area reporting to OHD.

If any of the adopted assumptions are found to be inaccurate or outdated, the potential impacts and required changes to the proposed OHD strategy should be investigated and appropriate changes be made to the monitoring plan.

9 Limitations

The Surface Water Monitoring Report for OHD has been undertaken based on the available information provided to WRM at the time of preparing this report. The data and information used has been obtained from previous reports prepared, survey and design drawings provided by Core and other consultants involved in the project.

While all reasonable care has been taken during the assessment to ensure that modelling undertaken by WRM accurately reflects the behaviour of OHD and the downstream environment, available data such as ground survey, cross section data, rainfall and water level data and design drawings have been sourced from third parties. The accuracy and reliability of model predictions is affected by the accuracy of the available data from third party sources. Although significant effort has been made to confirm the accuracy of available data during the studies undertaken by WRM, WRM takes no responsibility for inaccuracy in any information that has been supplied by a third party.

The following key limitations have been identified:

- The runoff parameters for the OHD catchment have not been validated against recorded data within the catchment. They have been based on recorded water level data from the Carawarra Creek gauge at Cox Peninsula Road. It is recommended that the runoff parameters in the OHD are validated using recorded water level, pumped extraction volumes and downstream water levels at BP SW2.
- The potential seepage rates from OHD are unknown. This assessment assumes that seepage would be negligible. However, if the seepage from OHD is significant in reality, this may affect the outcomes of this assessment.
- Site water demands have been based on the WMS configuration and estimated on site usages presented in WRM (2022). Changes to the adopted WMS may impact on the modelled potential downstream impacts.
- The TARP and risk matrix provided in this assessment have not yet been refined based on actual wet season data. It is recommended that these tools are considered as preliminary until they can be validated to recorded data.

The information used in this assessment is considered to be accurate at the date that supporting documentation was completed. The models, our interpretation of results and recommendations documented in our various reports apply to the site at the time of our investigations and may not necessarily apply to subsequent changes in site conditions or designed or constructed infrastructure in the study area that WRM is not aware of and has not had the opportunity to evaluate. The model should only be regarded as validly representing the conditions within the study area at the time of the investigation. WRM takes no responsibility for any changes that may have occurred after this time.

10 References

ANZECC & ARMCANZ, 2000	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
ANZG, 2018	Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines
ANCOLD, 2012	***'Guidelines on the Consequence Categories for Dams'***, Australian National Committee on Large Dams Incorporated, October 2012.
Core, 2019	'Grants Lithium Project - Environmental Impact Statement - Supplement', Core Lithium, 2019
Core, 2019a	***'Mining Management Plan*** *- Grants Lithium Project Mining* ***Operations',*** Core Lithium, June 2019
Enviroconsult, 2019	*'Supplementary Report: Surface water modelling'*, Enviroconsult, 2019
GHD, 2021	*'Observation Hill Dam Raise: Detailed design'*, GHD, March 2019
WRM, 2021	*Finniss Lithium Project BP33 Underground - Water Balance Modelling Report*, WRM Water & Environment, 2021

Appendix A - Surface Water Monitoring, Supplementary Report (EnviroConsult, 2019)

APPENDIX E SURFACE WATER MODELLING – SUPPLEMENTARY REPORT

The surface water modelling report was originally submitted as Appendix H of the Draft EIS.

This document provides supplementary information that should be read in conjunction with the original report.

Core Exploration Ltd, Cox Peninsula

Supplementary Report
Surface water modelling

Core Exploration Ltd, Cox Peninsula

Supplementary Report
Surface water modelling

February 2019

RELIANCE, USES and LIMITATIONS

This study, report and analyses have been based on the information available to EnviroConsult Australia Pty Ltd at the time of preparation. EnviroConsult Australia PTY Ltd accepts responsibility for the report and its conclusions to the extent that the information was sufficient and accurate at the time of preparation. EnviroConsult Australia Pty Ltd does not take responsibility for errors and omissions due to incorrect information or information not available to at the time of preparation of the study, report or analyses. No chemical analysis, groundwater hydrology, water quality or contaminant export studies of any kind were conducted. Any comment made in the report with respect to the above are speculative based on the surface hydrology analysis and should not be relied upon as fact.

Executive Summary

EcOz Environmental Consultants (EcOz) were engaged by Core Lithium Ltd (Core) to prepare the Draft EIS for Grants Lithium Project on Cox Peninsula. As part of the preparation of the Draft EIS, EnviroConsult Australia Pty Ltd (EnviroConsult) were engaged to conduct a hydrological assessment and water balance for the project. An independent review recommended that the hydrological and hydrogeological modelling (separate report) use consistent climate data and pit geometry. Additionally, since the submittal of the Draft EIS, project planning has resulted in a change to the mining site layout and pit dimensions.

This supplementary report addresses these recommendations and project changes by re-running the hydrological model using:

- Climate data consistent with the hydrogeological model
- Updated project layout and pit geometry.

Pre- and post-mining water balance

The surface water modelling was rerun simulating a low, average and high rainfall year based on 24-hour SILO rainfall data and updated mine layout and dimensions.

The HEC-HMS model was recalibrated and validated using the 24-hour(h) time steps using the methods in the initial EIS studies. Annual catchment outflows from the Darwin Harbour catchments 2 and 5 for the low, average (50th percentile) and high rainfall years were 6775ML, 16890ML, and 33631ML respectively. Annual catchment outflows from the Bynoe Harbour catchments for the low, average and high years were 9400ML, 23679ML, and 47294ML respectively.

For the Post-mining Darwin Harbour catchment with updated mine infrastructure only, the percentage reduction in stream flow at the catchment outlet for an average rainfall year is 18% of the pre-mine catchment outflow. This is based on a conservative simulation scenario where all water is retained in the sub-catchment containing the infrastructure.

During mining, when there are water releases from the mine infrastructure, the reduction in stream flow at the outlet of catchments 2 and 5 is 14% for an average rainfall year. When the mine site dam (MSD) is included in the Darwin Harbour catchment, reduction to catchments 2 and 5 outflow due to the dam and the infrastructure is about 19% of the pre-mine outflow. So, for an average year, MSD is responsible for a reduction of about 5%.

Observation Hill dam yield analysis

Updated results for 24-h timesteps for constant pump rates of 2.02 MLd^{-1} and 1.2 MLd^{-1}, for a 5-year scenario, indicate that there will be a water deficit for the low rainfall year for each of the lift scenarios. Overall, simulations indicate variable deficits of water for mine applications ranging from of 9 ML to 225 ML. Economies of water usage, such as no dust suppression in the Wet Season and de-watering of the pit allowing the dam to re-fill to capacity may address the deficit.

With respect to accumulated reduction in flows downstream of the dam, the maximum reduction in monthly flow volume is 100% at the spillway under the worst case scenario (2.02 ML pumping). For the

larger sub-catchment that contains the OHD, the maximum monthly reduction in stream flow discharge to Charlotte River was 58.3% when 2.02 MLd^{-1} pumping is applied. The maximum monthly reduction in stream flow discharge to Bynoe Harbour receiving waters was 12.6%.

Alternative water storage facilities

Apart from a wall lift or reduction in water usage, an alternative to achieve enough water storage may be the construction of a second smaller dam.

The preferred MSD in catchment 5 is assessed. The site has similar catchment sizes as the OHD. The simulations show the site is suitable for ancillary water storage for the worst-case scenario of an annual average deficit of 225 ML.

The cumulated impact of the MSD, with a spillway level of 16.93mAHD in catchment 5, on downstream flows were assessed at 4 locations. The impact of the dam on downstream flows during mining reduces progressively downstream from the catchment 5 outlet to the outlet of the watershed draining to the Darwin Harbour. When the impact of the mine infrastructure without the MSD is simulated, the maximum reduction in monthly total flows is 28.8% at the outlet of catchment 5 and 7.6% at the watershed outlet. When MSD is considered during mining, the maximum monthly reductions are 55.8% and 14.7%.

Flood Hydrological Modelling

The rainfall and hydrograph for the 1%AEP model simulations was determined probabilistically using the Monte Carlo simulation feature of the RORBwin hydrology model. The simulations gave a critical rainfall duration of 6h for the event and the probable maximum peak discharge for the pre-mining condition as 118.9m^3s^{-1} and 121m^3s^{-1} for the post-mining condition, a change of 2.5%. For total discharge there was a drop of 11% between the pre- and post-mining conditions. The change in peak discharge caused by the mine infrastructure is due to the ponds and the pit which are water retaining structures and, although the final depths of the ponds have not been designed, do not contribute to the total discharge under post-mining conditions.

Flood inundation

The HEC-RAS 2D modelling was updated for the 1%AEP flood inundation affected by mine infrastructures and MSD with the updated rainfall and runoff hydrographs for node inputs derived using RORBwin. The surge inundation is not considered as analysis in the initial report showed that storm surge did not affect the site.

There are some differences in inundation areas between pre- and post-mining caused by the mine infrastructure and the MSD. The mine site is protected from flood risk by the inundation bund and the flood water around the mine site can be drained away through natural stream lines and the haul road culvert.

Culvert 1 is inundated for a short period (3.5 hrs) compared to the pre-mine condition (7 hrs). Culvert 2, originally inundated under the pre-mine condition is prevented from inundation due to the presence of MSD.

In summary the mine infrastructure does not cause a flood risk off site. The presence of the mine infrastructure and MSD reduces the time of inundation on Cox Peninsula Road during floods.

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1 Introduction

EcOz Environmental Consultants (EcOz) were engaged by Core Lithium Ltd (Core) to prepare the Draft EIS for Grants Lithium Project on Cox Peninsula. As part of the preparation of the Draft EIS, EnviroConsult Australia Pty Ltd (EnviroConsult) were engaged to conduct a hydrological assessment and water balance for the project. The information in the hydrological assessment was used to inform the Water Management Plan which was submitted as part of the EIS.

The Draft EIS was submitted in October 2018, and the public comment period has been completed and the Water Management Plan has been independently peer reviewed. The independent review recommended that the hydrological and hydrogeological modelling (separate report) use consistent climate data and pit geometry. Additionally, since the submission of the Draft EIS, project planning has resulted in a change to the mining site layout and pit dimensions.

This supplementary report addresses these recommendations and project changes by re-running the hydrological model using:

- Climate data consistent with the hydrogeological model
- Updated project layout and pit geometry.

This supplementary report should be read in conjunction with the previously completed surface water reports:

1. Project 1[1]: Description of hydrological conditions of site and calibration of hydrological model,
2. Project 2[2]: Application of hydrological model to complete a hydrological assessment and water balance, and
3. Project 3[3]: Inundation modelling of the site.

The reports can be downloaded at:
https://ntepa.nt.gov.au/__data/assets/pdf_file/0006/590721/draft_eis_grants_lithium_appendixH_surface_water_modelling_reports.PDF

[1] EnviroConsult (2018a). Project 1: Existing hydrological condition and hydrology model calibration, Report prepared for Core Exploration Limited by EnviroConsult Pty Ltd, August 2018, Darwin.

[2] EnviroConsult (2018b). Project 2: Mining Lease 31726 and Observation Hill Dam Water Balance, Report prepared for Core Exploration Limited by EnviroConsult Pty Ltd, August 2018, Darwin.

[3] EnviroConsult (2018c). Project 3: Mining Lease 31726 Flood Inundation Study, Report prepared for Core Exploration Limited by EnviroConsult Pty Ltd, August 2018, Darwin

2 Climate data inconsistencies

Groundwater modelling[4] used SILO data from a national scale data base of climate records for Australia (https://www.longpaddock.qld.gov.au/). SILO products provide national coverage with interpolated infills for missing data. Averaged monthly data for a calendar-year from the SILO record from 1971 to 2018 at 12°39'S 130°48'E (Figure 1) were used.

For surface water modelling, 15-min rainfall data from the NTG water portal Winnellie site were used based on analysis of regional Bureau of Meteorology (BOM) and Northern Territory Government Water Portal (NTGWP) rainfall gauges. For modelling, the data for a full Wet Season were used – July one year to June the next year.

To address the inconsistency and relative uncertainties associated with the different data sets, surface water modelling was conducted for this supplementary report using the same rainfall period and SILO data source as the groundwater modelling, 1971 to 2018. For surface water modelling, the highest resolution, local data available should be used, however, only 24-hour rainfall from SILO were available. SILO products provide national coverage, mostly based on BOM data, with interpolated infills for missing data and the rainfall data. At the location coordinates,12°39'S 130°48'E, used in this study, data are interpolated.

[4] CLOUDGMS 2018. Groundwater Model for the Grants Lithium Project Final Version 1.0

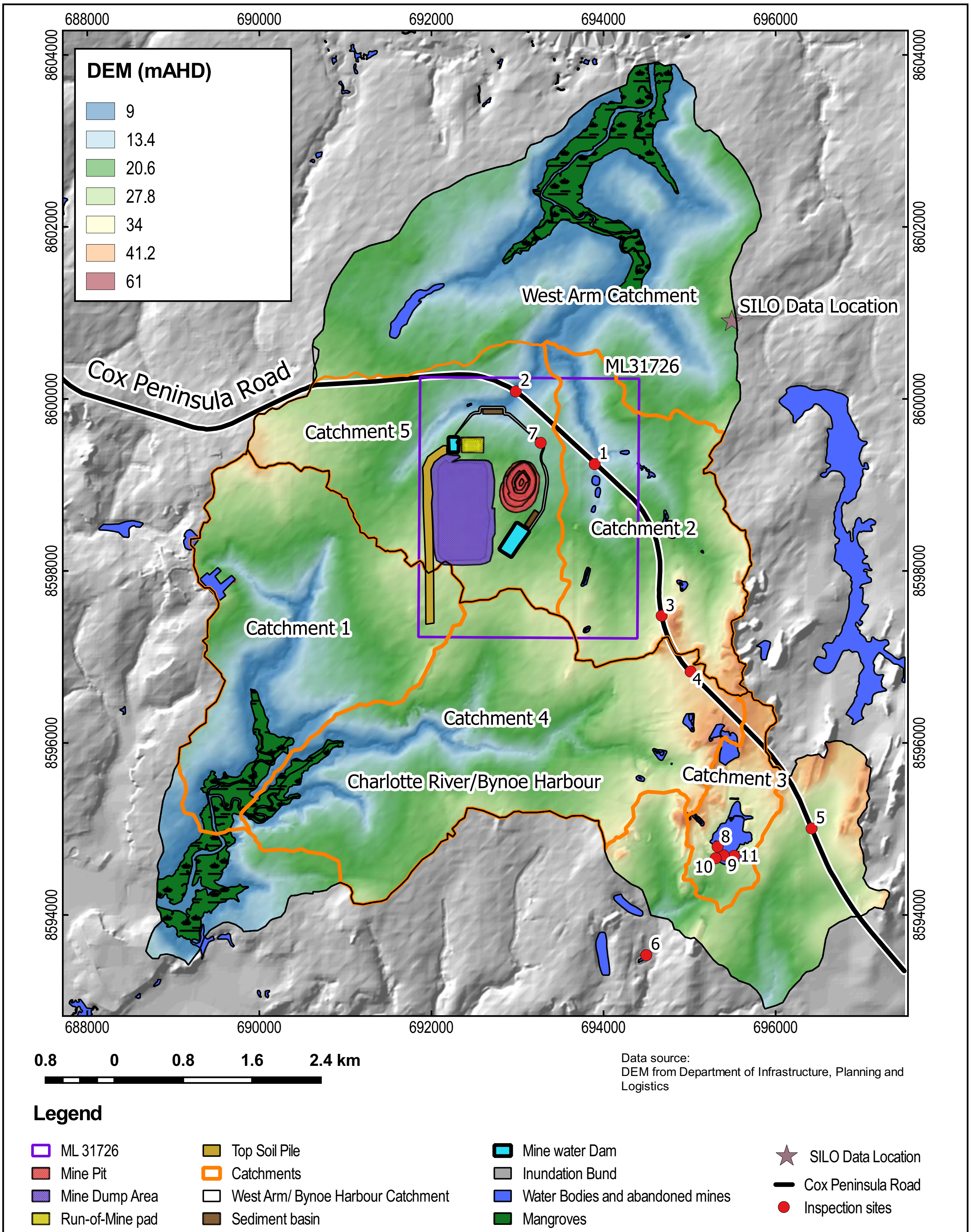

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Figure 1. Location of ML(A) 31726 showing new mine site infrastructure and SILO data coordinates 12°39'S 130°48'E.

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

CORE

The average monthly rainfalls and evaporation based on SILO data at the Core site are shown in *Figure 2*.

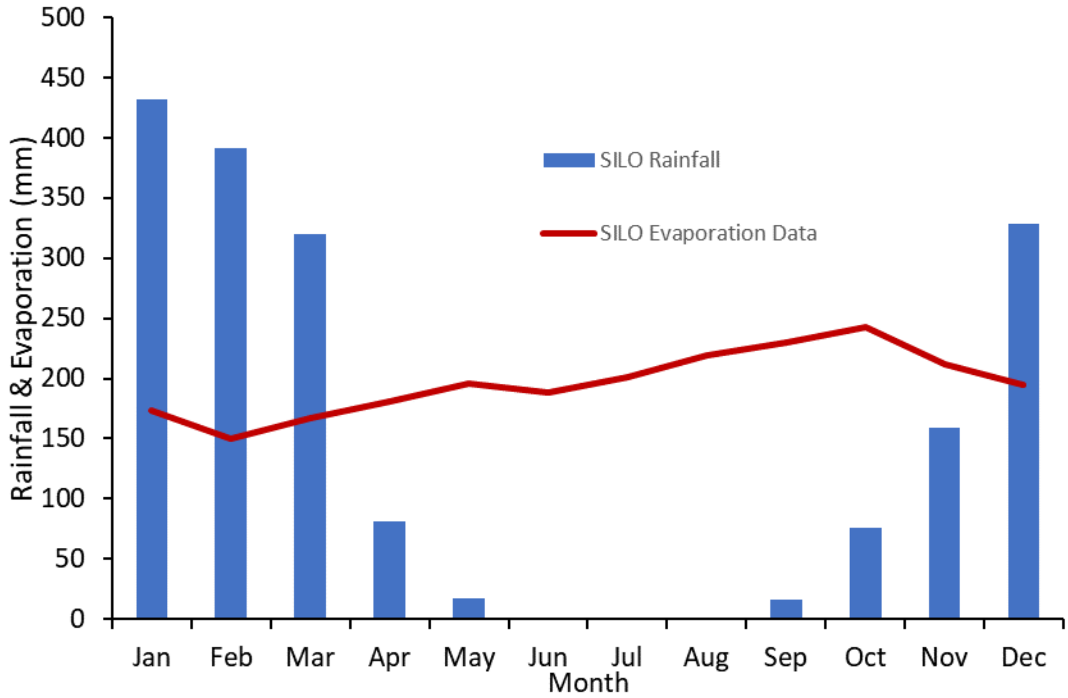

Figure 2 Average monthly rainfall and evaporation for SILO data from 1971 to 2018 for the Core site.

2.1 Gulungul Creek recalibration with 24-h inputs

Since input time steps for surface water modelling change from 15 minutes to 24 hours the HEC-HMS model was recalibrated using the Gulungul Creek monitoring data (Appendix B.4, Project 1[1]). The calibration and validation methods used in Project 1[1] were repeated here for Gulungul Creek using (24-hour rainfall and discharge data courtesy of the Environmental Research Institute of the Supervising Scientist – *eriss*).

HEC-HMS was calibrated to Gulungul Creek 24-h data from 29 December 2009 to 11 June 2010 and validated to 24-hour data from 12 December 2005 to 30 April 2006 (Section 4.2.5, page 27, Project 1[1])

The fitted parameters based on the 24-hour time step are shown in *Table 1*. The only change in parameter values from the recalibration was Continuing Loss which changed from 4.4mmh^{-1} to 0.3mmh^{-1}. This is due to the changed timestep.

Calibration results are presented in *Figure 3*. Validation results are presented in *Figure 4*.

Good fits were obtained for the calibration process (*Figure 3*). There was some underprediction for the larger peaks but for catchment water balance studies correct flow volumes are more important. The peak discharges are more important for flood inundation, erosion, drainage and road design.

Applying the fitted parameter values to the Gulungul 2005-2006 Wet Season, HEC-HMS simulated flows were similar to observed flows with some minor overprediction which is conservative. SILO rainfall data for Gulungul Creek for 2005-2006 gave validation results very similar to those using monitored rainfall data (*Figure 4*).

Table 1 Updated Table 2, page 23, Project 1[1]. Calibrated parameter values.

Parameter	Loss method parameter			Base flow method parameter		
	Initial (mm)	Constant (mmhr^{-1})	Impervious (%)	Initial discharge (m^{3}s^{-1})	Recession constant	Ratio to peak
Value	400.0	0.3	5%	0.00	0.90	0.05

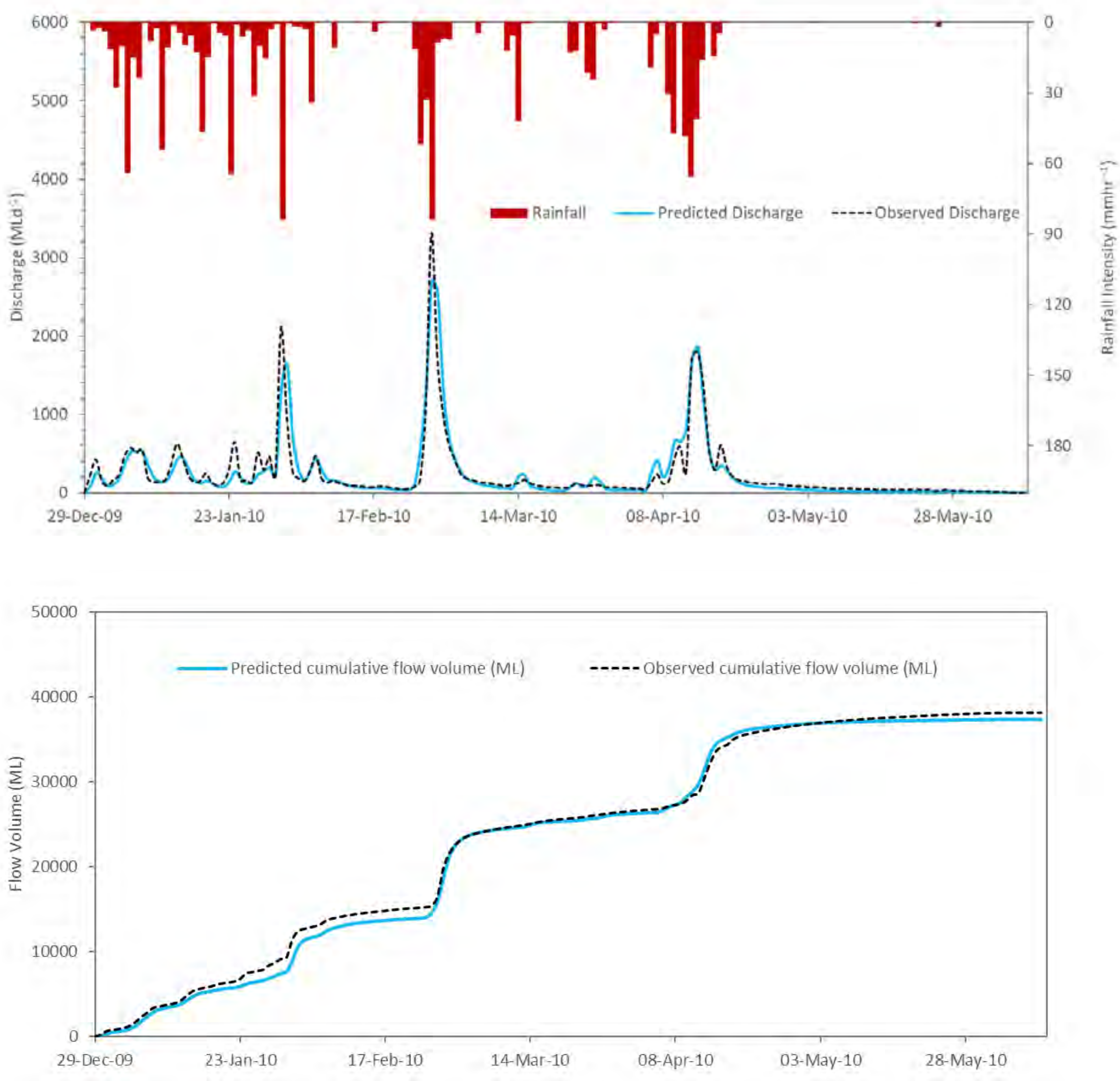

Figure 3. Graphs of fitted and observed hydrographs and cumulative flow (24-h intervals).

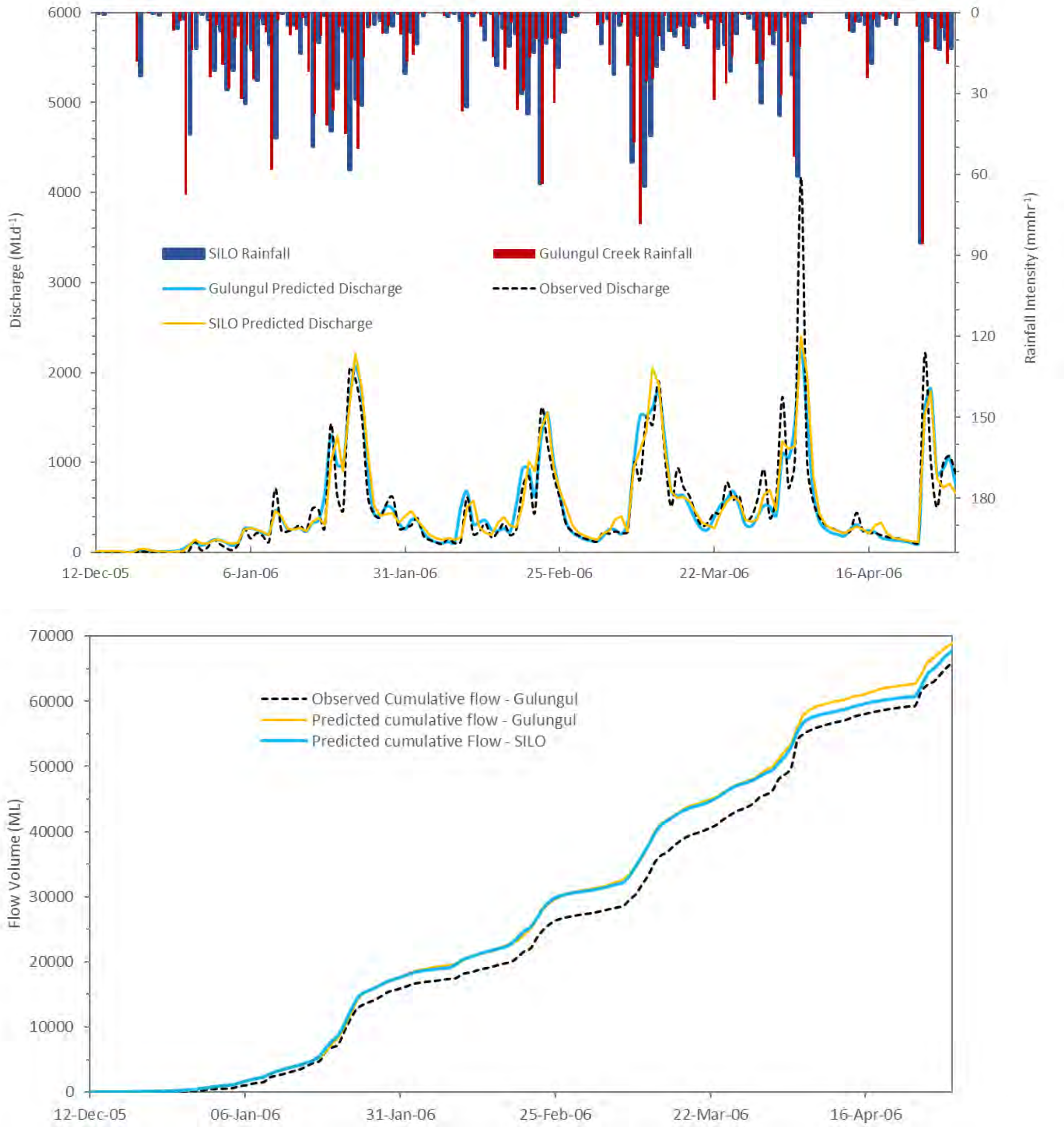

Figure 4 Comparison between fitted and observed 24-h discharge and cumulative discharge for the 2005-2006 Wet Season at Gulungul Creek.

2.2 Updated low, average and high rainfall year scenarios for HEC-HMS modelling

The Darwin Harbour HEC-HMS basin models for post-mining with the mine infrastructure only and the mine infrastructure plus MSD were updated to reflect the updated infrastructure (Appendix A1 & A2). Low, average (50th percentile event) and high rainfall-year scenarios for HEC-HMS modelling in this supplementary report were based on calendar-year SILO rainfall from 1st January to 31st December. Due to the distinct Wet and Dry seasons at the site the rainfall year is from July to June the following year (*Figure 2*). Therefore, antecedent rainfall and simulated antecedent discharge from 1st July the previous year was used to condition the catchment i.e. simulate initial losses, and continuing losses and generate runoff that can be applied to the simulations starting from 1 January of the year of interest. Since the HEC-HMS initial loss was fitted as 400mm (*Table 1*) it was important that the initial loss was applied to the antecedent simulations otherwise it would be applied at 1 January of the year of interest when the catchment is saturated or near saturation resulting in an underprediction of catchment discharge. An example of antecedent rainfall and discharge is shown in *Figure 5*. All simulations in this study have similar hydrograph form with the magnitude of volumes and magnitude and timing of peak discharges depending on catchment area and rainfall depth. The 24-hour SILO rainfall record was used for simulations (*Table 2*).

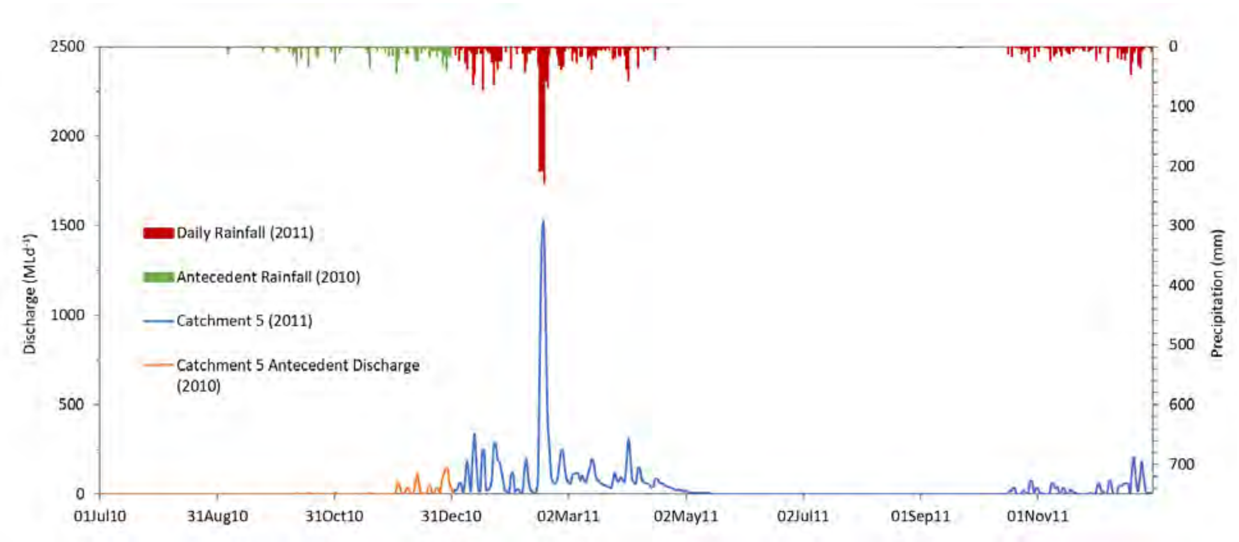

Figure 5 An example of the variation of instantaneous discharge with 24-hour rainfall for a simulation of a high rainfall year for Darwin Harbour catchment 5. The antecedent rainfall occurs prior to 1 January 2011. In this case the year of interest is 2011.

Table 2 Selected low, average and high rainfall years Update of Table 2,.page 14, Project 2[2].

Rainfall scenario	Year	Wet season annual rainfall depth (mm)	Annual Exceedance Probability	Probability of an equal or lower annual rainfall depth occurs in a 5-year period
Low	1979	919	0.99	0.05
50%ile	1991	1652	0.50	0.97
High	2011	2766	0.01	1.00

3 Updated catchment water balance

The HEC-HMS model calibrated to 24-h data was used to simulate rainfall discharge for Darwin Harbour catchments and the Bynoe Harbour catchments intersected by ML(A) 31726. The updated mine infrastructure (*Figure 1)* only affects Darwin Harbour catchment 5 and thus post-mining and during-mining condition were only run for this catchment.

Darwin Harbour simulation results, pre-, post- and during-mining are in *Table 3* and the Bynoe Harbour simulation results are in *Table 4*.

The mine infrastructure and MSD reduce total flows (ML) and peak flows (MLd^{-1}). For post-mining condition, the modelling assumes the worst-case scenario where all rainfall entering the mine infrastructure catchment is retained i.e. there is no release to the environment. For during-mining condition, mine infrastructure with and without the MSD scenarios were assessed. In addition, 2.02 $MLday^{-1}$ pumping and controlled release to the environment were applied for the during-mining scenarios.

For post-mining, the percentage reduction in combined stream flow at the outlet of catchments 2 and 5 outlet for low, average and high years was about 18%, 18% and 17% of the pre-mine catchment low respectively.

For during-mining, when MSD is not included, the percentage reduction in combined stream flow at the outlet of catchments 2 and 5 outlet for average rainfall years was about 14% of the pre-mine flow. When MSD is included, the percentage reduction increased to 19%. So, for an average year, MSD is responsible for a 5% reduction in flow.

Table 3 Results of surface water flow modelling for Darwin Harbour catchments 5 and catchment 2.

Catchment	Undisturbed Catchment Area (km^2)	Low rainfall year			Average rainfall year			High rainfall year		
		Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})	Discharge (ML)	Losses (ML)	Peak Q (MLd^{-1})	Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})
5 (pre-mining)	7.2	3630	2986	333	9050	2845	545	17980	1935	1520
5 (post-mining)	4.8	2447	1964	210	6087	1843	370	12156	1121	1025
5 (during-mining)	4.8	n/a	n/a	n/a	6576	1843	n/a	n/a	n/a	n/a
5 (during-mining + MSD)	4.8	n/a	n/a	n/a	5851	2396	n/a	n/a	n/a	n/a
2 (pre-mining)	6.4	3146	2735	276	7840	2732	464	15651	2051	1313
Common outlet (pre-mining)	**13.6**	**6775**	**5721**	**n/a**	**16890**	**5577**	**n/a**	**33631**	**3986**	**n/a**
Common outlet (post-mining)	**11.2**	**5593**	**4699**	**n/a**	**13927**	**4575**	**n/a**	**27807**	**3172**	**n/a**
Common outlet (during-mining)	**11.2**	**n/a**	**n/a**	**n/a**	**14462**	**4575**	**n/a**	**n/a**	**n/a**	**n/a**
Common outlet (during-mining+MSD)	**11.2**	**n/a**	**n/a**	**n/a**	**13687**	**5128**	**n/a**	**n/a**	**n/a**	**n/a**

Table 4 Results of surface water flow modelling for Bynoe Harbour catchments 1 and 4.

Catchment	Area (km^2)	Low rainfall year			Average rainfall year			High rainfall year		
		Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})	Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})	Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})
1	8.2	4035	3454	354	10221	3252	582	20421	2122	1697
4	10.7	5365	4485	467	13458	4252	748	26873	2779	2226
Total	**18.9**	**9400**	**7939**	**n/a**	**23679**	**7504**	**n/a**	**47294**	4,901	**n/a**

4 Observation Hill dam yield assessment

Observation Hill dam (OHD) is the main water storage facility near the mining lease and the stored water will be used for mining operations.

4.1 Catchment hydrology

Using the recalibrated HEC-HMS model, 3 24-h SILO annual rainfall scenarios (low, average and high rainfall years) were simulated and the total volume of direct rainfall and catchment run-off input to OHD and the peak rate of the run-off inflow determined (*Table 5*).

Table 5 Results of the HEC-HMS model of the sub-catchments draining to OHD.

Rainfall scenario	Total Rainfall (mm)	Total Inflow (ML)	Peak Inflow Rate (MLd^{-1})
Low rainfall year	919	403	35
Average rainfall year	1652	1117	86
High rainfall year	2766	2318	242

4.2 Yield analysis

The recalibrated HEC-HMS model, using 24-h timesteps, was used for a yield analysis for the various dam wall heights and rainfall scenarios as per those completed in Section 5.3 of Project 2[2].

4.2.1 OHD HEC-HMS model setup and simulation scenarios

The OHD HEC-HMS model was setup and simulation scenarios used the same specifications as those used in Project 2[2]. The main changes in the setup were the application of the SILO 24-h rainfall (*Table 2*) and SILO evaporation (*Table 6*).

Table 6. SILO monthly evaporation (mm) for the Core site.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaporation	173	150	167	181	195	187.99	201	219	229	243	212	195

4.2.2 Updated OHD water balance simulation results for 24-h timesteps

The modelling result for each water use scenario under the 30, 31.5 and 33.6 mAHD spillway elevation scenarios are shown in *Figure 6*, *Figure 7* and *Figure 8*[5]. The deficit of water for different scenarios are shown in *Table 7, Table 8* and *Table 9*. These tables are updates of Tables 9, 10 & 11 respectively, pages 24, 25, & 26, Project 2[2].

[5] Where the figures show the pump is off, this is due to a lack of water rather than the project not requiring water to be pumped during this period.

Table 7. Simulated deficits for 30.0 mAHD spillway level scenario

Water use scenario	2.02 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	56	222	102	72	105
Water deficit (ML)	113	448	206	145	212
Average annual deficit (ML)	225				
Water use scenario	1.2 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	120	48	0	0
Water deficit (ML)	0	144	57	0	0
Average annual deficit (ML)	40				
Water use scenario	1.07 MLd^{-1} in wet, 2.02 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	43	-	-	-	-
Water deficit (ML)	87	-	-	-	-
Water use scenario	0.64 MLd^{-1} in wet, 1.2 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-

Table 8. Simulated deficits for 31.5 mAHD spillway level scenario

Water use scenario	2.02 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	206	48	29	3
Water deficit (ML)	0	416	97	59	6
Average annual deficit (ML)	116				
Water use scenario	1.2 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	36	48	0	0
Water deficit (ML)	0	43	58	0	0
Average annual deficit (ML)	20				
Water use scenario	1.07 MLd^{-1} in wet, 2.02 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-
Water use scenario	0.64 MLd^{-1} in wet, 1.2 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-

Table 9. Simulated deficits for 33.6 mAHD spillway level scenario

Water use scenario	2.02 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	194	48	29	0
Water deficit (ML)	0	392	97	59	0
Average annual deficit (ML)	110				
Water use scenario	1.2 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	0	48	0	0
Water deficit (ML)	0	0	58	0	0
Average annual deficit (ML)	12				
Water use scenario	1.07 MLd^{-1} in wet, 2.02 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-
Water use scenario	0.64 MLd^{-1} in wet, 1.2 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-

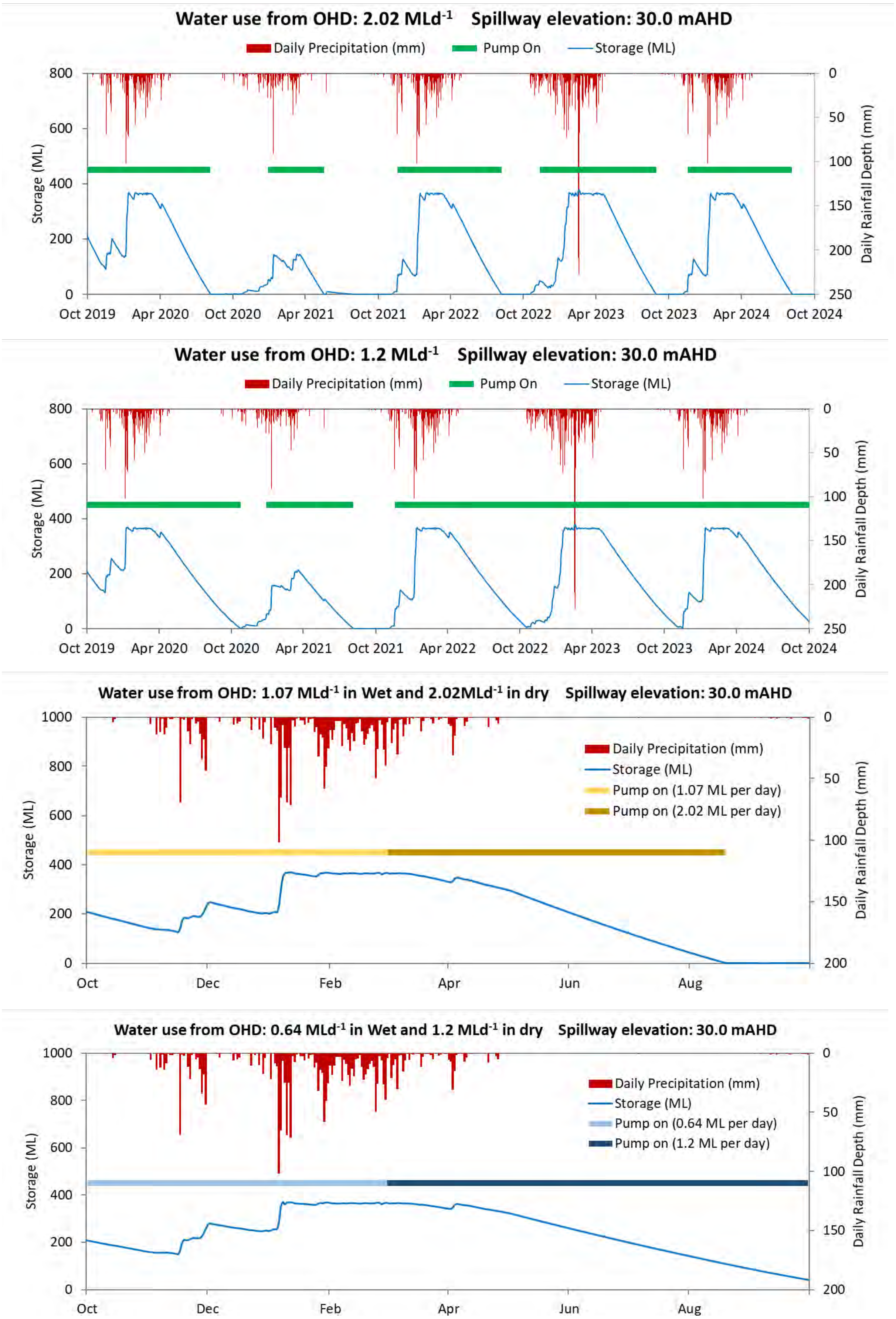

Figure 6 HEC-HMS modelling result for 30 mAHD spillway elevation scenario.

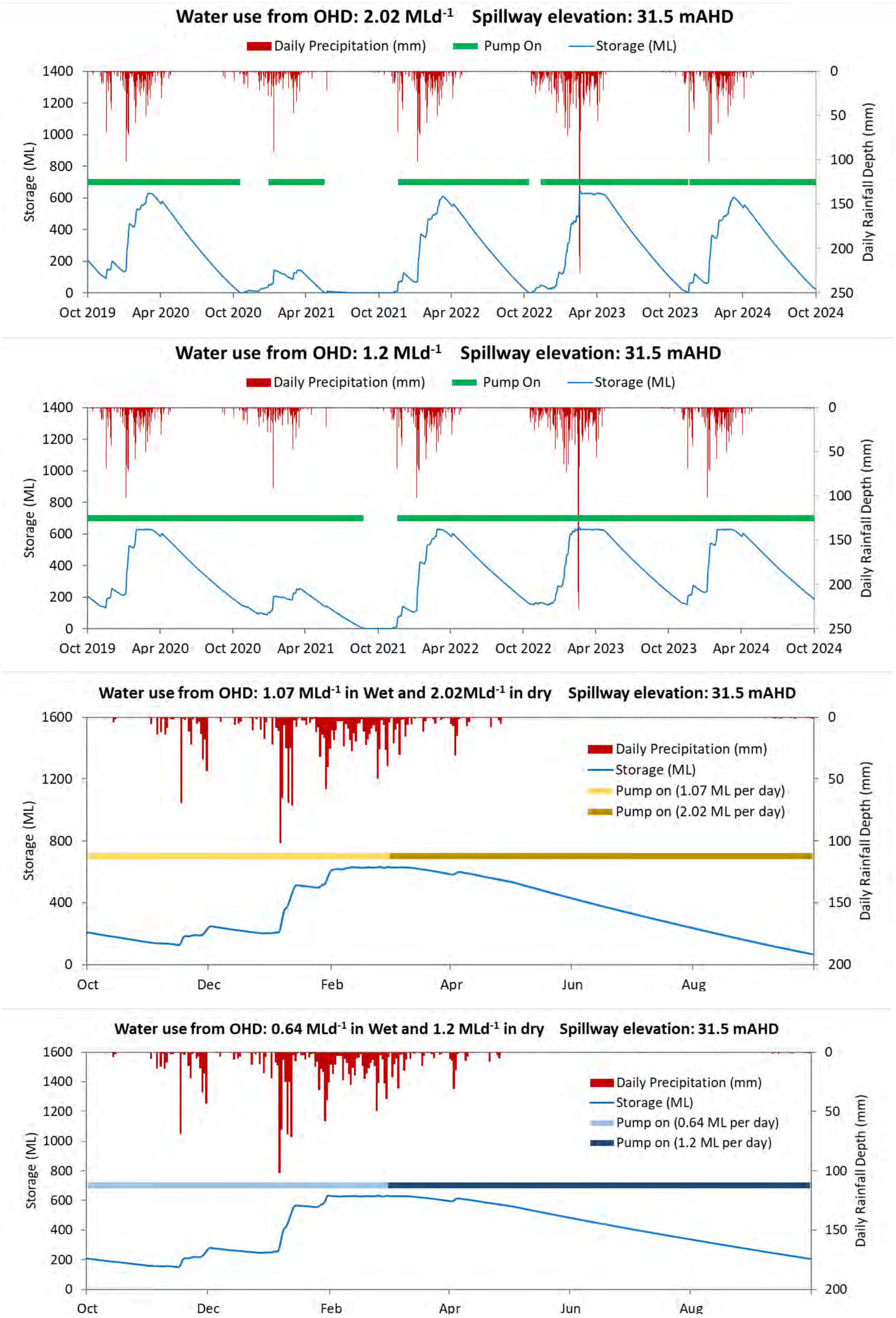

Figure 7. HEC-HMS modelling result for 31.5 mAHD spillway elevation scenario.

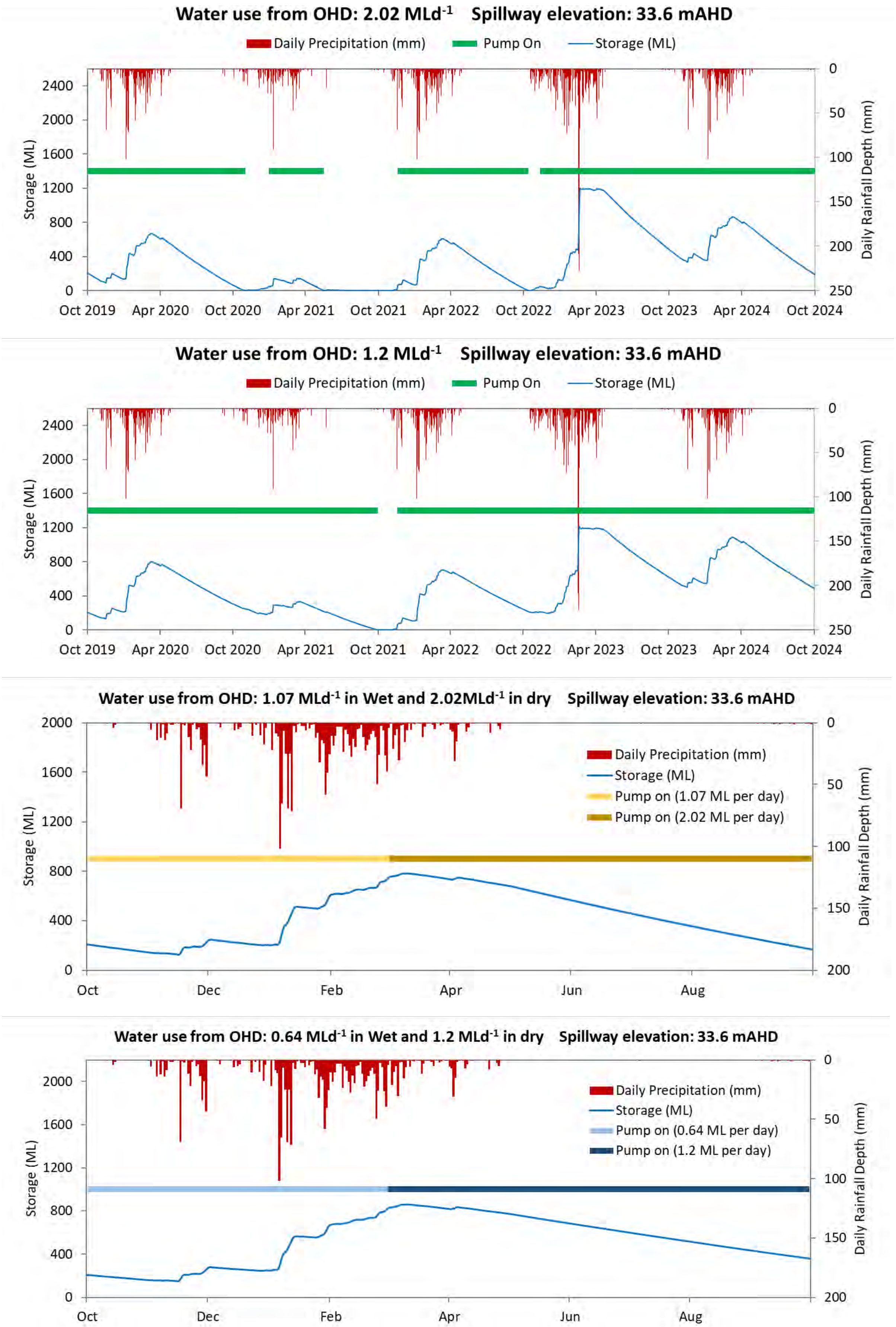

Figure 8. HEC-HMS modelling result for 33.6 mAHD spillway elevation scenario.

4.3 Influence of pumping and wall lift on downstream flows

The HEC-HMS simulations conducted in Section 5.4, page 30, Project 2[2] showed the impact of OHD on downstream flows is inversely proportional to downstream catchment size. That is, the further downstream the smaller the effect of OHD. The effect of the size (spillway height) of OHD and pumping on downstream flows was updated using the 24-h SILO rainfall data for an average year. The updated downstream flow volumes at different locations are shown in *Table 10*, *Table 11, Table 12*, and *Table 13* updating Table 12 & 13, page 32, Project 2[2]. These downstream locations and the catchments draining to them are shown in *Figure 9*.

Table 10. The flow volumes (ML) at OHD spillway outlet.

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr
Natural catchment condition (no OHD, no pumping)	58	14	554	289	145	51
Current OHD without pumping	0	0	323	253	108	28
Current OHD and 2.02 MLd^{-1} pumping applied	0	0	117	195	80	0
OHD spillway raised to 31.5 mAHD without pumping	0	0	78	240	98	26
OHD spillway raised to 31.5 mAHD and 2.02 MLd^{-1} pumping applied	0	0	0	42	79	0

Table 11. The flow volumes (ML) at the catchment outlet to Charlotte River

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr
Natural catchment condition (no OHD, no pumping)	100	28	2035	1097	612	177
Current OHD without pumping	42	13	1803	1062	574	155
Current OHD and 2.02 MLd^{-1} pumping applied	42	13	1598	1005	547	126
OHD spillway raised to 31.5 mAHD without pumping	42	13	1558	1049	565	152
OHD spillway raised to 31.5 mAHD and 2.02 MLd^{-1} pumping applied	42	13	1483	849	545	126

Table 12. The flow volumes (ML) at the watershed outlet to Bynoe Harbour

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr
Natural catchment condition (no OHD, no pumping).	453	164	14920	8482	4896	1308
Current OHD without pumping.	396	148	14687	8448	4858	1286
Current OHD and 2.02 MLd^{-1} pumping applied.	396	148	14482	8390	4830	1258
OHD spillway raised to 31.5 mAHD without pumping.	396	148	14442	8434	4849	1284
OHD spillway raised to 31.5 mAHD and 2.02 MLd^{-1} pumping applied.	396	148	14369	8233	4829	1258

Table 13. The accumulated % reduction (compared with natural catchment condition/no OHD) in down streams flows.

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr
Spillway **under current conditions. No pumping.**	100	100	41.8	12.2	25.6	43.9
Spillway **when raised to 31.5mAHD. No pumping.**	100	100	86.0	17.0	32.0	48.0
Approximately 3km downstream. Represents stream flow discharge to Charlotte River **under current conditions. No pumping.**	58.3	52.8	11.4	3.1	6.1	12.6
Approximately 3km downstream. Represents stream flow discharge to Charlotte River **when raised to 31.5mAHD. No pumping.**	58.3	52.8	23.5	4.4	7.7	14.0
Approximately 4.5 km downstream. Represents stream flow discharge at Charlotte River outlet to Bynoe Harbour receiving waters **under current conditions. No pumping.**	12.6	9.4	1.6	0.4	0.8	1.7
Approximately 4.5 km downstream. Represents stream flow discharge at Charlotte River outlet to Bynoe Harbour receiving waters **when raised to 31.5mAHD. No pumping.**	12.6	9.4	3.2	0.6	1.0	1.9
Spillway **under current conditions. 2.02 MLd-1 pumping applied.**	100	100	78.8	32.4	44.6	100
Spillway **when raised to 31.5mAHD. 2.02 MLd-1 pumping applied.**	100	100	100	85.6	46.7	100
Approximately 3km downstream. Represents stream flow discharge to Charlotte River **under current conditions. 2.02 MLd-1 pumping applied.**	58.3	52.8	21.5	8.4	10.6	28.7
Approximately 3km downstream. Represents stream flow discharge to Charlotte River **when raised to 31.5mAHD. 2.02 MLd-1 pumping applied.**	58.3	52.8	27.1	22.6	11.0	28.7
Approximately 4.5 km downstream. Represents stream flow discharge at Charlotte River outlet to Bynoe Harbour receiving waters **under current conditions. 2.02 MLd-1 pumping applied.**	12.6	9.4	2.9	1.1	1.3	3.9
Approximately 4.5 km downstream. Represents stream flow discharge at Charlotte River outlet to Bynoe Harbour receiving waters **when raised to 31.5mAHD. 2.02 MLd-1 pumping applied.**	12.6	9.4	3.7	2.9	1.4	3.9

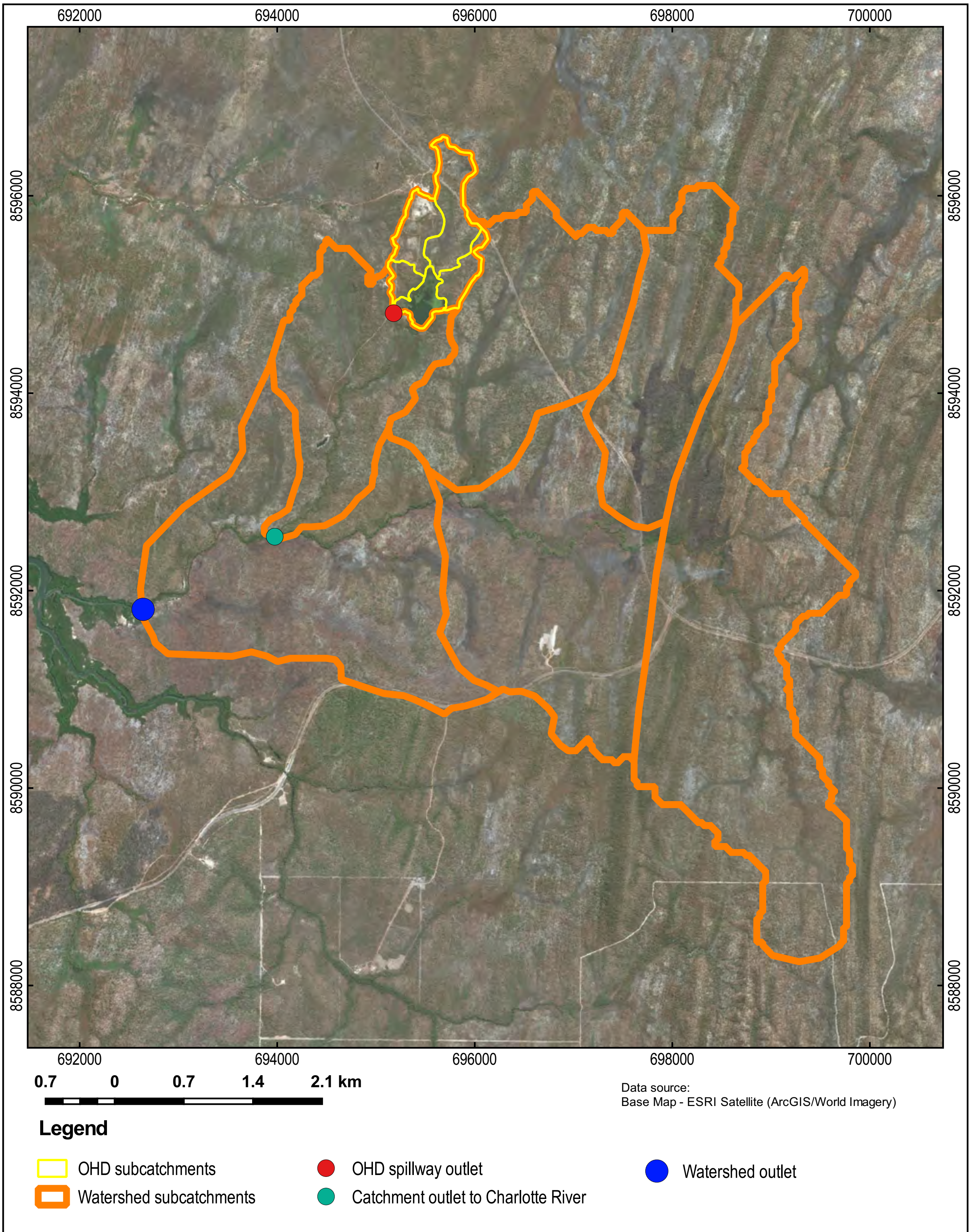

Figure 9. The watershed drains to the Bynoe Harbour tributary

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

4.4 Summary

The updated 5-year simulations, with constant pump rates, indicate that for all spillway levels, should a low rainfall year occur during mining, there will be a deficit of water for mine applications. The 1-year simulation, for an average rainfall year, for the existing OHD indicates that for a pump rate of $0.64MLd^{-1}$ in the wet, and $1.2MLd^{-1}$ in the dry, water storage will be enough for mining operations, however, this does not take into consideration the effect of lower than average rainfall years. Apart from a wall lift or reduction in water usage, or in addition to these strategies, an alternative to secure mine application water requirements may be the construction of a second dam (MSD).

With respect to accumulated reduction in flows downstream of the dam, the maximum reduction in monthly flow volume is 100% at the location right after the spillway under the worst scenario (2.02 ML pumping). For the larger sub-catchment that contains the OHD, the maximum monthly reduction in stream flow discharge to Charlotte River was reduced to 58.3% when 2.02 MLd^{-1} pumping is applied. The maximum monthly reduction in stream flow discharge to Bynoe Harbour receiving waters was only 12.6%.

5 Alternate water storage

The potential storage capacity of the preferred MSD was updated using the SILO rainfall data. Updated pump extraction volumes, and evaporation and seepage losses are shown in *Table 14, Table 15,* & *Table 16*.

Table 14. Pump extraction volumes and evaporation and seepage losses during dry season for the existing OHD

Pumping rate in dry season	Evaporation and seepage losses L (ML)	Pump extraction volume P (ML)	Total storage P+L	The ratio of total storage to pumped volume
2.02 MLd^{-1}	100	264	364	1.38

During the dry season, a part of storage is lost due to evaporation. The total storage in a dam can be 1.38 times the actual storage available for pumping based on the simulation results for OHD (*Table 14*). Therefore, the required storage capacity of MSD to provide required water is estimated as 1.5 times the worst-case scenario average annual deficit of 225 ML (*Table 7*). In this way, the required storage capacity in an alternate dam is 338 ML which is smaller than 387 ML identified in previous analysis (Project 2[2]). However, the more conservative storage requirement of 387 ML is recommended to be used for the planning of MSD. The minimum spillway level for MSD to meet the storage requirement is in *Table 15*.

Table 15. Minimum spillway levels for MSD to meet the deficit of water under the worst-case scenario.

Dam	Minimum spillway level to meet the required storage capacity of 387 ML (mAHD)
MSD	16.93

Updated HEC-HMS modelling determined the amount of runoff draining to the MSD in low, average and high rainfall years (*Table 16*).

Table 16. The total volume of inflow to MSD for low, average and high rainfall year scenarios.

Scenario	Total Inflow (ML)
Low rainfall year	1140
Average rainfall year	2735
High rainfall year	5380

The simulations show that the site received enough annual inflow to fill the proposed MSD to the spillway level (16.93 mAHD) in a single wet season.

5.1 Influence of MSD on downstream flows

If the MSD is constructed in catchment 5, the retention of surface flow and pumping could cause changes in downstream flows; these flows can be important to environmental values in downstream areas, especially where catchment outlets meet mangroves.

The investigations conducted in Project 2[2] (Section 6) were updated using the SILO 24-h rainfall inputs to HEC-HMS. The updated results of monthly flow volumes at 4 locations shown in *Figure 10* are shown in *Table 17.* The cumulated percentage reduction in downstream flows against the pre-mining condition is in *Table 18*.

The maximum percentage reduction in downstream monthly flows due to mine site infrastructure range from 28.8% at the catchment 5 outlet to 7.6% at the watershed outlet (DS4). When MSD is included in the modelling, the reductions in flow are greater (55.8% at the catchment outlet to 14.7% at the watershed outlet). The effect of MSD on downstream flows was greatest in early and late wet season months. *Figure 11* shows the changes in downstream hydrographs due to the presence of mine infrastructure and MSD.

Table 17. Monthly flow volumes at 4 locations downstream from proposed MSD during the wet season months.

Scenarios	Outflow location	Jan	Feb	Mar	Apr	Nov	Dec
Pre-mining	Catch-5 DS	3715	2015	1287	363	1313	326
	Catch-2&5 DS	6923	3769	2409	678	2439	621
	DS 5	8704	4808	3074	860	3035	838
	DS 4	13279	7500	4780	1331	4570	1391
During mining when MSD is not constructed. Controlled release form mine infrastructure area applied.	Catch-5 DS	2647	1470	985	259	982	299
	Catch-2&5 DS	5873	3222	2105	574	2113	590
	DS 5	7667	4278	2770	765	2729	808
	DS 4	12268	6953	4468	1234	4284	1342
During mining when MSD is constructed, 2.02 ML pumping applied. Controlled release form mine infrastructure area applied.	Catch-5 DS	2488	1441	922	218	594	204
	Catch-2&5 DS	5714	3193	2042	533	1725	495
	DS 5	7479	4235	2705	715	2335	696
	DS 4	12077	6914	4401	1183	3910	1211
Post-mining. No MSD. No release from mine infrastructure area.	Catch-5 DS	2508	1353	863	243	969	299
	Catch-2&5 DS	5734	3105	1983	558	2020	507
	DS 5	7528	4161	2648	749	2636	725
	DS 4	12129	6836	4346	1218	4191	1259

Table 18. The accumulated % reduction in downstream flow volumes (compared to pre-mining catchment condition).

Scenarios	Outflow location	Jan	Feb	Mar	Apr	Nov	Dec
During mining when MSD is not constructed. Controlled release form mine site applied.	Catch-5 DS	28.8	27.1	23.5	28.7	26.2	8.3
	Catch-2&5 DS	15.2	14.5	12.6	15.4	13.9	5.0
	DS 5	11.9	11.0	9.9	11.1	10.5	3.6
	DS 4	7.6	7.3	6.5	7.3	6.5	3.5
During mining when MSD is constructed, 2.02 ML pumping applied. Controlled release form mine site applied.	Catch-5 DS	33.0	28.5	28.4	40.0	55.8	37.4
	Catch-2&5 DS	17.5	15.3	15.3	21.4	29.8	20.3
	DS 5	14.1	11.9	12.0	16.9	23.5	16.9
	DS 4	9.1	7.8	7.9	11.1	14.7	12.9
Post-mining. No MSD. No release from mine site.	Catch-5 DS	32.7	32.4	32.3	32.5	33.3	29.1
	Catch-2&5 DS	17.2	17.6	17.7	17.7	17.2	18.4
	DS 5	13.5	13.5	13.9	12.9	13.1	13.5
	DS 4	8.7	8.9	9.1	8.5	8.3	9.5

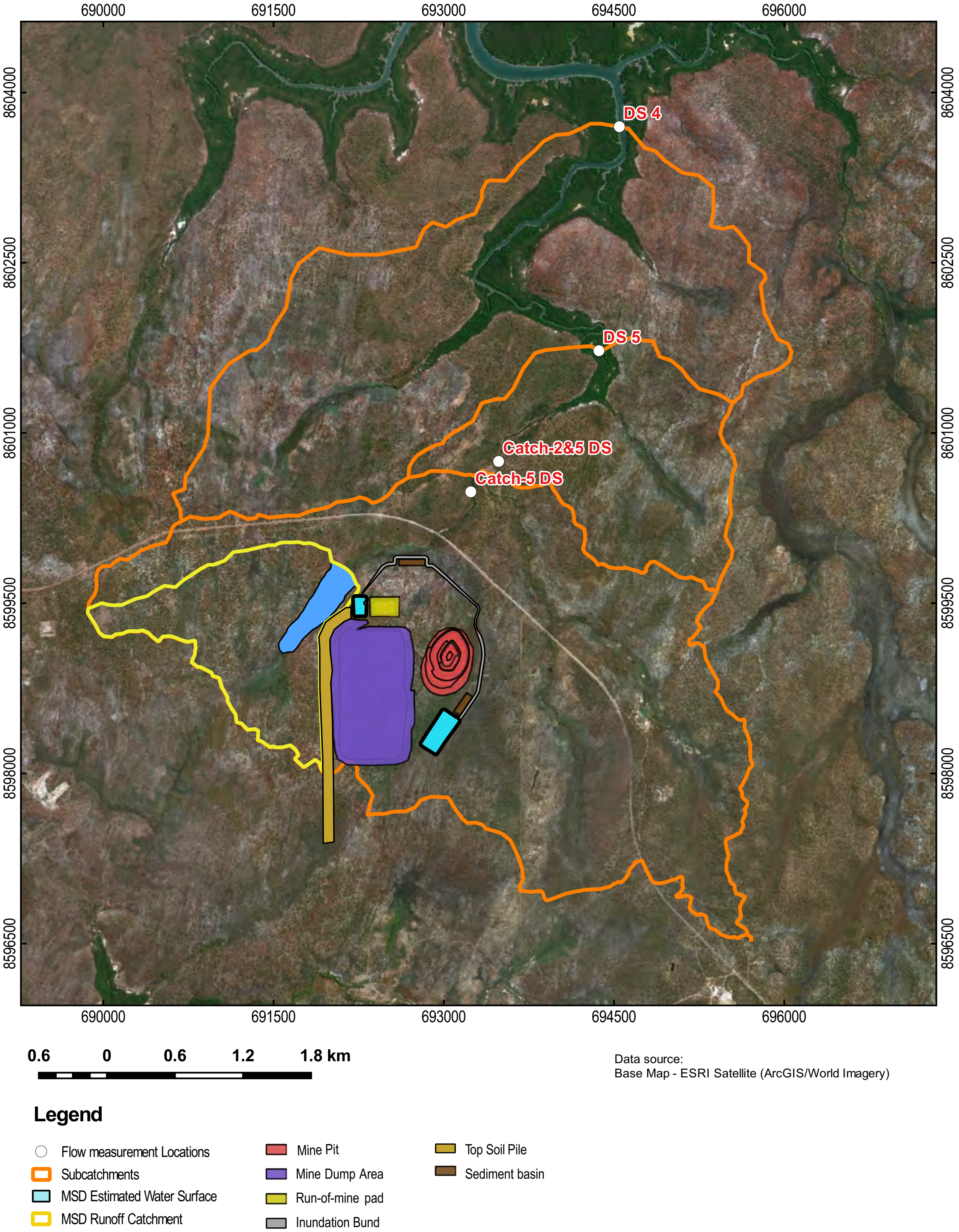

Figure 10. The watershed and the catchments draining to Darwin Harbour tributaries

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

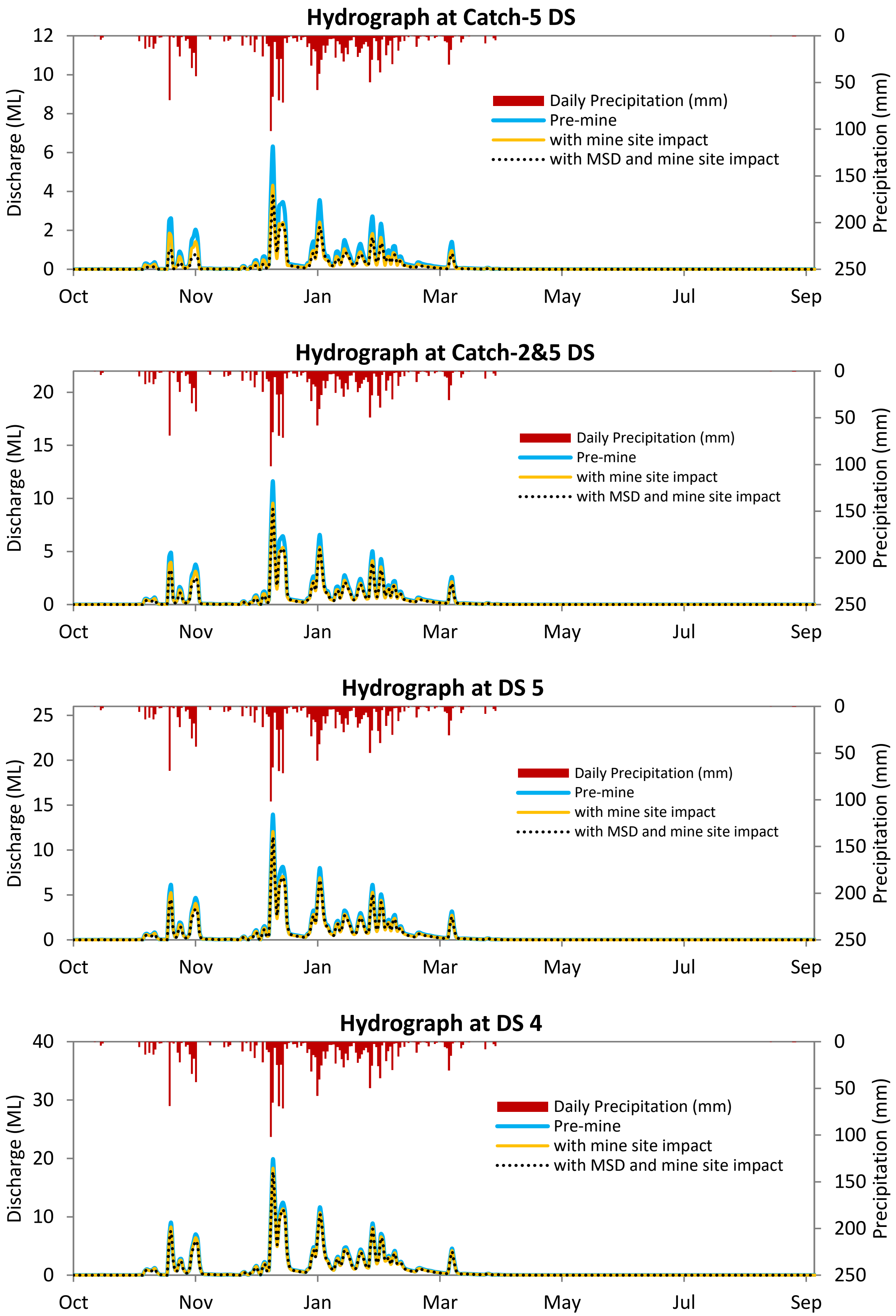

Figure 11. Hydrographs at Catch-2 DS, Catch-2&5 DS, DS 5 and DS 4.

6 Updated Flood Inundation Modelling

The section describes the changes in flood inundation due to the updated mine infrastructure (*Figure 1*) and the consideration of MSD. Project 3[3]**Error! Bookmark not defined.** assessed flood inundation of the site pre-mining and post-mining and focused on Darwin Harbour catchments 2 and 5. The methods in Sections 1 & 2 of Project Report 3[3] were used here with the updated DEM based on the revised mine infrastructure.

Using the updated DEM, a 1%AEP (Annual Exceedance Probability) rainfall event was used for the inundation studies. RORBwin hydrology model (Section 2.2, page 3, Project Report 3[3]) and the HEC-RAS 2D hydrodynamic model (Section 2.3, page 4, Project Report 3[3]), which uses the RORBwin output hydrographs, where used to simulate flood inundation modelling. The 24-h SILO data are not used in this analysis.

RORBwin was used to determine the hydrograph for a 1%AEP rainfall event at the various locations in catchment 5 (catchment 2 is no longer impacted by the updated mine infrastructure) (*Figure 13*). These hydrographs were used as an input for the HEC-RAS 2D model to determine the inundation scenarios caused by the rainfall event (Section 2.3, Project Report 3[3]).The input hydrographs for each node in *Figure 13* are shown in *Figure 14*.

6.1 The effect of primary storm surge in Darwin Harbour

The simulation of when a 1%AEP rainfall event coincides with storm surge was not updated as previous analysis (Section 3.2.3, page 23, Project 3[3]) showed that storm surge did not affect the site.

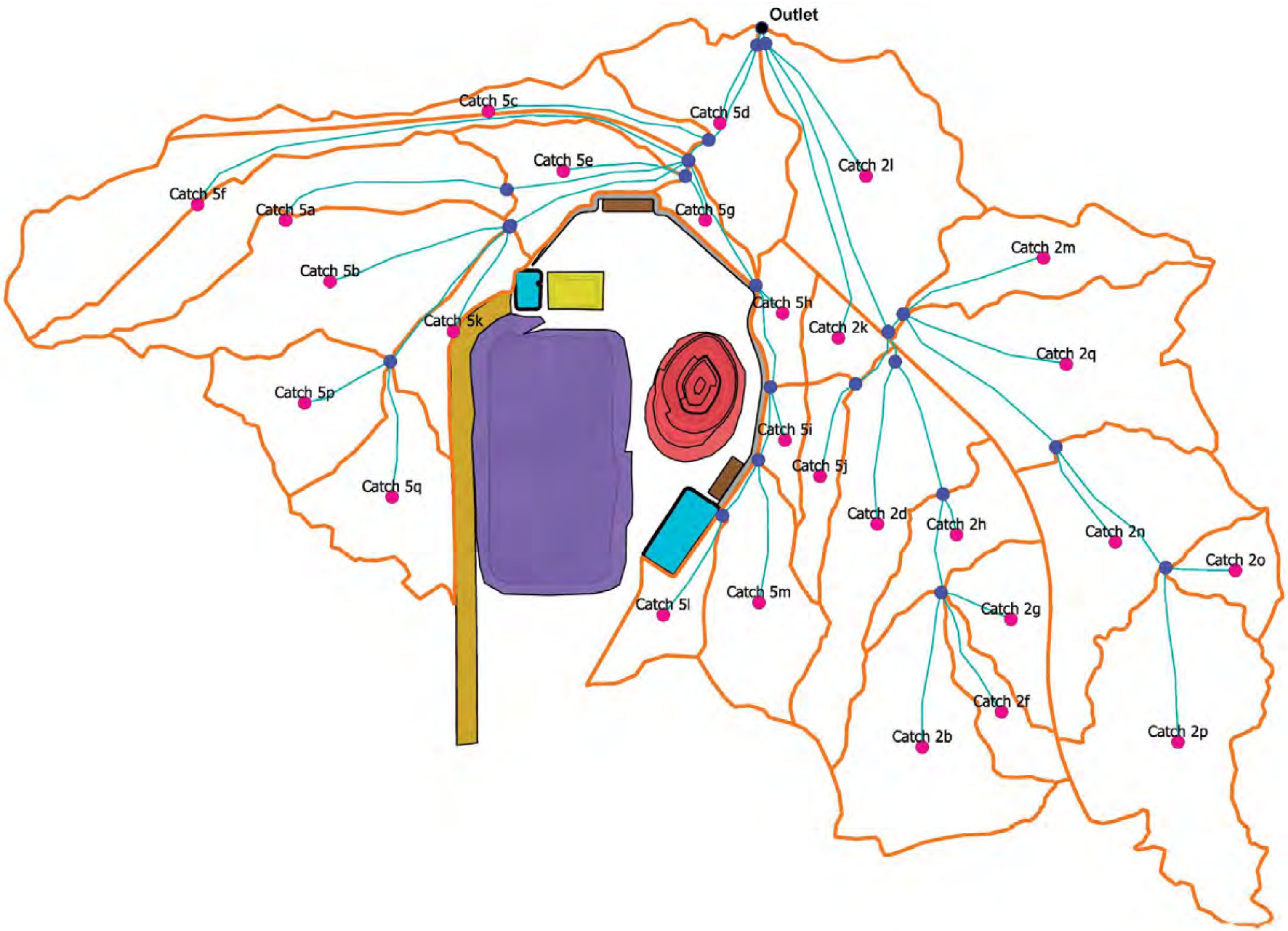

Figure 12. RORB catchment model

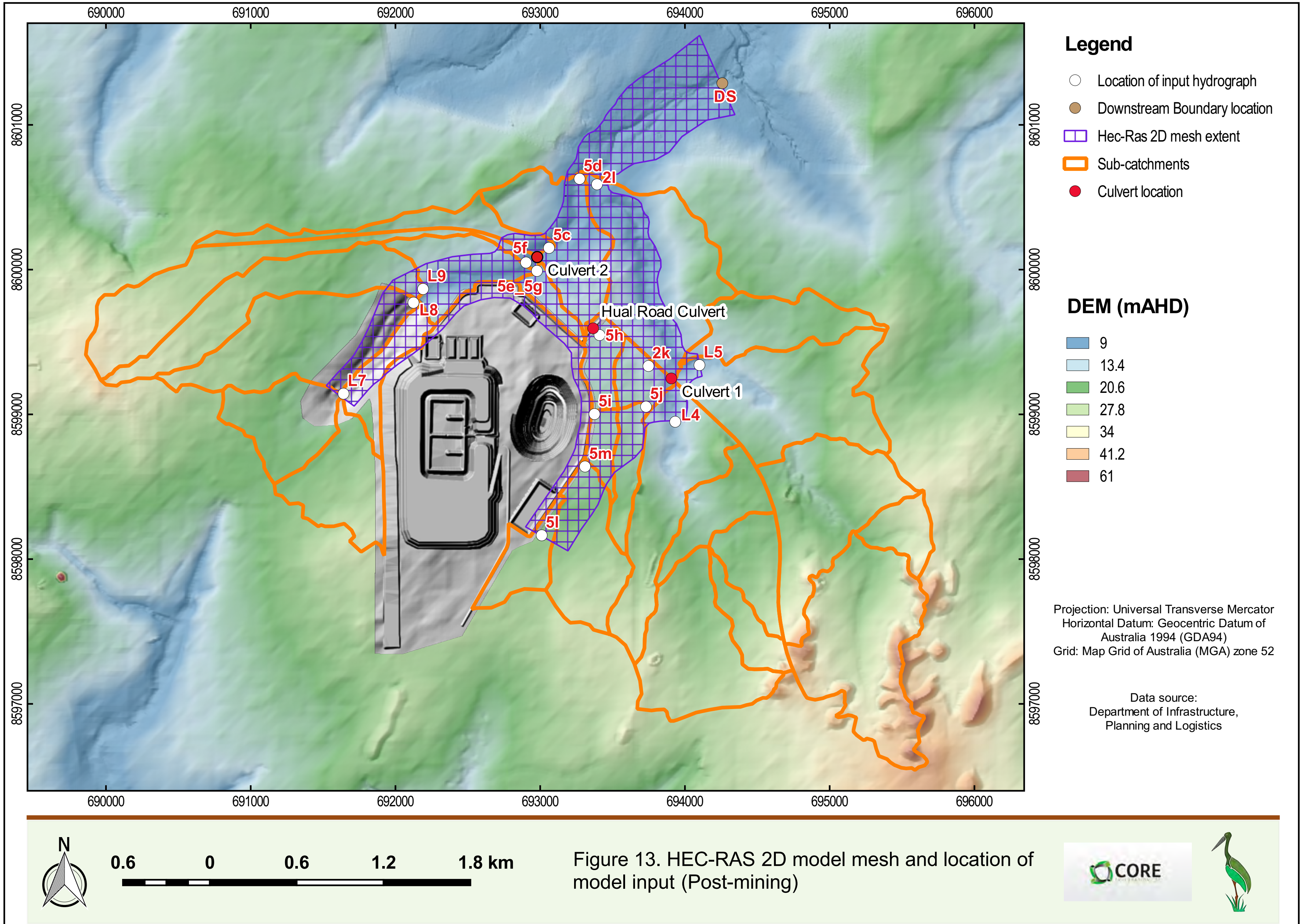

Figure 13. HEC-RAS 2D model mesh and location of model input (Post-mining)

6.2 RORBwin modelling

The calibrated RORBwin parameter values were IL = 15mm, CL = 3.1mmh^{-1}, k_c = 4.22, and m = 0.8. The empirically derived Se value was 8.15mkm^{-1}.

The RORBwin simulated 1%AEP event peak discharge and total discharge for the HEC-RAS 2D nodes for post-mining conditions are given in *Table 19*. The differences in pre- and post-mine peak discharges for the same nodes are because the mine infrastructure affects drainage routes and the area of sub-catchments draining through those nodes. Pre-mine total discharges and peak discharge are provided in Table 1, page 13, Project 3[3].

The RORBwin Monte Carlo simulations gave the critical rainfall duration of 6h for the 1%AEP event. RORBwin simulated peak discharge at the Outlet node (*Figure 12*) as 118.90m^{3}s^{-1} for pre-mine scenario, and 121.0m^{3}s^{-1} for post-mine scenario, an increase of 2.5%, and a time to peak discharge as approximately 2h. Total discharge at the outlet of catchments 2 and 5 for the 1%AEP event is 2090ML for pre-mine scenario and 1850ML for the post-mine scenario, a drop of 11% between the pre- and post-mining condition. It should be noted that the MSD is not considered in RORB model due to the limitation of the model. The peak discharge and flow volume at model outlet were calculated under the condition when the impact of MSD is not considered. The impact of MSD was assessed in the HEC-RAS model using the sub catchment hydrograph (*Figure 14*) generated by RORB.

The RORBwin simulated rainfall hyetographs and their resulting hydrographs for sub-catchments as they combine downstream for the 1%AEP event are shown in *Figure 14* (update of Figure 9, page 15, Project 3[3]). The upper hyetograph is the rainfall depth per 15-min interval and the continuous hydrograph are those simulated by RORBwin Monte Carlo simulations for the probable peak discharge of the event.

These hydrographs are used as input to the HEC-RAS 2D inundation model to assess local inundation as a result of 1%AEP rainfall event and the 1%AEP rainfall event occurring at the same time as primary storm surge.

Table 19. RORBwin simulated total discharge and peak discharge for the updated post-mining HEC-RAS 2D input nodes for the 1%AEP event.

HEC-RAS 2D Node	Post-mining		
	Area (km^2)	Peak Q (m^3s^{-1})	Total Q (ML)
L7	0.782	15.04	124.00
L8	0.941	16.33	149.00
L9	0.604	9.043	95.90
5e_5g	0.381	7.332	60.40
5f	0.842	8.67	134.00
5c	0.606	7.35	96.30
5d	0.486	9.88	71.40
5l	0.192	3.510	30.50
5m	0.434	7.95	68.80
5i	0.093	1.959	14.80
5h	0.137	3.132	21.70
5j	0.163	3.077	25.90
L4	1.999	27.48	317.00
L5	3.029	40.31	418.00
2k	0.126	15.01	134.00
2l	0.844	1.421	20.00
Outlet	11.66	121.1	1850.00

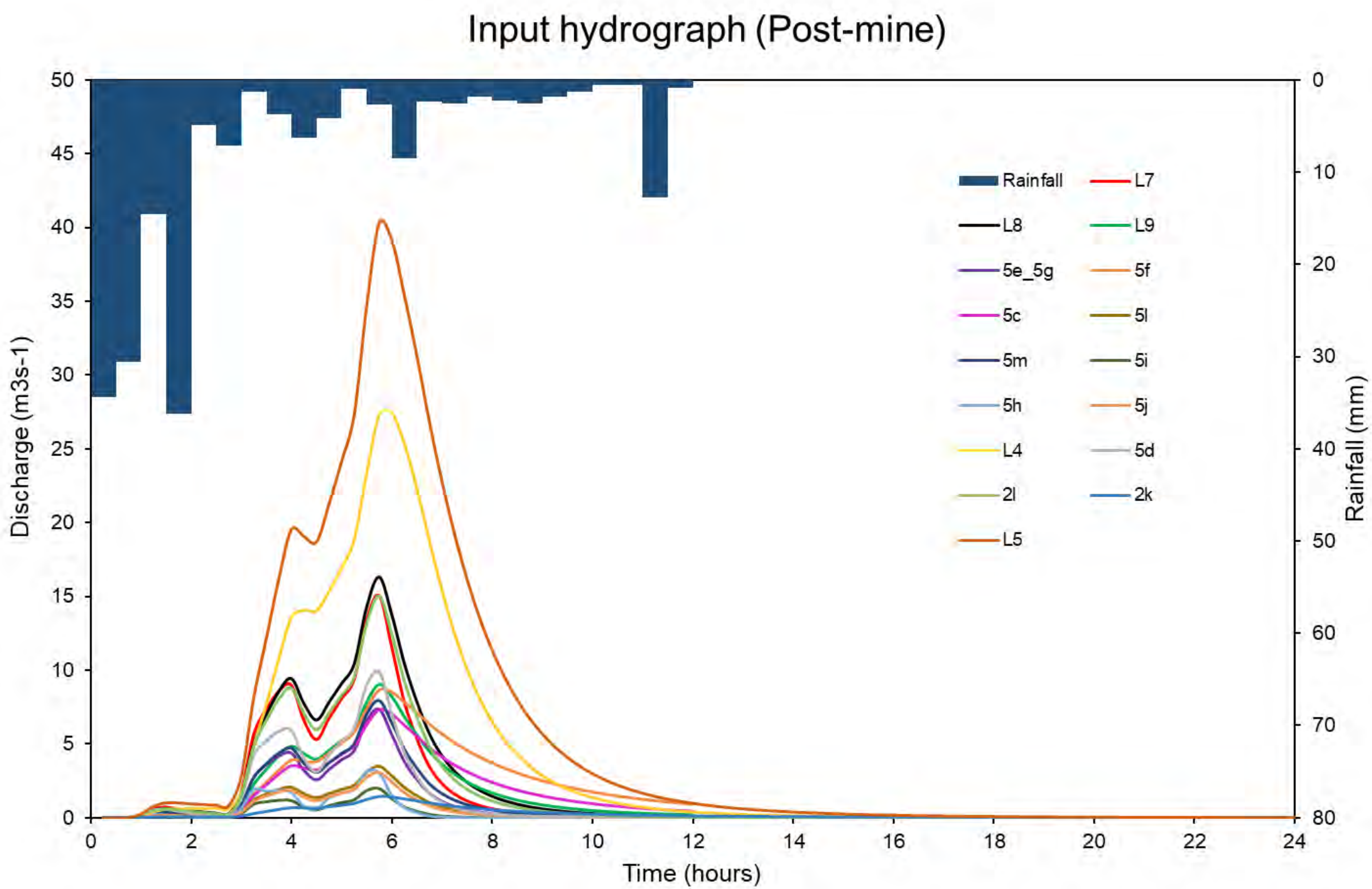

Figure 14. Input hydrographs from RORBwin for post-mining scenario for the 1%AEP design rainfall event. Update of Figure 9, page 15, Project 3[3].

6.3 Flood Inundation Modelling

The results of inundation modelling for a 1%AEP rainfall event for the new mine infrastructure allowed the re-assessment of the following:

1. What impact will inundation have on mine infrastructure, and
2. How would the mine infrastructure affect flooding of the Cox Peninsula Road at the culverts 1 and 2 (*Figure 17*) where the road intersects catchments 2 & 5.

6.3.1 Update of catchment inundation

Figure 16 shows the post-mine flood inundation for the 1%AEP rainfall event for catchments 2 and 5. The pre-mine inundation does not change. The post-mine inundation area is less than the pre-mine area because some pre-mine flow paths are no longer existed due to the presence of mine infrastructure (Green arrows in *Figure 17*). The inundation of Cox Peninsula Road around culvert 2 will be considerably reduced if MSD is constructed (*Figure 17*). The slightly increases in the inundation area to the east of the mine (Red circles in *Figure 17*) is due to water originally drained to culvert 2 (Yellow flow path in *Figure 17*) flow towards northeast due the mine infrastructure. The mine site is protected from an overland flood to the east of the mine site by the inundation bund (*Figure 16*). After the flood peak, the flood water is gradually drained away through natural stream lines and the culverts under the haul road and Cox Peninsula Road (*Figure 18*). The hydrograph of the flow through the haul road culvert is shown in *Figure 15*.

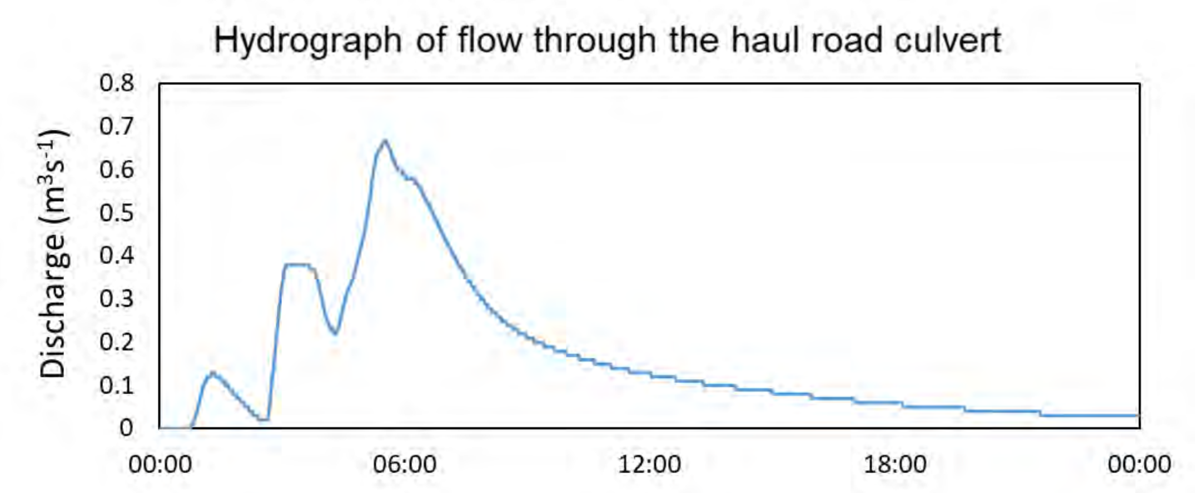

Figure 15. Simulated hydrograph of flow through the haul road culvert.

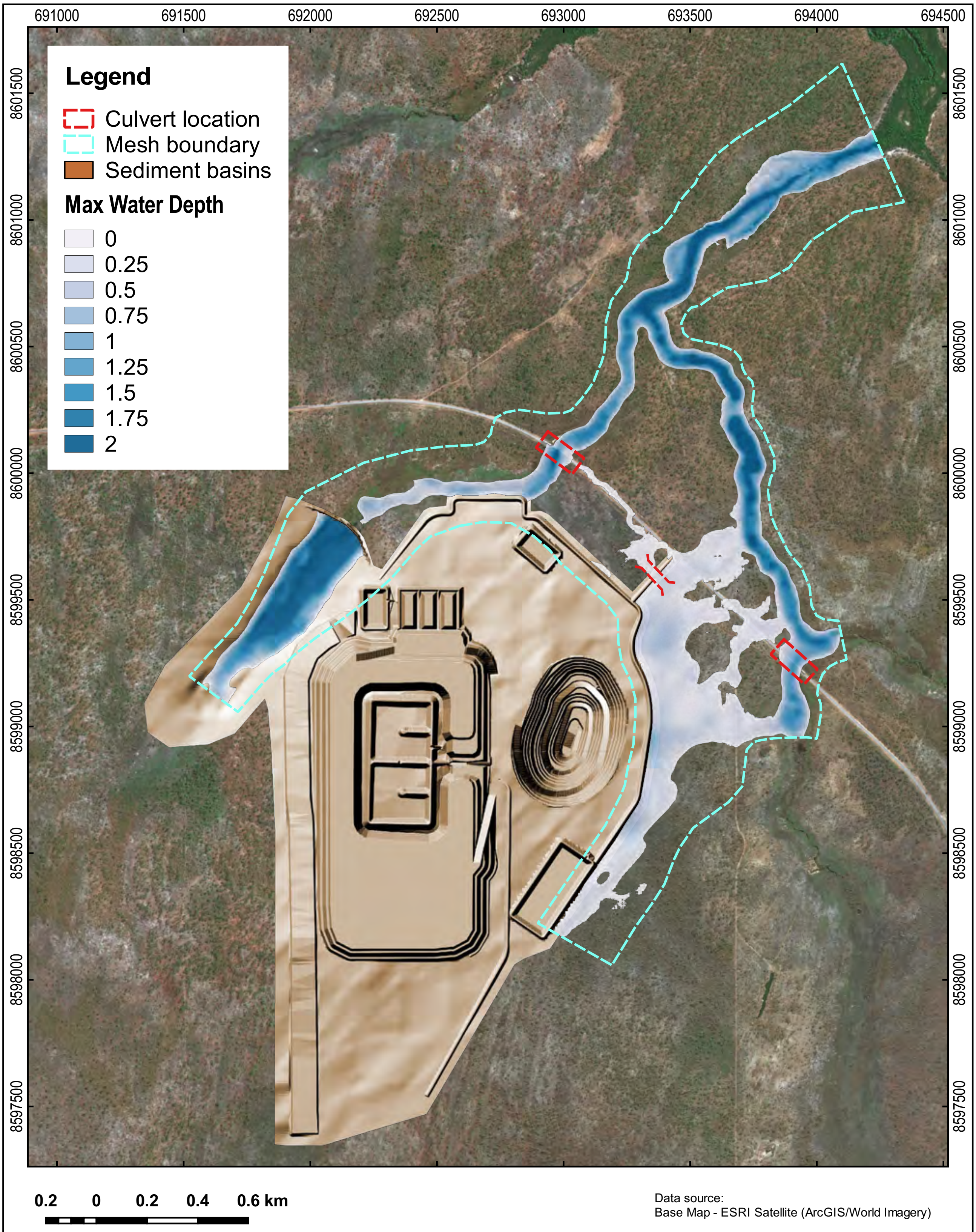

Figure 16. Post-mine 1%AEP rainfall inundation extent

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94) Grid: Map Grid of Australia (MGA) zone 52

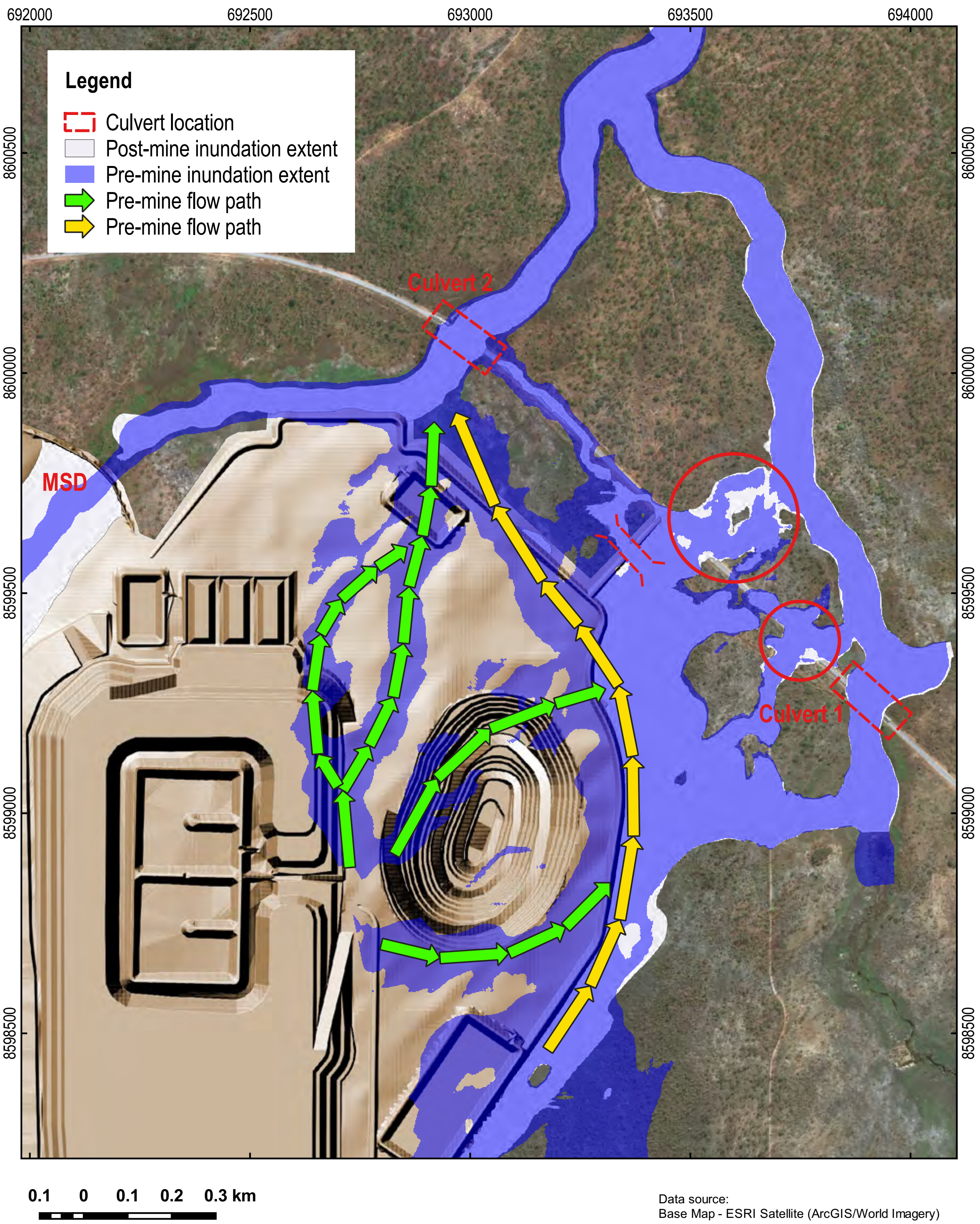

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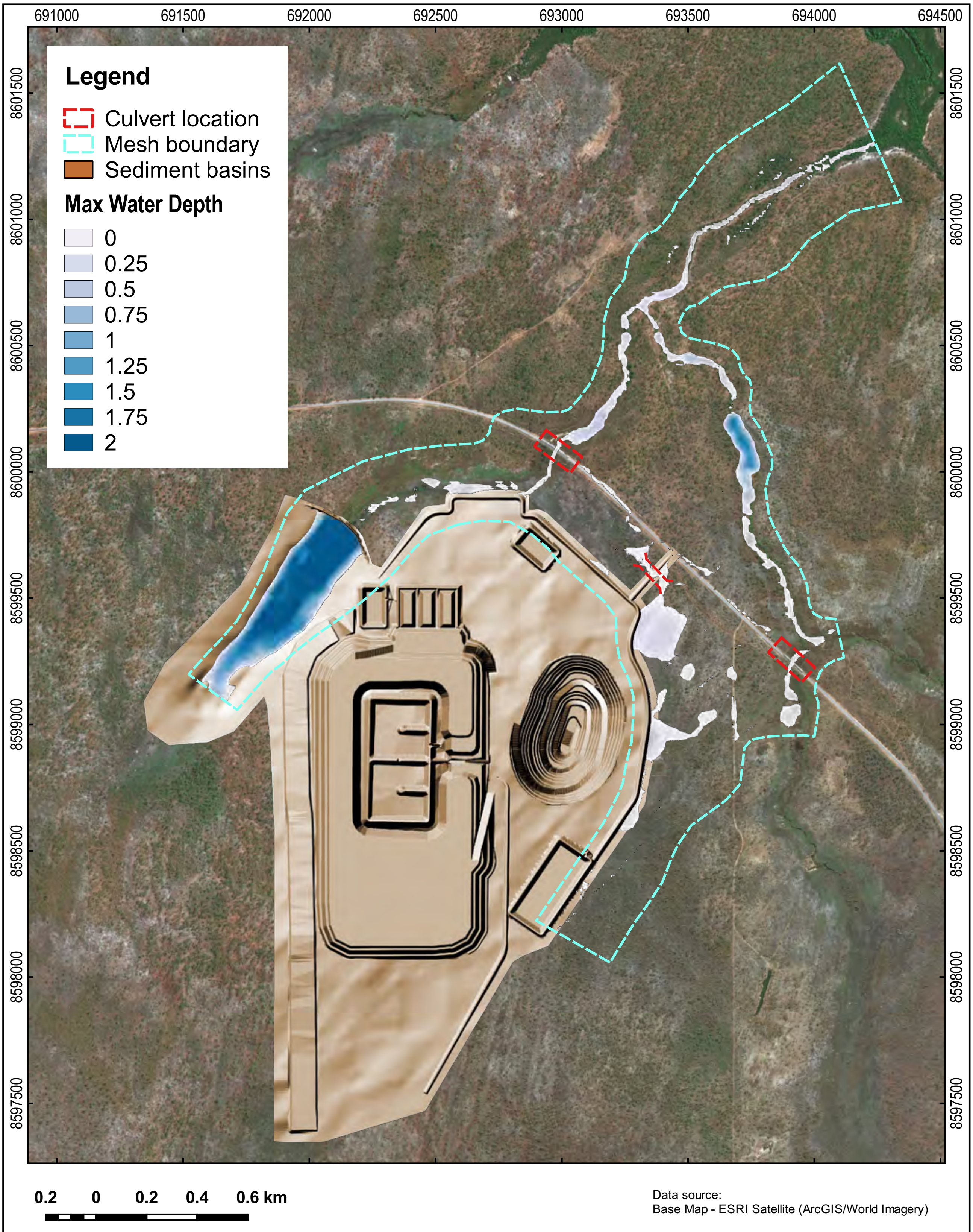
Figure 17. Pre- and post-mine 1%AEP rainfall inundation extents

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52



Data source:
Base Map - ESRI Satellite (ArcGIS/World Imagery)

Figure 18. Post-mine 1%AEP rainfall inundation extent 18 hours after cease of rain

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

6.3.2 Update of Cox Peninsula Road inundation

The simulation results for the 1%AEP flood for the post-mine conditions for Culvert 1 are shown in *Figure 19.* Cox Peninsula Road is inundated for a shorter period for post-mine conditions (4.5 hrs) than for the pre-mine conditions (7.0 hrs). The maximum water depth above the road surface at the location of this culvert is 0.38m for pre-mine and 0.28m for post-mine scenarios.

The updated simulation results for the 1%AEP flood for pre- and post-mine conditions for Culvert 2 are shown in *Figure 20*. As the flood water is retained by the MSD, the Cox Peninsula Road is not inundated under post-mine conditions while it was inundated for 3.5 hrs under the pre-mine condition. The maximum water depth above the road surface at the location of this culvert is 0.29m for pre-mine scenarios.

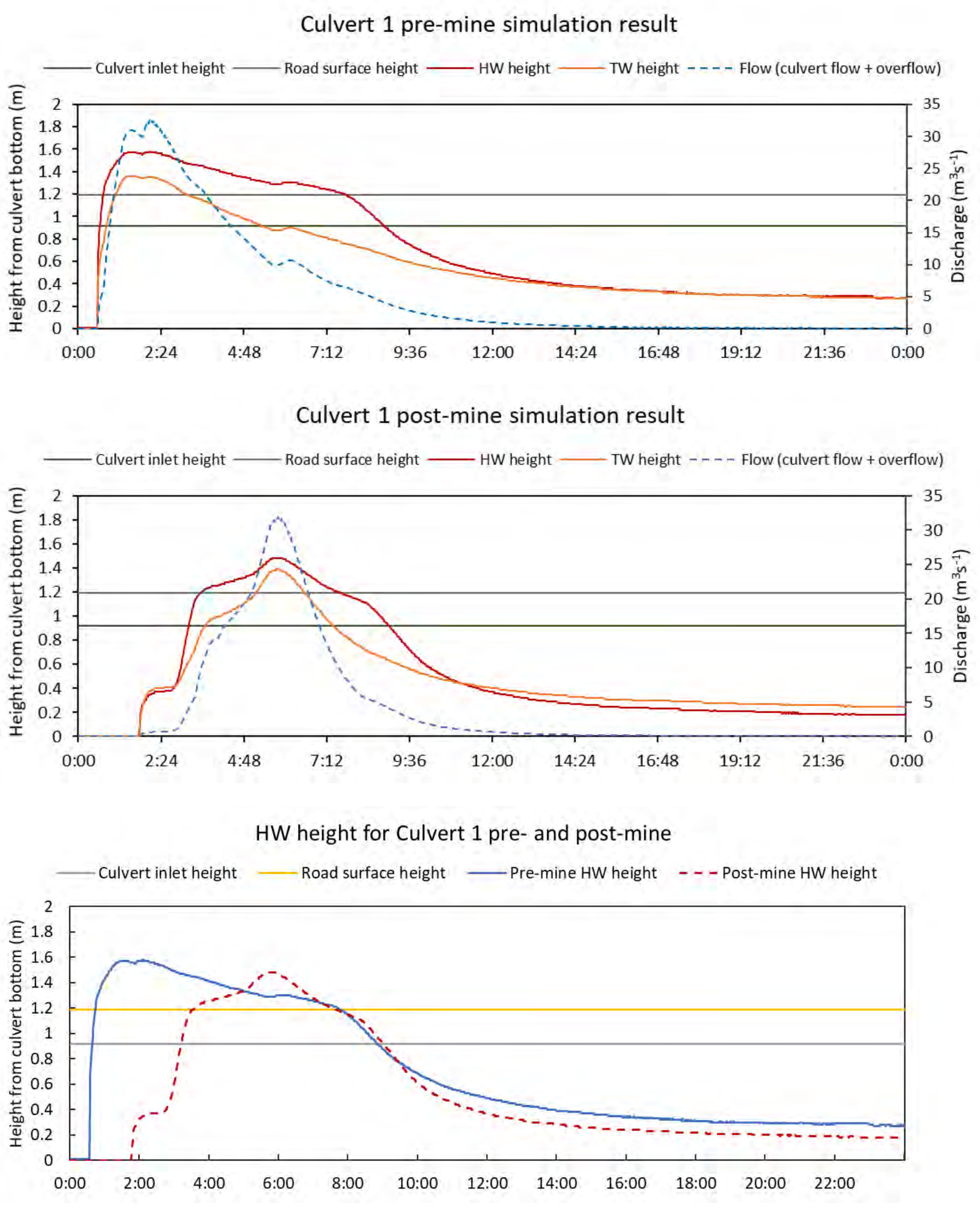


Figure 19. Culvert 1 pre- and post-mine simulation results. (Updated Figure 15, page 22, Project 3[3])

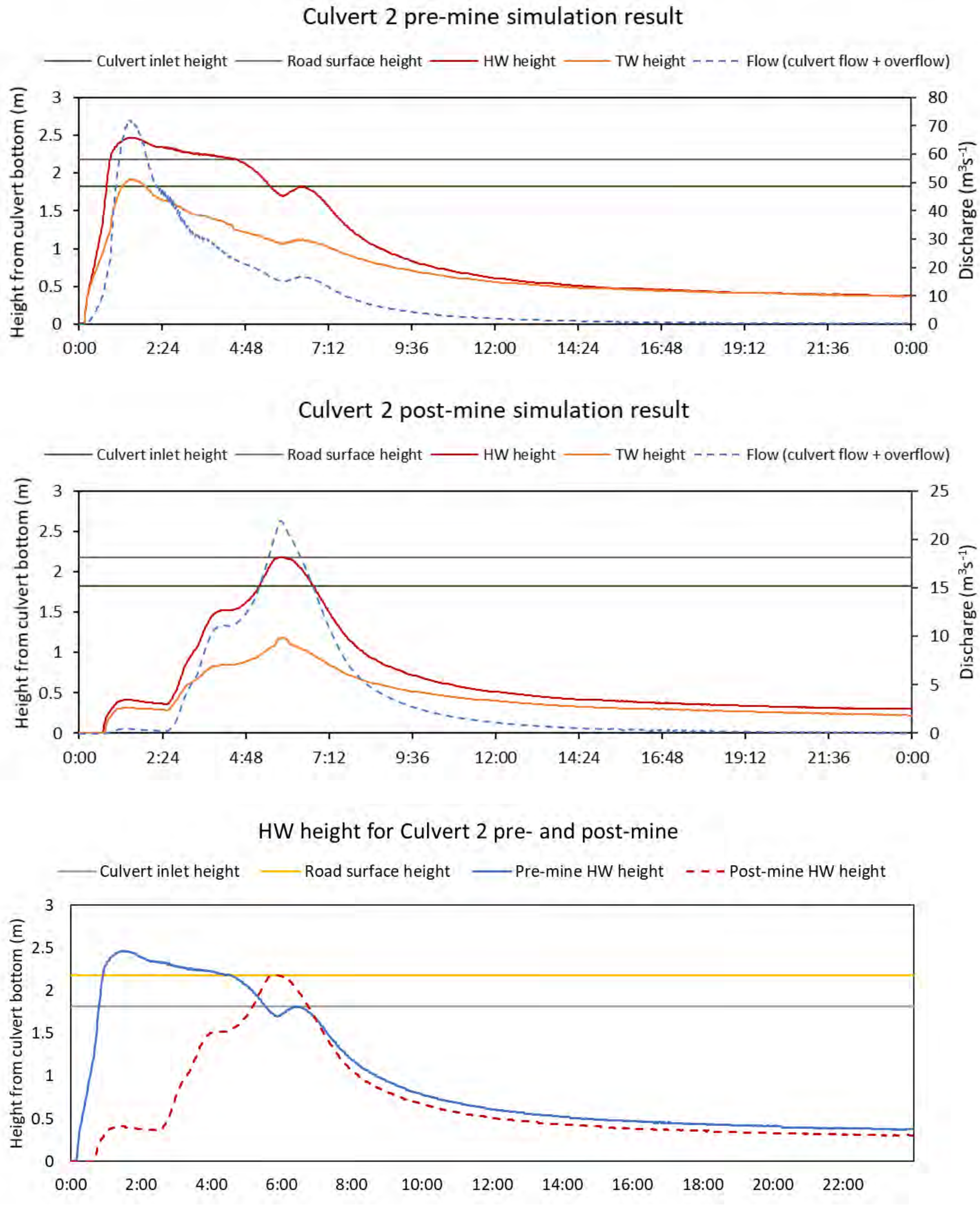


Figure 20. Culvert 2 pre- and post-mine simulation results. (Updated Figure 16, page 23, Project 3[3])

7 Summary

The HEC-HMS model was recalibration using 24-h rainfall inputs to address inconsistencies in climate data used for groundwater and surface water studies. The only change to parameter values was CL which was due to the change in time step from 15 minutes.

Applying 24-h rainfall and the new CL value to HEC-HMS for the pre-mine condition gave similar results to the simulations using 15-min input data.

The updated HEC-HMS simulations show that for the post-mining Darwin Harbour catchment with updated mine infrastructure only, the percentage reduction in stream flow at the catchment outlet for an average rainfall year is 18% of the pre-mine catchment outflow. This is based on a conservative simulation scenario where all water is retained in the sub-catchment containing the infrastructure.

During mining, when there are water releases from the mine infrastructure, the reduction in stream flow at the outlet of catchments 2 and 5 is 14% for an average rainfall year. During mining when the mine site dam (MSD) is included in the Darwin Harbour catchment, reduction to catchments 2 and 5 outflow due the dam and the infrastructure is about 19% of the pre-mine outflow. So, for an average year, MSD is responsible for a reduction of about 5%.

Observation Hill dam yield analysis indicated a water deficit for low rainfall year scenarios for the 2 wall lifts tested. The monthly reduction in flows to Bynoe Harbour receiving waters ranged from 1.4% to 12.6% for the same scenarios.

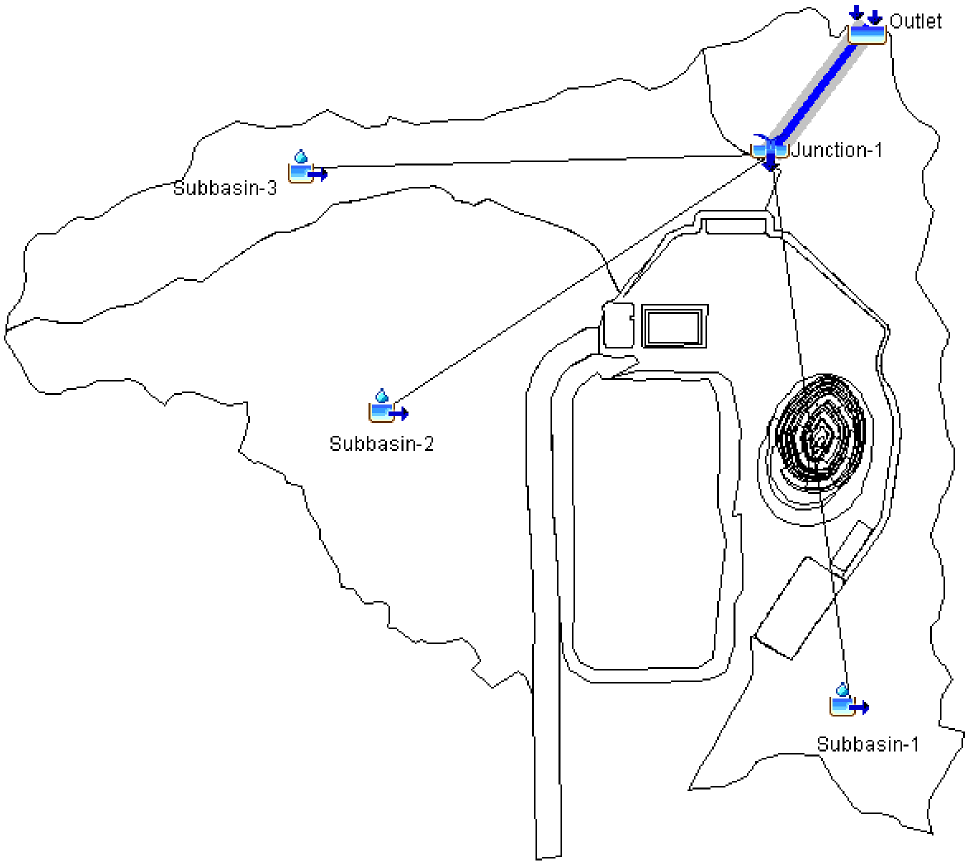
The assessment of the effects of the mine infrastructure on downstream flows at the outlet (DS 4) to Darwin Harbour indicated a monthly reduction ranging from 9.5% to 8.3%; and 16.5% to 9.4% when the MSD was included.

There was little change in the peak discharge (+2.5%) and total discharge (-11%) at the outlet of catchments 2 and 5 for for pre-mining and post-mining conditions for the probabilistic 1%AEP rainfall runoff event.

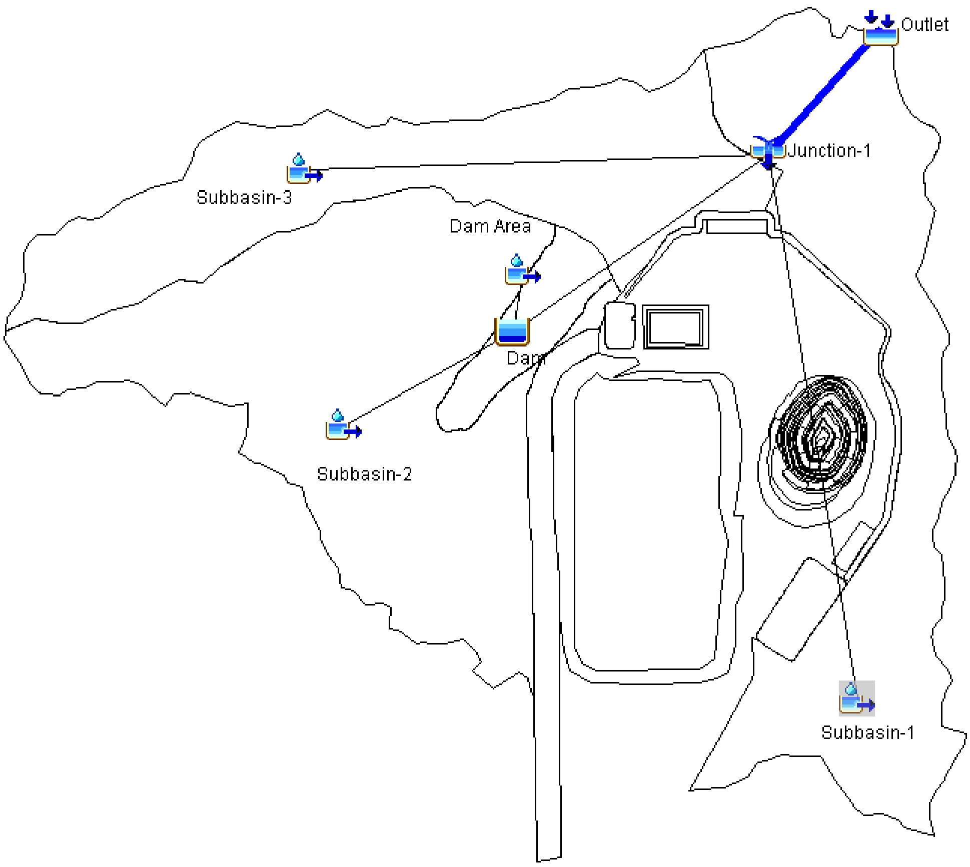
There is a reduction in the catchment inundation area between pre- and post-mining caused by the mine infrastructure and MSD retaining water. The mine site is protected from flood risk by the inundation bund. Flood water around the mine site drains away through natural stream lines and the haul road and Cox Peninsula Road culverts. Inundation of Cox Peninsula Road is reduced in time, extent and depth in the post-mining condition compared to the pre-mining condition.

Appendix A

A1. Darwin Harbour catchment post-mining HEC-HMS model (without mine site dam)



A2. Darwin Harbour catchment post-mining HEC-HMS model (with mine site dam)



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Description	Author	Reviewer	Approved for Issue		
			Name	Signature	Date
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Riparian Vegetation Monitoring Plan

Finniss Lithium Project

Core Lithium

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1 INTRODUCTION

This plan documents the riparian vegetation monitoring program (RVMP) that will be implemented to monitor impacts associated with water extraction from Observation Hill Dam (OHD) under Surface Water Extraction Licence (SWEL) 8151018 and operation of the Finniss Lithium Project, BP33 underground mine located on the Cox Peninsula (Figure 1). Riparian vegetation health downstream of the mines could be affected by changes to:

- surface water flows associated with extraction of water from the OHD
- groundwater levels due to dewatering of BP33 underground mine.

Riparian vegetation monitoring is required as a condition of the following approvals and licences:

- Environmental Approval 2020/001-001 for BP33 underground lithium mine
- SWEL 8151018.

The RVMP will be implemented in conjunction with the surface water, groundwater, sediment and biota monitoring programs detailed in the Grants Water Management Plan and BP33 Water Management Plan.

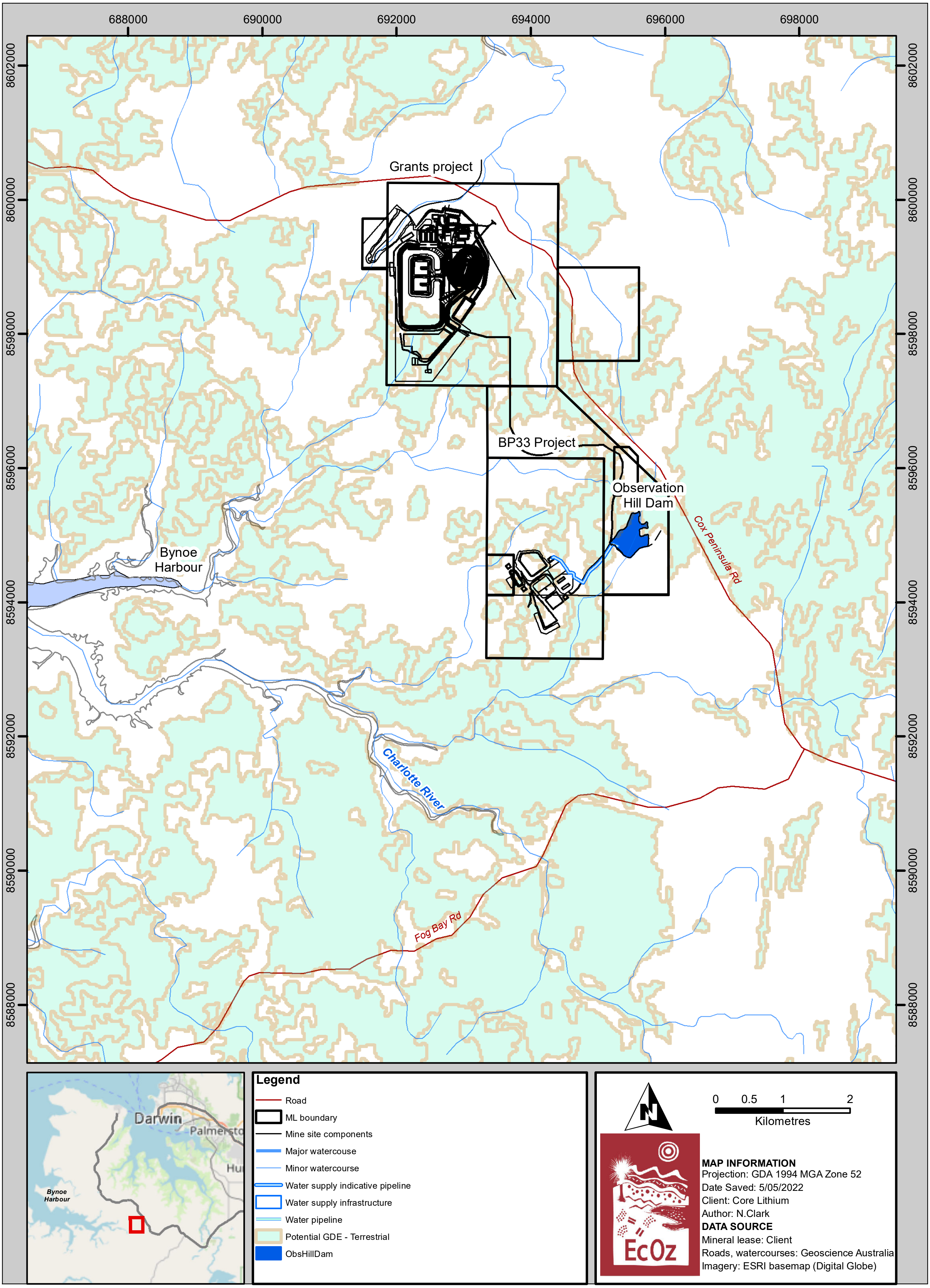
Riparian communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

The plan has been developed by EcOz botanist, Nicole Clark, whom is a suitable qualified professional. The plan includes:

- monitoring parameters, methods and frequency for monitoring downstream attributable to water under the SWEL on riparian vegetation
- a review process to ensure continuous improvement of the monitoring program.

To develop this RVMP, the following steps were undertaken:

- a desktop review of the existing baseline information available
- research of best practise methodologies in riparian monitoring including the monitoring of plant health
- addressing gaps in existing information to design a robust monitoring method.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 1. Map of the project location.mxd

Figure 1. Map of Finniss Lithium Project location

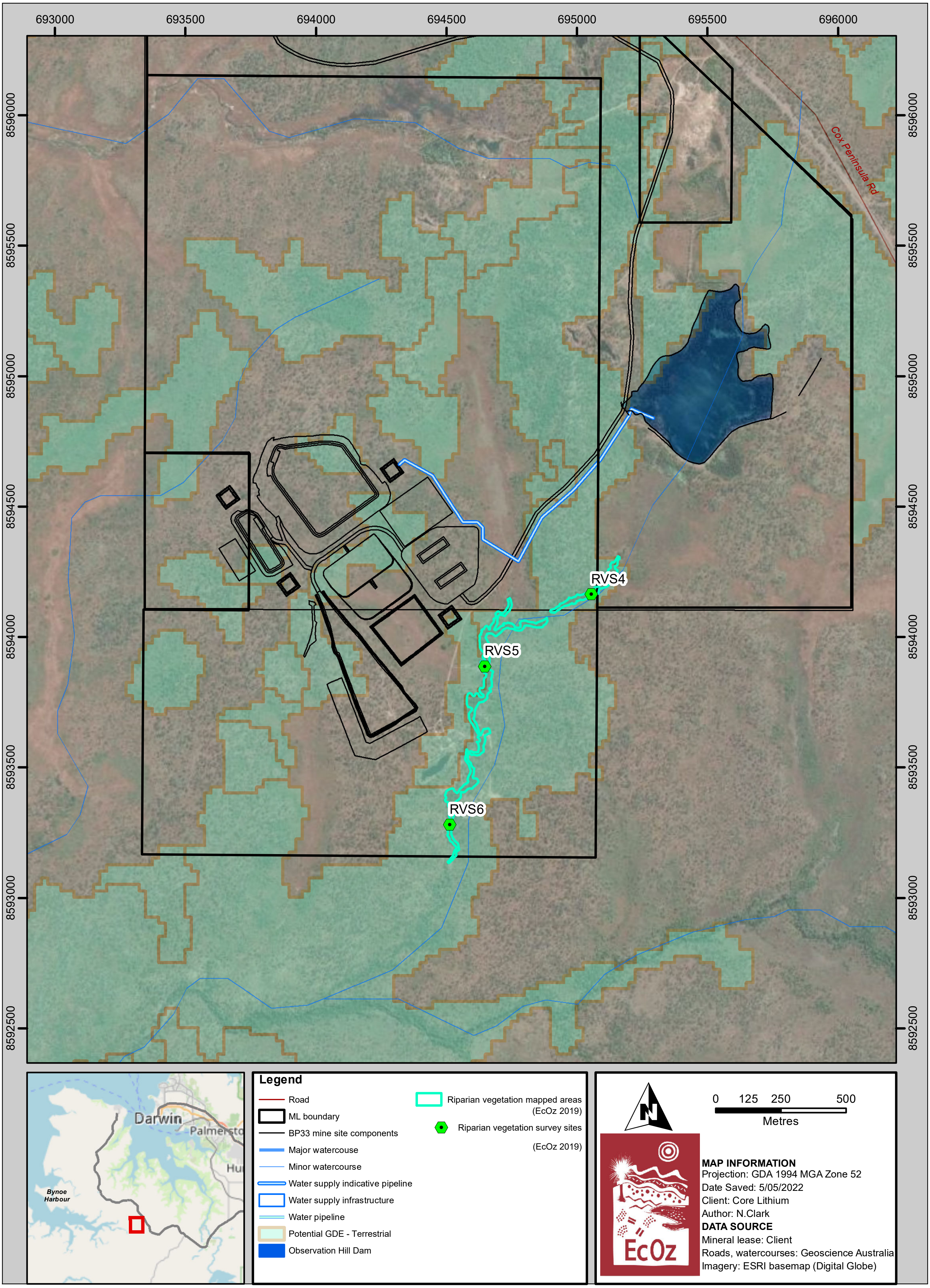
1.1 Summary of baseline surveys

Previous surveys and assessments undertaken for the Grants Environmental Impact Statement (EIS) identified presence of an ephemeral drainage line downstream of OHD which supports closed riparian vegetation identified as a potential Groundwater Dependent Ecosystem (GDEs) (see Figure 2) based on desktop modelling. These riparian vegetation communities downstream of the OHD water supply could be susceptible to impacts associated with changes to surface water flows. The Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019) baseline study (Appendix A) was undertaken to further assess the vegetation prior to mining activities commencing.

The intent of the baseline survey was to produce a vegetation map and record vegetation characteristics and condition of the sensitive vegetation communities downstream of OHD, which is now near the proposed BP33 underground mine.

Two types of baseline surveys were undertaken; an aerial drone survey to look at the overall riparian vegetation health and assist in mapping the riparian vegetation extent, and on-ground field survey to assess vegetation structure and composition within the mapped riparian vegetation extent. See Appendix A for the Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019).

Additional baseline surveys will be undertaken during 2022 to support implementation of this plan. Further details of additional baseline studies are provided in Section 1.1.1.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 2. Map of baseline studies for BP33 project area.mxd

Figure 2. Map of baseline riparian monitoring area and vegetation monitoring sites (EcOz 2019)

1.1.1 Gaps in baseline

Based on the existing information available, a few gaps were identified in the baseline surveys and are proposed to be addressed as outlined below.

- The drone survey was only undertaken post wet-season. It is recommended to undertake additional drone flight for BP33 project area in the dry season to account for seasonality differences.
- The orthomosaic images obtained from drone mapping only used false colour imagery (i.e. green indicating to examine vegetation health). Further remote sensing analysis is required to quantify vegetation health and compare data between 2019 and 2022.
- No upstream of Charlotte's River riparian vegetation site assessments undertaken outside of the modelled groundwater drawdown (CloudGMS 2021) for BP33 project area. A site will be established outside of the modelled 1m contour groundwater drawdown zone of influence (ZOI) to be used as a baseline reference site and assessed prior to significant water extraction from OHD and BP33 mining operations.
- No vegetation site assessment data was collected post-wet season. To account for seasonality differences, it is recommended to undertake biannual vegetation site assessment monitoring post-wet season for the 2022 baseline surveys. This data can be used for future reference if additional monitoring is required in accordance with the trigger action response plan (TARP) (see section 4).
- Though some data was obtained while undertaking vegetation site-based assessments post wet-season 2019, there was a lack of quantitative data collected - ground cover percentage, presence of recruitment, number of alive vs dead plants, erosion scoring etc. These attributes will assist in monitoring the condition of riparian vegetation and data comparison.
- Further investigation is required to determine the extent of the riparian vegetation within the identified ZOI of the BP33 predicted groundwater drawdown modelling. The ZOI has been defined by the one metre groundwater drawdown contour shown Figure 5. It is assumed that drawdown of less than that would only affect water availability for a short period of time in the mid-late dry season when groundwater levels are naturally lowered. The ZOI encompasses a 4.5 km section of stream order one ephemeral watercourse.
- Additional baseline surveys will be conducted biannually during 2022 to address these gaps. A baseline assessment report will be developed to include outcomes of the 2019 monitoring and the 2022 monitoring and the RVMP revised as required.

2 RIPARIAN VEGETATION MONITORING PLAN

Healthy riparian zones are essential for maintaining healthy ecosystems and economic productivity along rivers (Dixon & Douglas 2015). When maintaining a riparian vegetation system, it is vital to retain a diverse vegetation cover to assist in maintaining the functions that a riparian vegetation community provides i.e. supporting aquatic habitats, shading the river and regulating the temperature, bank stabilisation, filtering of sediments and improving water quality of river by reducing contaminants (Dixon & Douglas 2015).

Riparian vegetation are able to access water multiple ways i.e. through the upper un-saturated zone as a result from recent rain events, the groundwater at depth via the capillary fringe above an unconfined aquifer, and through creek water (generally a combination of groundwater and rain water in the wet season, but may be predominantly groundwater in the dry season) (SKM 2012) (see Figure 3). There are particular species that are more likely to be more sensitive to declines in available ground water such as monsoon forest species that grow in areas where there is perennial water supply.

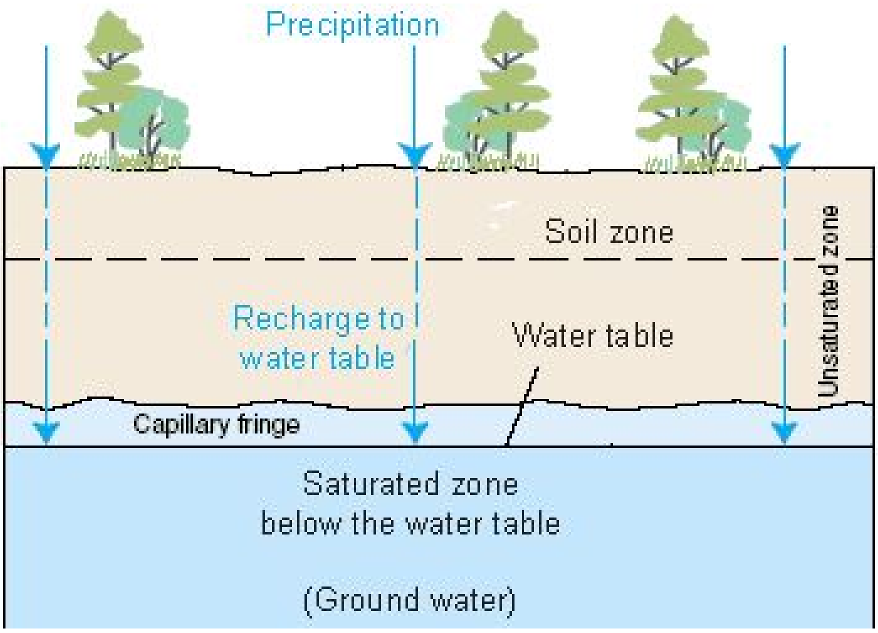


Figure 3. Diagram showing the capillary fringe (SKM 2012)

Riparian vegetation recruitment and germination heavily depends on the level of surface water and ground water regimes as plants depend on predictable patterns in terms of structure and diversity according to water availability in the landscape (Eamus & Lamontagne 2006). Riparian tree recruitment typically occurs after large floods when viable plant material is transported onto point bars and the floodplains of naturally flowing rivers (Eamus, D., & Lamontagne 2006). If dry season flow is modified, or the water table recedes too quickly, new cohorts fail to recruit and the species composition may alter over time (Figure 4). Ultimately the intent of monitoring the riparian vegetation a is to detect changes over time.

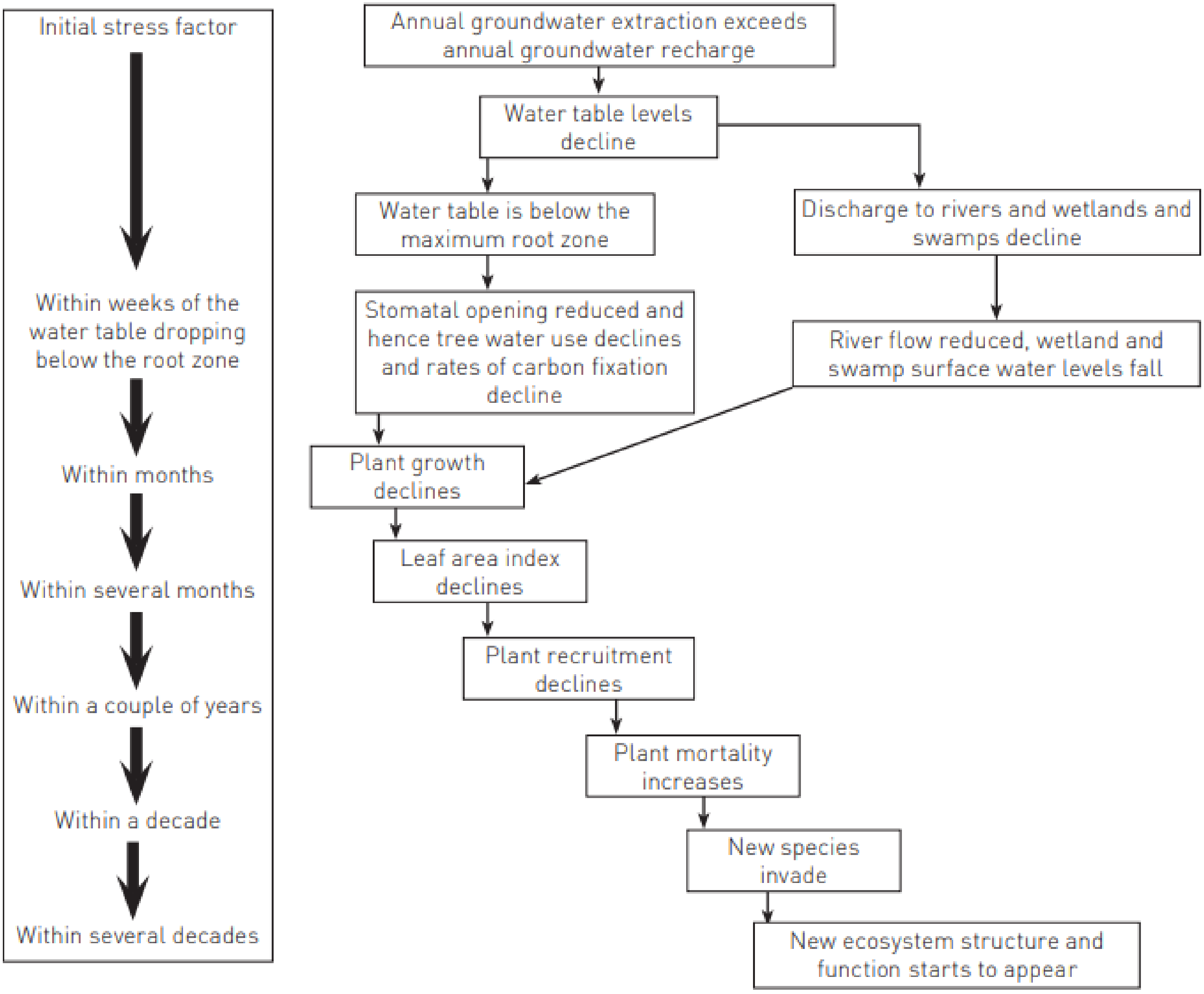


Figure 4. Diagram showing the potential consequences of groundwater drawdown affect (Eamus, D., & Lamontagne 2006)

Some of the information obtained from the baseline studies and the associated gaps identified have been used to develop this RVMP. The monitoring plan outlines objectives and parameters that can be used to assess the riparian vegetation health during the drawdown and reduced surface flows from OHD as part of operations. For each monitoring type, the following headings have been used:

- Objective
- Survey method – these may include ongoing methods previously used in the baseline surveys or additional (new) methods
- Record keeping - maintenance of data for analysis
- Data analysis.

2.1 Best practice and standards

The following best practice and standards for vegetation monitoring been adopted and assisted in developing this RVMP:

- Brocklehurst et al 2007. *Northern Territory Guidelines and field methodology for vegetation survey and mapping*
- Dixon, I., & Douglas, M (2015). *A Field Guide to Assessing Australia's Tropical Riparian Zones*, Tropical Savannas Cooperative Research Centre for Tropical Savannas Management.

- Eamus, D., & Lamontagne (2006). Groundwater use by riparian vegetation in the wet-dry tropics of Northern Australia, Australian Journal of Botany.
- Florabank (1999-2000) Florabank guidelines and codes of practice www.florabank.org.au/ Greening Australia. Revised 2016. Accessed March 15, 2016
- Lloyd, J., & Cook, S (1996). NT Sampling and Processing Manual, Natural Resources Division, *Department of Lands, Planning and Environment*
- International Erosion Control Association (IECA) (2008). *Best Practice Erosion and Sediment Control.* Picton, NSW. Available at: https://www.austieca.com.au/documents/item/57
- Society for Ecological Restoration (SER) (2018). *National Standards for the Practice of Ecological Restoration in Australia*. 2nd edition, Australia.
- Han., Y., Jung, S., & Kwon, O (2017). *How to utilize vegetation survey using drone image and image analysis software*, Journal of Ecology and Environment 41:18.
- Ancin-Murguzur, F., & Munoz, L., Monz C., &. Hausne V. (2019). *Drones as a tool to monitor human impacts and vegetation changes in parks and protected areas,* Remote Sensing in Ecology and Conservation.
- Wegmann, M., Leutner, B., & Dech, S. (2017). Remote Sensing and GIS for Ecologists using Open Source Software, *Pelagic publishing*

2.2 Drone survey

2.2.1 Objective

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey is to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover.

2.2.1 Methodology

- Create new drone flight path based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI. The new flight path will be an extension of the existing baseline survey (EcOz 2019) to capture the riparian vegetation extent downstream of OHD to the 1m contour groundwater drawdown ZOI (see Figure 5 for indicative drone survey boundary). The indicative flight path will be field verified during 2022 baseline surveys prior to establishing a set flight path.
- Previously Drone Deploy (Software program) was used to design the flight path, however WebODM will be used for this monitoring. WebODM was selected as it contains the correct platform selected for to measure plant health.
- Drone will be flown in the middle of the day to avoid sun light interference i.e. shading. Observations will also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- When importing drone data to create the orthomasoaic, the same methods as per methods in baseline report outlined in section 3 (Appendix A) will be applied, except using WebODM.
- The boundary of the riparian vegetation will then be delineated using the orthomosaic imagery and remote sensing techniques.
- Drone data analysis will be undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.

- These values will be categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, will then be calculated.
- Investigate other environmental factors that may affect results i.e. amount of rainfall between October – April compared to rainfall amounts based on baseline studies to discern environmental factors.

Frequency

- The drone survey will occur biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring during 2022, then the monitoring will be reduced to annual (in the late dry season only).

2.2.2 Record keeping

- Vegetation monitoring database comprised of:
  - The riparian vegetation area size (ha) based on drone mapping for each drone survey.
  - VARI calculations for each survey conducted including varying colour bands and associated class intervals, the area (ha) that occurs within the class intervals and a percentage (%) of pixels that lie within these class intervals.
  - Additional observations that may need to be recorded if further on-ground investigation is require.
- Spatial data
  - All drone images captured during the drone surveys organised in folders.
  - A zip-file of all tiff files derived from drone surveys (both orthomosaic and plant health image).

2.2.3 Data analysis

Before After/Control Impact (BACI) approach will be applied by performing statistical analysis (VARI) to test whether there is a significant difference between the baseline health data and the riparian vegetation health based on ongoing drone survey assessments.

2.3 Riparian vegetation site assessments

2.3.1 Objective

Monitoring and evaluating riparian vegetation diversity and composition at established vegetation sites within ZOI, and an additional site established outside of the ZOI (reference site) to detect changes in riparian vegetation according to diagram presented in Figure 4 (Eamus, D., & Lamontagne 2006).

2.3.2 Methodology

Site selection

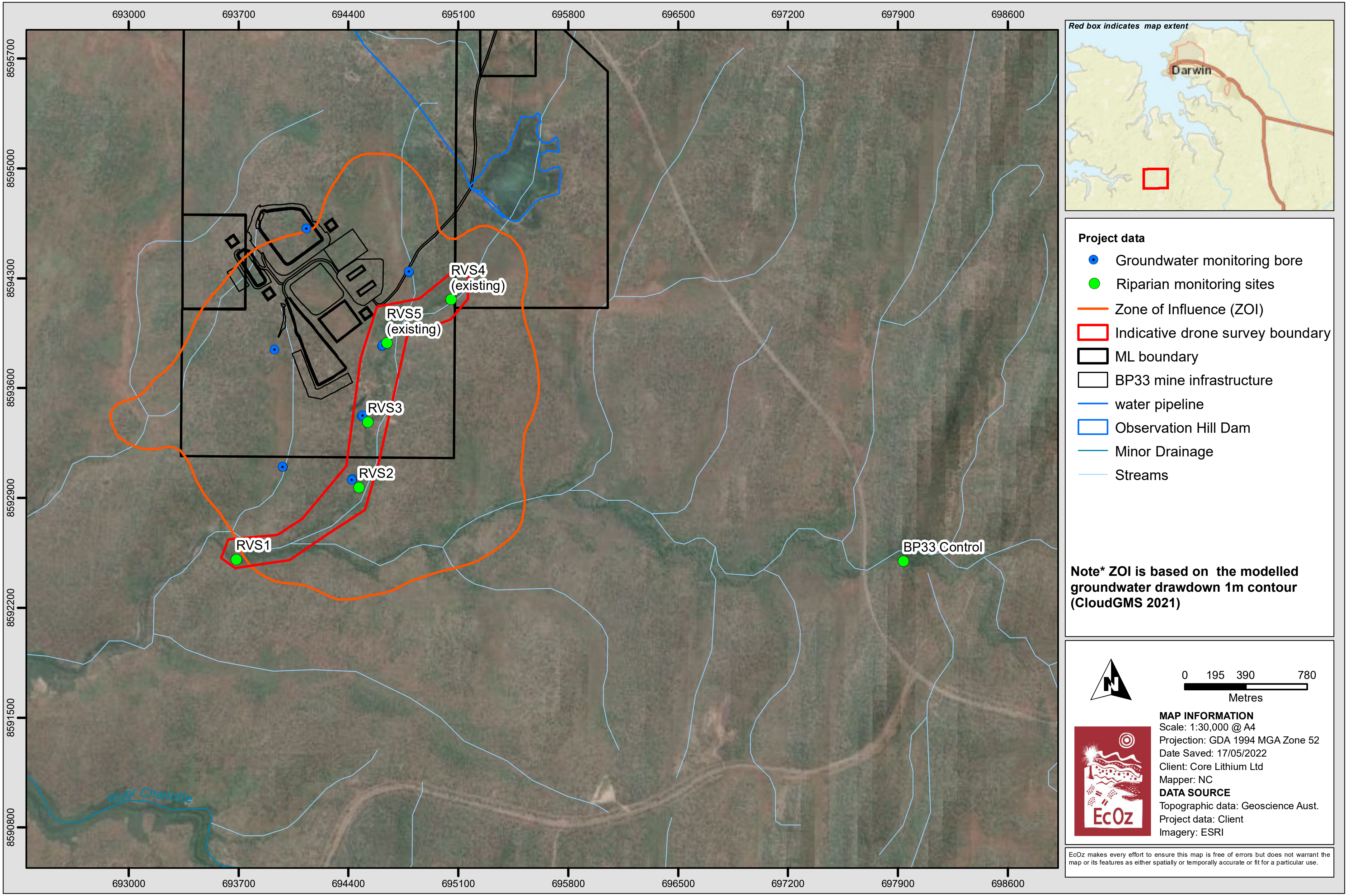
- Two existing sites RVS4 and RVS5 will continue to be monitored using the updated monitoring method within this RVMP. Site RVS4 has been kept in the monitoring plan to detect immediate

impacts from reduced SW flows downstream OHD. Existing site RVS5 has been retained as it is nearby a groundwater monitoring bore.

- Three new monitoring sites (RVS1, RVS2 and RVS3) will be established downstream of OHD within the ZOI (Figure 5). The location of these sites are suitable for monitoring as they lie within the potential GDE areas, align near existing bores for groundwater level monitoring (RVS3 and RVS2) and spatially correspond to immediate groundwater drawdown impacts (RVS3 located closest to the underground) and longer term potential impacts (RVS1 located near the 1m contour) (Figure 5).
- One new reference site upstream of Charlottes Creek (BP33 Control), in a similar riparian zone within the potential GDE area will be established with baseline monitoring commencing post-wet season 2022 (Figure 5). This site is outside of the predicted ZOI. The site was selected using various resources including up to date aerial imagery, mine components, and Land Units of the Greater Darwin Region (Fogarty et al. 1984).
- Sampling site locations for other BP33 project studies, such surface water, groundwater and biota monitoring have also been considered when selecting the new riparian vegetation monitoring sites. The precise locations will be verified in field during the 2022 post wet season survey.

Frequency

- Monitoring is to occur at all sites biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring, then monitoring will be reduced to annual (in the late dry season only).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 6. Map of all baseline monitoring sitesv2.mxd

Figure 5. Map of proposed riparian vegetation monitoring sites, indicative drone imagery boundary and modelled groundwater drawdown 1m contour

Vegetation monitoring

Vegetation site assessment monitoring methods have been adopted utilising the potential consequences of the groundwater drawdown affect as presented in the diagram outlined Figure 4. As indicated, the effect may take several years before physical changes become apparent. Monitoring methods are outlined below:

- A plot size of 20 x 20m will be established at each new riparian monitoring site, using star pickets. Existing plots RVS4 and RVS5 will be re-monitored at established plots (existing star pickets present).
- In each plot the dominant layer/emergent layer species will be recorded; this includes all seedlings (woody plants under 1m in height), saplings (woody plants between 1m and 3m high and < 2cm diameter at breast height, or DBH) and trees (woody plants with stems ≥ 2cm DBH and greater than 3m high) will be identified (both native plants and invasive plants included). For each individual the height will be estimated and the % cover will be measured. All individual woody plants within the plot will also be marked alive or dead, whether the plant is fruiting/flowering. Note, deciduous trees will not be recorded as dead during the dry-season monitoring.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) will be tagged on hand held GPS for future ongoing measurements. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* (observed at RVS4, RVS5).
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) will be recorded. The results from this method will be used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation will be recorded to a standard that is equivalent to Level 5 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity will be monitored by traversing along a 100m transect from the middle monitoring site and visually estimate the canopy cover (or by using a densitometer) of the native vegetation to indicate how continuous the canopy cover is along the transect. Note, a break in the continuity must be at least 5 m between tree crowns and span the entire width of the transect (Figure 6). If one tree is missing within a wide riparian zone it will not be counted as a break in the canopy continuity because the break must span the entire width of the riparian zone.

Table 2-1 summarises monitoring methods and how they will be used to measure the potential consequences of the reduction in surface flows and/or groundwater drawdown.

Table 2-1. Summary of monitoring methods that will be used to measure potential impacts of the reduction of surface water flows and groundwater drawdown

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree tagging	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 5 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

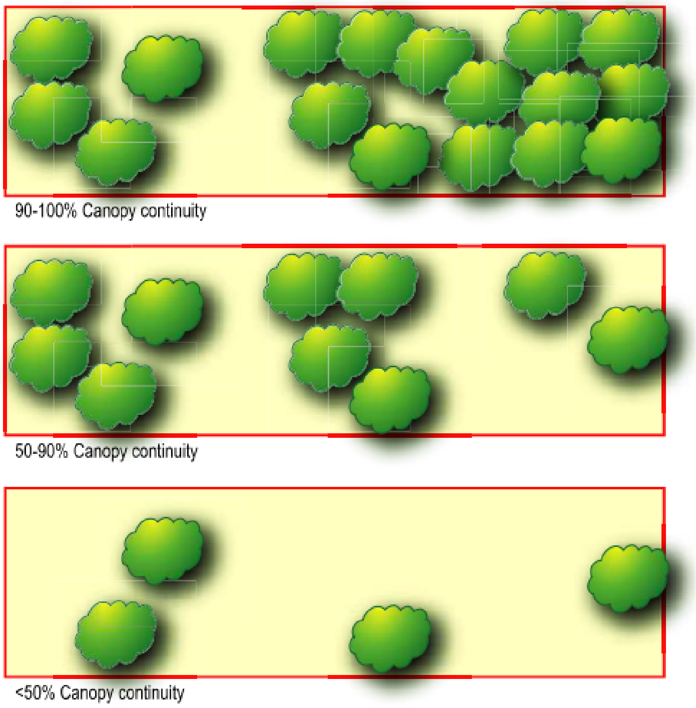


Figure 6. An example pictorial used for measuring canopy continuity (Dixon & Douglas 2015).

Photo point monitoring

- Four cardinal photo monitoring points (north, east, south, west) will be obtained within each plot.

2.3.3 Record keeping

- Vegetation monitoring database – comprised of seedling, sapling, and tree data for individual species and associated heights, DBH's and records of vegetation health e.g. % dead or sick plants.
- Ground cover data - percent cover and species richness.
- Photo monitoring point database.

2.3.4 Data analysis

The data collected based on monitoring methods outlined Table 2-1 will be statistically analysed using the Before After/Control Impact (BACI) approach. BACI will be applied by performing statistical analysis to test whether there is a significant difference between the baseline health data and riparian vegetation assessment data at the same sites, and riparian vegetation assessment data compared to reference site data.

Data captured for analysis includes:

- Species composition (%) using individual dominant/emergent plant data.
- Average heights of individual plants across riparian vegetation sites compared to reference site.
- Canopy cover (%) for each dominant, and emergent species across riparian vegetation assessment sites compared to reference site data.
- Plants alive or dead (%) across all riparian vegetation sites compared to reference site data.
- The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site.
- The ground cover percentages (vegetation type, soil, rock, litter).
- Type of ground cover percentages in the form of herbs/vines/grasses/ferns and sedges).

2.4 General observations

2.4.1 Objective

Monitoring of other environmental factors is critical as they are contributing factors that can severely impact the health of riparian vegetation. Objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is discussed below.

2.4.2 Other environmental factors

Weeds

Weed data collection will be conducted in accordance with the Northern Territory Weed Management Branch (WMB 2015), Northern Territory Weed Data Collection Manual.

The percentage cover of weed species (declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat will be visually estimated for each weed species.

A GPS will be used to record locations of identified weed species, and will record the following information:

- Weed name
- Distribution - size (20, 50 or 100m diameter)
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1-5, 1 (absent) to 5 (>50%)
- Growth stage (seedling, juvenile, adult)

- Seeded (has the weed seeded?)
- Treatment (has the weed been treated and if so with what method of treatment)
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data will also be recorded outside of the plots to obtain surrounding data while traversing along the riparian area to visit each monitoring site.

Fire - broad scale and site based monitoring

Broadscale

Fire scar mapping and scoring will be determined by drone survey and mapped with NAFI each year to investigate frequencies and severity across the mapped riparian area.

At each plot an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and for recently burnt sites the severity will be scored from 1 to 4. Categories for characterisation of fire are:

- No evidence of fire
- Evidence of groundcover fire only
- Evidence of burnt saplings
- Evidence of fire in canopy layer.

Erosion - broad scale and site based monitoring

Broadscale

- Monitoring the presence of erosion (on a broader scale basis) may be more effective using remote sensing with the use of the drone imagery captured as per section 2.2. Monitoring erosion using monitoring plots can often mean that issue areas can be missed.
- It is recommended to flag any potential erosion issues identification with aerial imagery and follow-up with on-ground monitoring so that erosion risks are to be measured and remedial actions implemented.

Site (plot) based

At each plot note the presence or absence of erosion will be recorded, and if present the following characteristics will be recorded:

- Types of erosion i.e. gullying, sheet erosion etc
- The amount of bare ground above
- Tree root exposure – any roots exposed due to disturbance
- Slumping
- Fallen trees/woody debris
- Presence of surrounding erosion
- Width of riparian zone – measure or estimate the width of the riparian zone (facing downstream) for both sides of banks.

Aquatic life

Presence of aquatic life within the water will also be recorded. This will involve a record of aquatic fauna and flora at the nearest water access point from each of the vegetation monitoring plots.

Surface water flows

Presence of water flows at the time of surveying will be documented. Surface water flows will be assessed in accordance with the surface water flows monitoring plan (WRM 2022).

Sedimentation

Presence of sedimentation within the water and on the riparian vegetation.

Contamination

- Presence of potential contamination (foam/scum/oils) and odour will be documented.

Climatic conditions

Weather observation will be documented during the monitoring. The annual rainfall, evaporation and temperature will be recorded from the same station and discussed for survey data comparison.

The following monitoring will be undertaken in accordance with the Grants and BP33 water management plans:

- surface and groundwater quality
- sediment monitoring
- macroinvertebrate monitoring
- groundwater levels will be assessed in accordance with the GDE Management plan (Groundwater Enterprises and RDM Hydro 2022).

2.4.3 Record keeping

All observations and data captured will be uploaded after each monitoring event, mapped as required and all records maintained in excel database.

3 MONITORING SCHEDULE

Table 3-1 outlines the RVMP schedule, prior to any significant disturbance and for the duration of the OHD SWEL, BP33 life of mine and three years post operations when the groundwater levels are predicted to return to pre-mining conditions (CloudGMS 2021).

Table 3-1. Riparian vegetation monitoring schedule

Monitoring	When	Monitoring undertaken	Frequency of monitoring	Locations
Baseline drone survey	End of Wet season (May) and end of dry season (October) 2022	Drone flight path to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Baseline riparian vegetation site assessment survey	End of Wet season (May) and end of dry season (October) 2022	Site assessment at all identified locations to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Drone survey	End of dry season (October) 2023 onwards	Drone flight	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Riparian vegetation site assessment survey	End of dry season (October) 2023 onwards	Site assessments	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control

4 PERFORMANCE INDICATORS AND TRIGGERS

A trigger action response plan (TARP) has been detailed in Table 4-1 below. The TARP incorporates triggers and responses from the surface water monitoring program (WRM 2022) and GDE Management Plan quantitative triggers and limits and/or adaptive management actions.

Table 4-1. Trigger action response plan

Level	Trigger	Monitoring Performance Indicator	Action	Response
Level 1 (normal)	No reduction in riparian vegetation extent and/or structure/ composition compared to baseline	Drone: • vegetation biomass using VARI analysis comparable to baseline mapping. Riparian vegetation site assessment: • No change in in general vegetation health compared to reference sites i.e. no tree mortality or physical changes to health of plants through the use of on-ground assessment and photo monitoring points	• No action required	• No response required
Level 2 (early warning)	10% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 10% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 10% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 10% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 10% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 90% of the dominant species present within each strata)	• Continue to monitor in accordance with RVMP • Investigate other potentially contributing environmental factors and likely reason for reduction in riparian vegetation extent. • Conduct drone monitoring in GDE reference site • Implement action in surface water flows monitoring program (WRM 2022) TARP Level 2. • Investigate management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022).	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 2. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		• Tree canopy continuity – there is no greater than 10% reduction in tree canopy cover (%) along transect compared to the representative reference sites		
Level 3a (elevated risk)	25% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 25% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 25% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 25% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 25% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 75% of the dominant species present within each strata) • Tree canopy continuity – there is no greater than 25% reduction in tree canopy cover (%) along transect compared to the representative reference sites	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Further investigate extent of riparian vegetation reduction within ZOI, including assessment of the drainage line flowing east to west within the ZOI. • Conduct biannual riparian vegetation site assessment (end of wet season and end of dry season) and compare seasonal variability to 2022 baseline data.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Report on the outcomes of the investigation of riparian vegetation health within ZOI to regulator. • Report on the outcomes of the seasonal variability (additional monitoring at end of wet season and dry season) to regulator. • Report on outcomes of the investigation of management actions as outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) to the regulator.
Level 3b (imminent Risk)	50% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 50% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 50% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 50% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Further investigate extent of riparian vegetation reduction outside 1m contour groundwater drawdown ZOI. • Revise BP33 mine closure plan (MCP) and rehabilitation management plan (RMP) to	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		representative reference sites • Tree mortality – there is no greater than 50% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 50% of the dominant species present within each strata) • Tree canopy continuity – there is no greater than 50% reduction in tree canopy cover (%) along transect compared to the representative reference sites	include reinstatement of habitat values in the affected riparian areas and monitoring of ecosystem recovery and submit to Controller or Water Resources and NT EPA CEO for approval.	
Level 4 (exceedance of approved limits)	Loss of >3.6 ha of identified GDE vegetation extent and/or structure/ composition	Drone: • There is no greater than a 100% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 100% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 100% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 100% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 does not align with the representative reference site descriptions (i.e. indicating new ecosystem structures and functions have appeared) • Tree canopy continuity – there is no greater than 100% reduction in tree canopy cover (%) along transect compared to the representative reference sites	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 4. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Implement approved RMP. • Notify NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 4. • Report on the outcomes of the actions undertaken to the regulator.

6 REVIEW PROCESS AND MANAGEMENT

A review process will be undertaken annually based on the biannual riparian vegetation monitoring to ensure continuous improvement of the monitoring program and in accordance with condition 4.1 of the SWEL (8151018) be implemented immediately following the DEPWS Water Resources Controller's approval. Data management and reporting is key to inform the review process.

The management during riparian monitoring is related to the management of water availability for the riparian vegetation/GDE's. Refer to management outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) and the Surface Water Management Plan (WRM 2022).

7 REPORTING

A monitoring reporting will be developed as per condition 4.2 of the SWEL (8151018) and include *data collected in accordance with the monitoring program under condition 4.1 for the previous water accounting year (1 May to 30 April)* and *discuss the measured and modelled impacts of water taken from SWEL (8151018) on the downstream riparian vegetation.*

In accordance with the NT EPA (2022), LDGNT will *notify the NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.*

The plan will be submitted to the:

- NT Department of Environment, Parks and Water Security (DEPWS) Controller of Water Resources Division as a Condition 4-1 of the SWEL (8151018)
- Chief Executive Officer (CEO) of the DEPWS for review and approval at least 3 months before substantial disturbance at BP33, as per condition 6-2 of the NT EPA BP33 Draft Environmental Approval (NT EPA 2022) as part of the GDE Management Plan.
- NT Department of Industry, Tourism and Trade (DITT) as appendices to BP33 Mine Management Plan (MMP).

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APPENDIX A RIPARIAN VEGETATION ASSESSMENT REPORT

Mangrove and Riparian Vegetation Assessment Grants Lithium Project

Core Lithium

www.ecoz.com.au

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1 INTRODUCTION

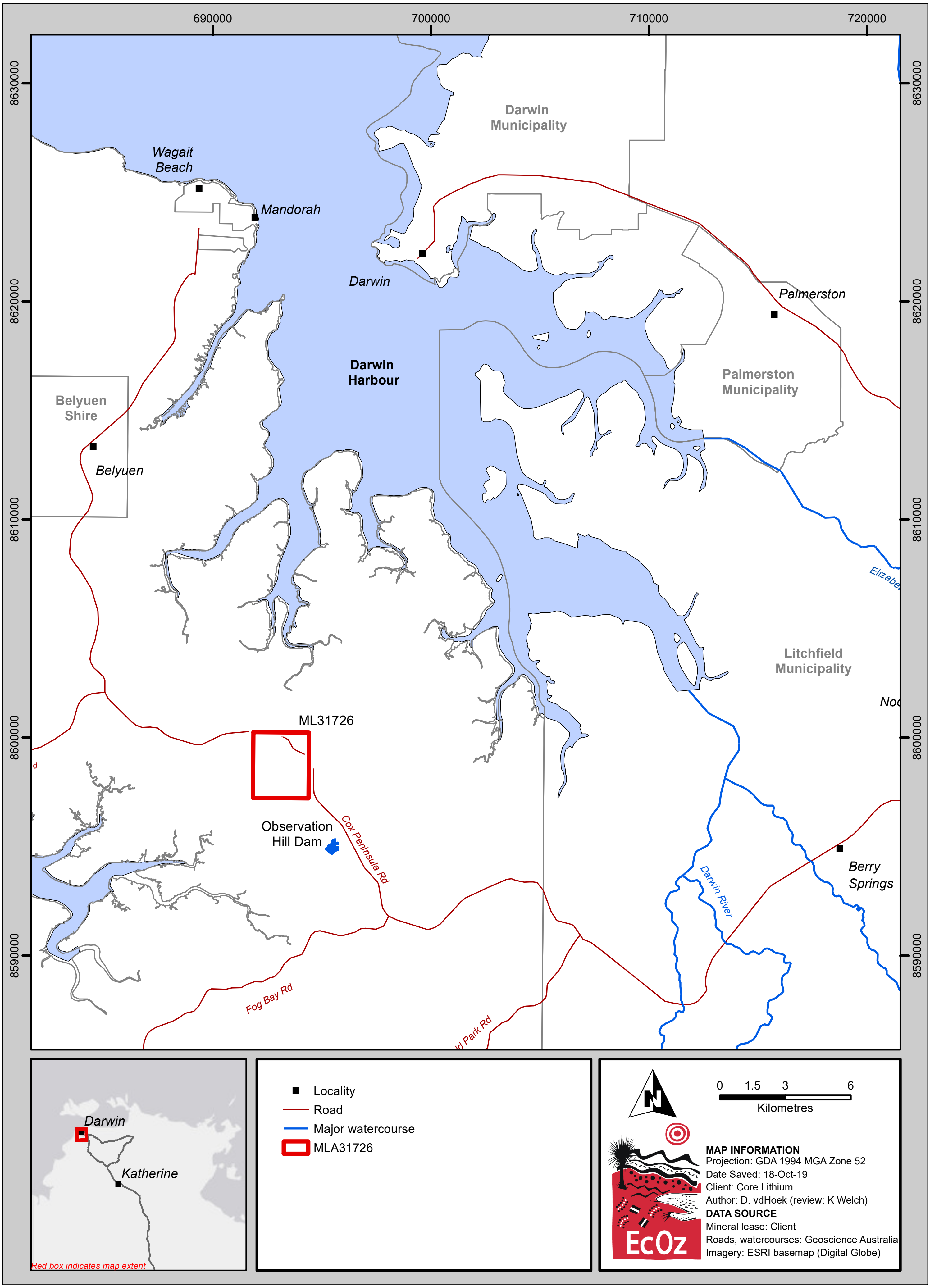
Core Lithium Ltd proposes to develop the Grants Lithium mine on the Cox Peninsula, approximately 90 km by road from Darwin CBD, or 25 km south as the crow flies, Northern Territory (Figure 1). The project area is located south of the Cox Peninsula Road, approximately 36 km west of the township of Berry Springs.

The proposal was assessed under the *Environmental Assessment Act* at the level of an Environmental Impact Statement (EIS). Surveys and assessments undertaken for the EIS process identified riparian mangrove communities downstream of the mine site and closed riparian vegetation communities downstream of the Observation Hill Dam (OHD) water supply that could be susceptible to impacts associated with changes to surface water flows. Both riparian and mangrove communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

To allow for future monitoring of impacts associated with mining activities on Core Lithium mineral leases, EcOz Environmental Consultants (EcOz) was engaged to map mangrove and riparian community boundaries and collect baseline information about community structure and condition prior to development. This report presents the survey methods and findings, including:

- Site selection.
- Methodology used to undertake drone aerial surveys and field surveys.
- Drone captured orthomosaic images (5cm/pixel) of the selected study sites
- Vegetation mapping at 1:500 scale of riparian vegetation boundaries
- Vegetation community descriptions for each mapped vegetation type

The baseline information documented in this report will allow future comparative assessments to detect any major changes in vegetation structure and composition because of project activities.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 1. Map of the project location.mxd

Figure 1. Map of the project location

2 SITE SELECTION

The objective of the baseline assessment was to record vegetation characteristics and condition of the sensitive vegetation communities downstream of the project area. The survey areas were determined with reference to the following spatial datasets:

- Proposed mine site components footprint (Core 2019)
- Digitalglobe aerial imagery (ArcGIS 10.6.1)
- Ground Water Dependant Ecosystem Atlas Dataset (BOM-GDE 2019)
- Land units of the Greater Darwin Area (Fogarty et al. 1984).

Assessment of the above datasets identified two riparian sites downstream of the project area. Mangrove communities associated with the West Arm of Darwin Harbour occur downstream of the proposed mine site. A closed riparian vegetation community occurs downstream of the OHD water supply, which based on community structure, is a potential Groundwater Dependent Ecosystem (GDE). The locations of the two selected study areas are shown in Figure 2.

2.1 Mangrove Ecosystem

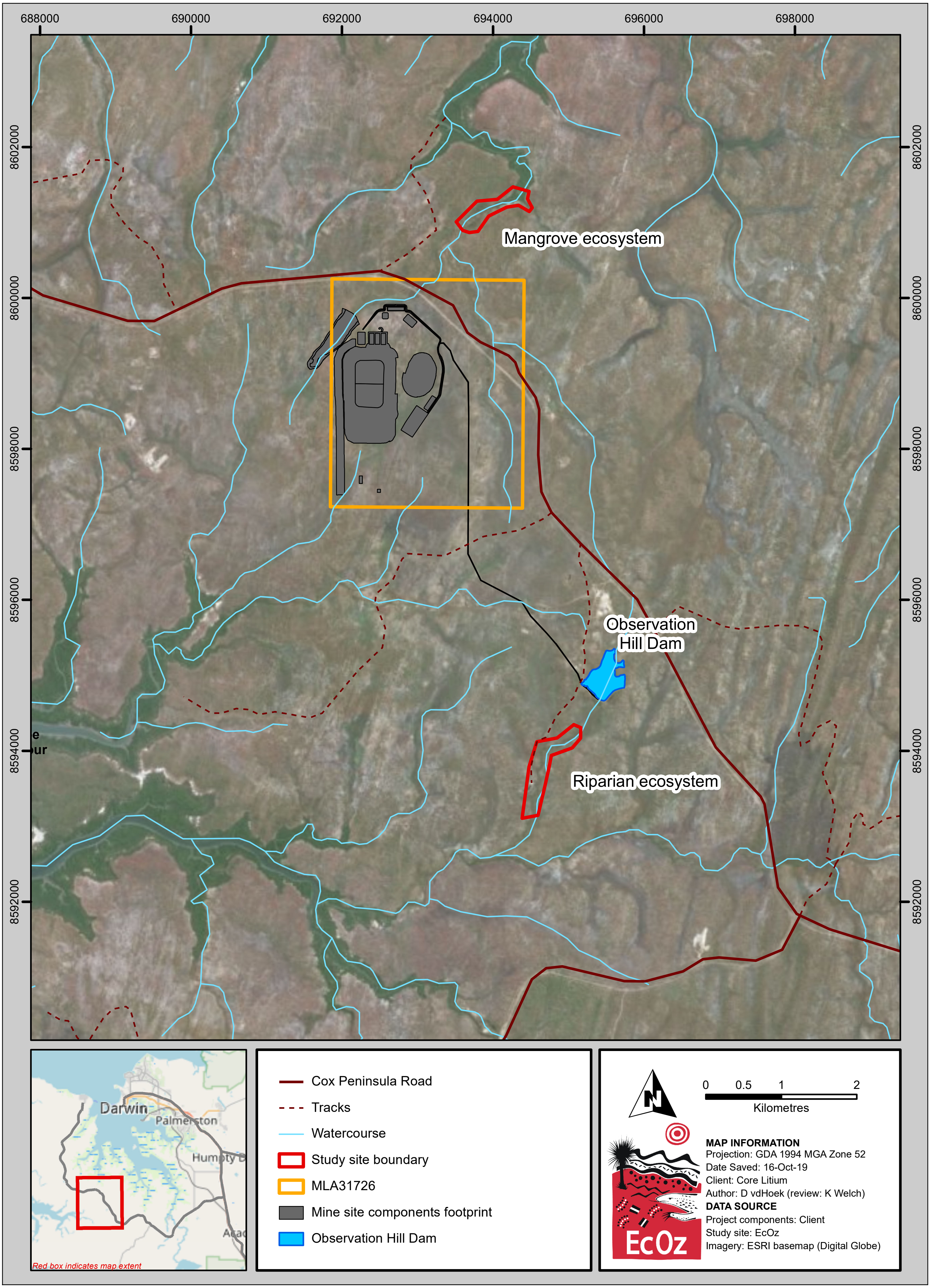
The proposed mine site and dam are located within the catchment of an ephemeral creek that flows into the West Arm of Darwin Harbour approximately 2.6 km to the north. Approximately 1.4 km north-east of the Mineral Lease (ML) boundary, the riparian zone of the creek supports mangrove vegetation. A baseline mangrove study site was established at this location.

Three vegetation survey plots were located within the mangrove study site, representing riparian, swamp and mangrove communities. The study site is located on two land units. The riparian and swamp survey sites are located within land unit 6b – Drainage System, and the mangrove survey site is in land unit 9b – Estuarine Fringes (Fogarty et al. 1984), see Figure 3.

2.2 Riparian Ground Water Dependant Ecosystem

The ephemeral drainage line downstream of OHD supports closed riparian vegetation identified as a potential GDE. The creek flows into the Charlotte River approximately 3 km downstream of the OHD wall, and discharges into Bynoe Harbour. The OHD is an artificial aquatic system that provides year round freshwater seepage into the downstream riparian system. Impacts to either the drainage system or the OHD can potentially result in impacts to downstream riparian vegetation communities.

One vegetation survey plot was located on the receiving channel of each surface water inflow to the riparian vegetation community allow future assessments to determine the potential upstream source of impact. A third survey plot was located downstream of both potential upstream inputs. The riparian study site is situated on land unit 5b1 – Drainage System. A neighbouring land unit 5a – Alluvial Plains is the source of surface water inflows into the study area (Fogarty et al. 1984), see Figure 4.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 2. The location of the riparian study sites.mxd

Figure 2. The location of riparian study sites in relation to the project infrastructure

3 METHODS

Assessment of the riparian vegetation was undertaken in two stages. Stage 1 involved an aerial drone survey to record an up to date orthomosaic photo of riparian vegetation boundaries. Stage 2 involved a ground field survey to assess vegetation structure and composition. A riparian vegetation map was created with reference to the drone orthomosaic image and mapped vegetation types were described with reference to the field vegetation assessments. The methods used for survey and mapping of the study sites are outlined in the sections below.

3.1 Drone survey

A drone survey was undertaken on the 13th of March, towards the end of the annual wet season. The timing of the survey was selected to record maximum vegetation growth within the survey area. Surveys were flown at both the Mangrove and Ri[arian Ground Water Dependant Ecosystem study sites. The drone survey was conducted by EcOz Chief Remote Pilot, David van den Hoek, according to the EcOz Remotely Piloted Aircraft Operations Manual. A DJI Phantom 4pro drone was used to capture images at a height of 75m (75% front overlap and 65% side overlap) using the DroneDeploy app. Images were then uploaded to the DroneDeploy website for processing and orthomosaic images were exported. Two 5cm pixel images were exported for each survey site, a colour orthomosaic and a plant health image, displayed in red, green and blue.

3.2 Vegetation mapping

Vegetation boundaries were delineated at a scale of 1:500 using the 5cm pixel orthomosaic aerial images captured during the drone survey. Individual trees, vegetation cover and soil colour was identified from the imagery to inform the mapping of vegetation boundaries. The following riparian vegetation types were mapped within each of the study sites:

Mangrove Ecosystem (downstream of mine site)

- Mangrove
- Riparian
- Swamp

Groundwater Dependant Ecosystem (downstream of OHD)

- Riparian

3.3 Field survey

Vegetation survey plots were located within each of the mapped riparian vegetation types. A baseline vegetation assessment was undertaken on the 5th of June 2019 by EcOz staff trained in botanical survey, Stephen Reynolds and Nicole Clark. Vegetation community assessments were undertaken based on the *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst et al. 2007).

Six vegetation survey plots, three in each study site, were surveyed to characterise vegetation types to a standard equivalent to NVIS Level V. Assessments were undertaken with a 20 m x 20 m quadrat and for each stratum (upper, mid and ground), three dominant species were recorded (but an attempt was made to record all species), cover was estimated and height values measured. Photographs were taken at the four cardinal directions for each site and NT declared weeds were recorded if present.

4 RESULTS

Vegetation maps were created to record the baseline boundary locations of riparian vegetation types situated within the study sites. The resulting maps and associated information is presented in the sections below.

4.1 Mangrove Ecosystem

The mangrove ecosystem study site records the ecotone between a freshwater creek and side swamp and a marine influenced mangrove community. The site is approximately 950 m long and 250 m wide, with an area of 23.2 ha. The boundaries of three riparian vegetation communities were delineated within the study site. Vegetation type descriptions and unit areas are provided below in Table 1. The vegetation map is presented in Figure 5. A table showing the results of field data collected at each survey site is present in Appendix A.

Incidental observations recorded during the survey noted that mangrove vegetation communities were generally in good condition. No major weed populations or fire impacts were observed within the mangrove and riparian communities. However, recent impacts were recorded within the landward swamp community where evidence of an off-road race track were observed. A number of weeds were also recorded within the swamp community, including Hyptis (*Hyptis suaveolens*), declared Class B – Spread to be controlled, under the Northern Territory *Weed Management Act* and environmental weeds including Annual mission grass (*Cenchrus pedicellatus*), Calopo (*Calopogonium mucunoides*) and Stinking passionfruit (*Passiflora foetida*).

Table 1. Mangrove Ecosystem - Riparian vegetation descriptions and unit areas

Vegetation Type	Vegetation Description	Survey site	Area (ha)
Mangrove	*Lumnitzera racemosa, Bruguiera exaristata, Avicennia marina* low open forest, over *Fimbristylis* sp. and *Xerochloa imberbis* mid sparse tussock grassland	MVS1	5.18
Riparian	*Melaleuca viridiflora* mid woodland over *Acacia plectocarpa* mid open shrubland over *Germainia grandiflora* mid tussock grassland	RVS2	0.76
Swamp	*Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa* mid woodland over *Lophostemon lactifluus* mid open shrubland over *Sorghum intrans* mid tussock grassland	SVS3	1.5

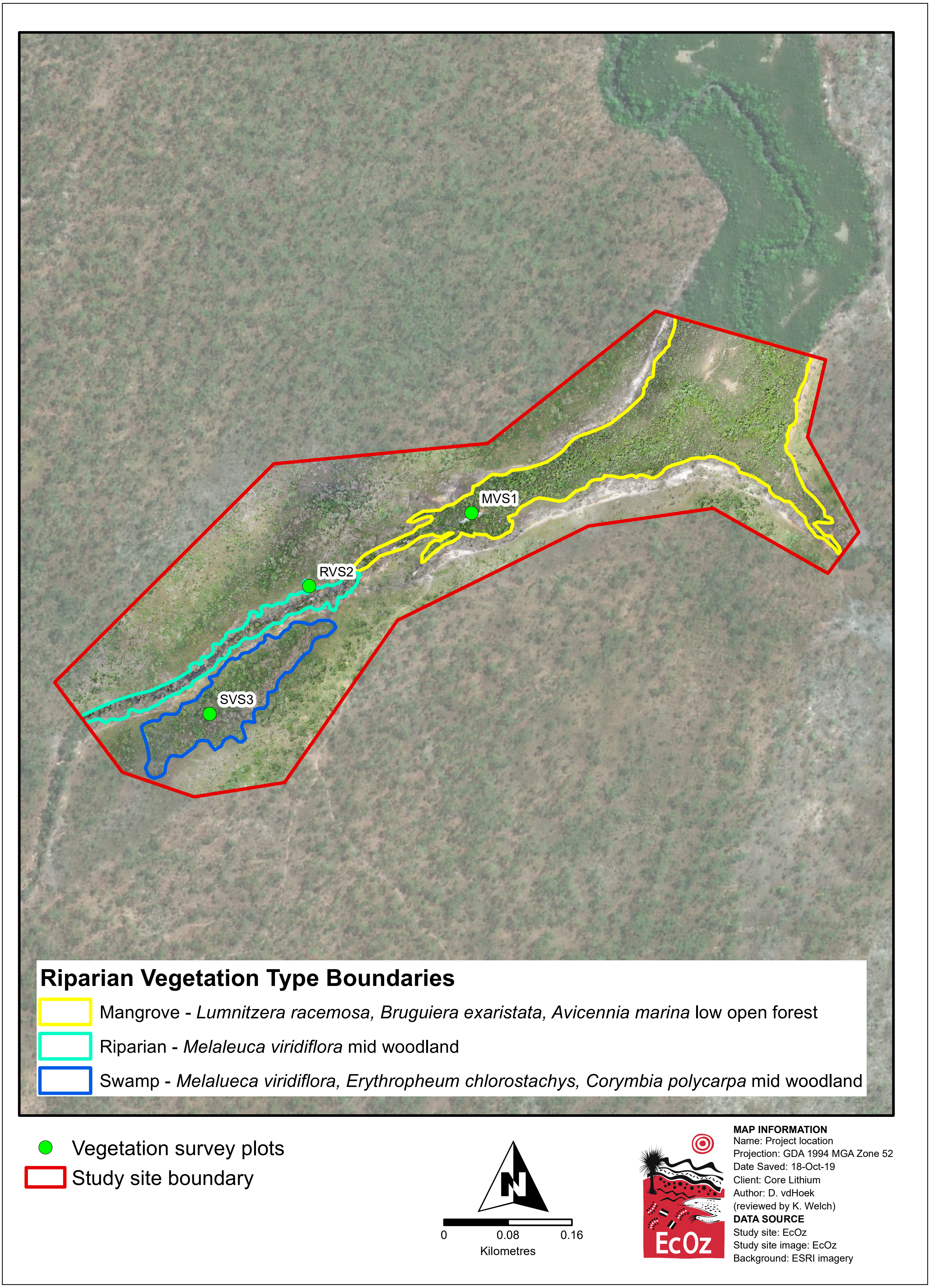
4.2 Riparian Groundwater Dependant Ecosystem

The riparian GDE study site is approximately 1.45 km long and 250 m wide, with an area of 33 ha. The boundary of one riparian vegetation community type was delineated within the study site. Vegetation type descriptions and unit areas are provided below in Table 2. A vegetation map is presented in Figure 6. A table showing the results of field data collected at each survey site is presented in Appendix A.

At the time of survey, riparian vegetation was observed to be in good condition. No major weed populations or fire impacts were recorded.

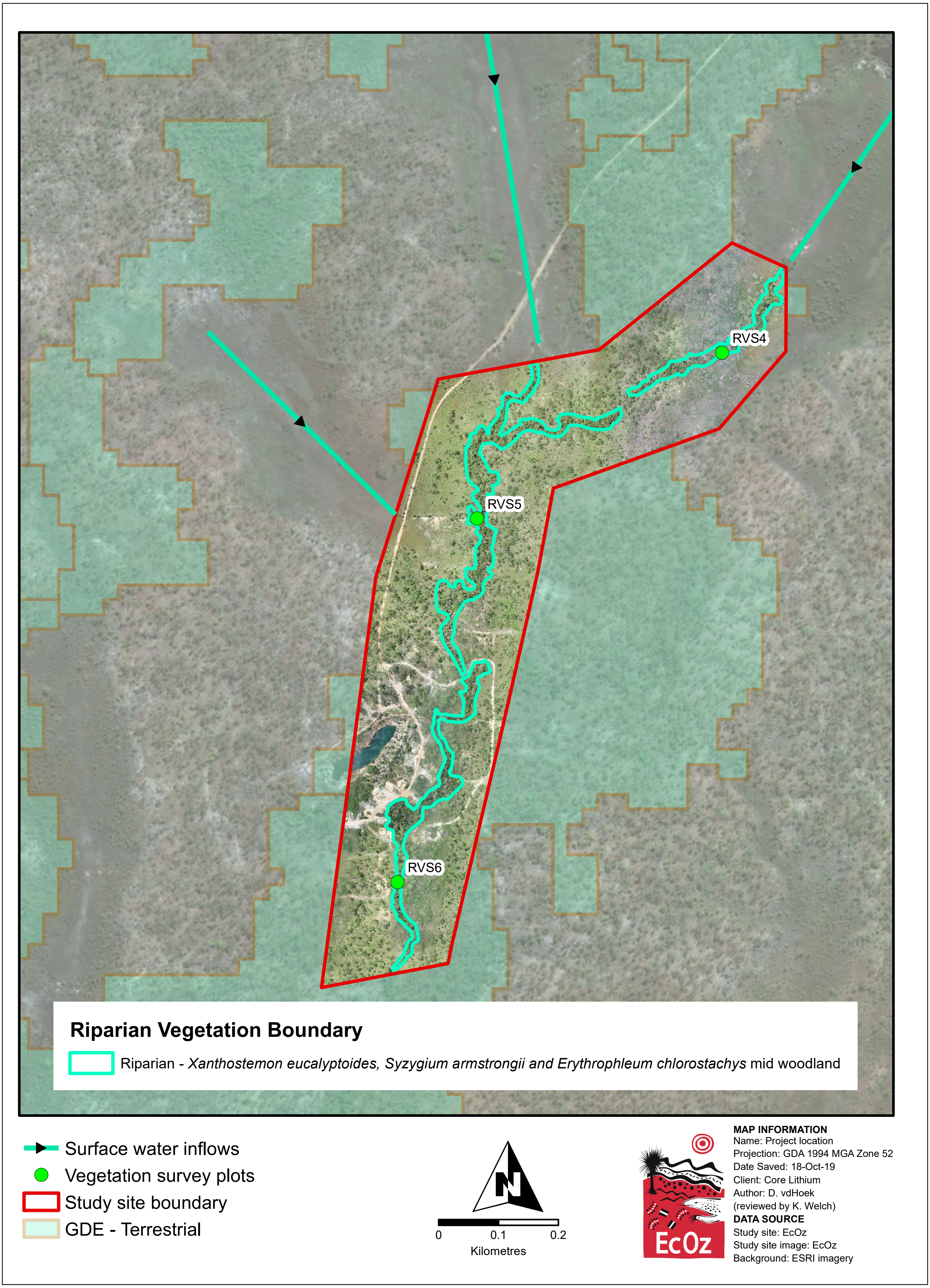
Table 2. Groundwater Dependant Ecosystem – Riparian vegetation descriptions and unit areas

Vegetation Type	Vegetation Description	Survey sites	Area (ha)
Riparian	*Xanthostemon eucalyptoides, Syzygium armstrongii* and *Erythrophleum chlorostachys* mid woodland over *Pandanus spiralis, Helicia australasica* and *Carallia brachiata* mid shrubland over *Eriachne triseta* mid tussock grassland	RVS4, RVS5, RVS6	3.62



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 3. Mangrove ecosystem vegetation boundaries.mxd

Figure 3. Mangrove ecosystem vegetation boundaries



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 4. GDE vegetation boundaries.mxd

Figure 4. Groundwater dependant ecosystem vegetation boundaries

5 CONCLUSION AND RECOMMENDATIONS

The assessment of vegetation boundaries presented within this report provides a baseline spatial dataset from which to monitor changes in riparian vegetation boundaries within the study sites. The baseline assessment indicates that vegetation communities within the study sites are in good condition, with limited pre-development disturbance. This is with the exception of the swamp community, which occurs downstream of the mine site in the West Arm catchment. Weeds and impacts from off-road racing tracks were observed within this vegetation community.

Future monitoring should repeat drone and vegetation surveys at the same time of the year that baseline surveys were conducted. This will allow for the capture of vegetation data in a similar seasonal state and enable more accurate analysis and interpretation of results.

When analysing the results of future drone survey against the baseline dataset, any significant retraction in riparian vegetation patch boundaries should trigger further assessment to determine the extent and potential cause of impact i.e. is the change confined to the impacted watercourse or occurring more broadly. This may require re-survey of vegetation plots to determine if there has been a change in vegetation structure and composition in response to vegetation boundary impacts.

Changes in vegetation structure and composition along the landward edge may indicate changes in surface and or groundwater flows entering those communities. However, further contextual assessment will be required as these changes could also occur because of bushfire and weed invasion unrelated to the project activities

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APPENDIX A FIELD VEGETATION PLOT DESCRIPTIONS

Site MVS1 – *Lumnitzera racemosa, Bruguiera exaristata, Avicennia marina* low open forest over *Fimbristylis* sp. and *Xerochloa imberbis* mid sparse tussock grassland
NVIS Code: T6c
Location (GDSA94, z52): 694035E, 8601220N
Upper 1: Mid open forest dominated by *Lumnitzera racemose* and *Avicennia marina*
Mid 1: *Bruguiera exaristata, Avicennia marina* with isolated *Excoecaria ovalis*
Ground 1: Sparse tussock grassland dominated by *Fimbristylis* sp. and *Xerochloa imberbis*
 
 
Other species **Upper stratum (U1):** - **Mid stratum (M1):** **Ground stratum (G1):** -
Land unit (Greater Darwin 25K) – 9b Marine
Landform: Mangrove flat near tidal creek
Soils: Brown sandy clay surface soils, some pebbles present ranging in size (2 – 6 cm)
Drainage: Very poorly drained
Fire history: No fire impact
Weeds: Absent
Disturbance: None
Hydrology: tidal, towards upper tide limit. Large pool located adjacent to vegetation assessment site – approximately 4 m wide.

Site RVS2 – *Melaleuca viridiflora* mid woodland over *Acacia plectocarpa* mid open shrubland over *Germainia grandiflora* mid tussock grassland

NVIS Code: T7i

Location (GDA94, z52): 693834E 8601132N

Upper 1: Mid woodland dominated by *Melaleuca viridiflora*

Mid 1: Mid open shrubland dominated by *Acacia plectocarpa, Lumnitzera racemosa* (on the edge of creek) and *Avicennia marina* (in creek channel)

Ground 1: Mid tussock grassland dominated by *Germainia grandiflora, Dapsilanthus* sp. and *Xerochloa imberbis*




Other species
Upper stratum (U1): -
Mid stratum (M1): *Thespesia populneoides*
Ground stratum (G1): - *Asteraceae sp.*, *Wrightia saligna, Flagellaria indica, Acrostichum speciosum, Gymnanthera nitida, Lindernia lobelioides, Diospyros littorea*

Land unit (Greater Darwin 25K) – 6b Drainage system

Landform: Flat, adjacent to creek channel

Soils: Brown clay loam; rocks and pebbles common in channel adjacent to site

Drainage: Poorly drained

Fire history: 2+ years since last fire causing minimal impact

Weeds: None

Disturbance: Motorbike tracks nearby

Hydrology: Some pools nearby, inundated on large high tides and with freshwater during wet season

Site SVS3 – *Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa* mid woodland over *Lophostemon lactifluus* mid open shrubland over *Sorghum intrans* mid tussock grassland

NVIS Code: T7i

Location (GDA94, z52): 693708E, 8600969N

Upper 1: Mid woodland dominated by *Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa*

Mid 1: Mid open shrubland dominated by *Lophostemon lactifluus, Clerodendrum floribundum* and *Denhamia obscura*

Ground 1: Mid open tussock grassland dominated by *Sorghum intrans, Aristida* sp. and *Pandanus spiralis*




Other species

Upper stratum (U1): -

Mid stratum (M1): *Alphitonia excelsa, Grevillea decurrens*

Ground stratum (G1): - *Germainia grandiflora, Acacia difficilis,* Fern sp., *Themeda* sp., *Wrightia saligna, Livistona humilis, Osbeckia australiana, Dianella odorata, Brachychiton megaphyllus, Fern sp.1, Antidesma ghesaembilla*

Land unit (Greater Darwin 25K) – 6b: Drainage system

Landform: Lower slope, flat open depression

Soils: Brown sandy loam. Some quartz present near creek

Drainage: Poorly drained – some wet season inundation

Fire history: Last year (relatively low impact fire)

Weeds: Annual mission grass scattered near site. Patches of *Hyptis suaveolens*, *Calopogonium mucunoides* and *Passiflora foetida* recorded nearby

Disturbance: None

Hydrology: Wet season inundation

Site RVS4 – *Syzygium armstrongii and Xanthostemon eucalyptoides* mid open woodland over *Pandanus spiralis* mid shrubland over *Scleria lingulata* mid open tussock grassland
NVIS Code: T7r
Location (GDA94, z52): 695055E 8594164N
Upper 1: Mid open woodland dominated by *Syzygium armstrongii* and *Xanthostemon eucalyptoides*
Mid 1: Mid shrubland dominated by *Pandanus spiralis, Flagellaria indica* and *Helicia australasica*
Ground 1: Mid open tussock grassland dominated by *Scleria lingulata*, *Sorghum intrans* and *Eriachne triseta*
 
 
Other species **Upper stratum (U1):** *Lophostemon lactifluus* **Mid stratum (M1):** *Myrsine benthamiana, Melicope elleryana, Cyclophyllum schultzii, Carallia brachiata, Gmelina australis, Grevillea pluricaulis* **Ground stratum (G1):** *Melastoma malabathricum* (*polyanthum*), *Themeda triandra, Eulalia mackinlayi, Osbeckia australiana, Dianella odorata, Cheilanthes* sp
Land unit (Greater Darwin 25K) – 5b1: Drainage System
Landform: Flat, adjacent to creek channel
Soils: Black clay in channel
Drainage: Poorly drained
Fire history: Very recent adjacent (other side of the creek) but 2+ years since last fire at the site
Weeds: None
Disturbance: Some pig damage
Hydrology: Site situated adjacent to large pool (approximately 8 m x 15 m) 40 cm ~ 1m deep, steep bank (0.5 m).

Site RVS5 – *Xanthostemon eucalyptoides* mid woodland over *Leptospermum madidum* mid open shrubland over *Eriachne triseta* mid tussock grassland
NVIS Code: T6d
Location (GDA94, z52): 694646E 8593887N
Upper 1: Mid woodland dominated by *Xanthostemon eucalyptoides; Syzygium armstrongii;* and *Melaleuca viridiflora*
Mid 1: Mid shrubland dominated by *Leptospermum madidum; Helicia australasica; Carallia brachiata* and *Cyclophyllum schultzii*
Ground 1: Mid tussock grassland dominated by *Eriachne triseta, , Fern sp.2* and *Mnesithea rottboellioides*
 
 
Other species **Upper stratum (U1):** - *Melaleuca viridiflora; Syzygium armstrongii; Corymbia polycarpa* **Mid stratum (M1): -** *Pandanus spiralis; Helicia australasica; Acacia 'pellita'; Carallia brachiate; Cyclophyllum schultzii; Carpentaria acuminata,* **Ground stratum (G1):** - *Livistona humilis; Grevillea pluricaulis; Osbeckia Australiana; Mnesithea rottboellioides; Dianella odorata; Eulalia mackinlayi; Heteropogon triticeus, Fern sp.2 Cyperus sp., Themeda triandra; Germainia grandiflora; Philydrum lanuginosum*
Land unit (Greater Darwin 25K) – 5b1: Drainage System
Landform: open depression (watercourse/gully)
Soils: Brown loam sand. Clay in channel
Drainage: Poorly-very poorly drained
Fire history: unburnt-fire nearby
Weeds: Absent
Disturbance: Some pig disturbance
Hydrology: Some pools nearby, inundated with freshwater during wet season

Site RVS6 – *Erythrophleum chlorostachys* mid woodland over *Xanthostemon eucalyptoides* mid open shrubland over *Eriachne triseta* mid tussock grassland
NVIS Code: T7i
Location (GDA94, z52): 694513E 8593280N
Upper 1: Mid woodland dominated by *Erythrophleum chlorostachys*
Mid 1: Mid open shrubland dominated by *Xanthostemon eucalyptoides; Melicope elleryana; Carallia brachiate; Lophostemon lactifluus; Pandanus spiralis*
Ground 1: Mid tussock grassland dominated by *Eriachne triseta;* Fern *sp1*; *Xanthostemon eucalyptoides*
 
 
Other species **Upper stratum (U1):** - *Erythrophleum chlorostachys; Xanthostemon eucalyptoides; Corymbia polycarpa* **Mid stratum (M1):** *Xanthostemon eucalyptoides; Melicope elleryana; Carallia brachiate; Lophostemon lactifluus; Pandanus spiralis* **Ground stratum (G1):** - *Asteraceae sp., Wrightia saligna, Flagellaria indica, Acrostichum speciosum, Gymnanthera nitida, Lindernia lobelioides, Diospyros littorea; Mnesithea rottboellioides; Eulalia mackinlayi; Themeda triandra*
Land unit (Greater Darwin 25K) – 5b1: Drainage System
Landform: Lower slope adjacent to creek. Open depression from edge.
Soils: Brown clay loam
Drainage: Moderately well drained. Poorly drained FP. Very poorly drained channel seasonal creek.
Fire history: 2+ years since last fire causing minimal impact
Weeds: None
Disturbance: No visible impact
Hydrology: Seasonal freshwater in the creek during wet season

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Riparian Vegetation Monitoring Report – post dry-season 2023

Finniss Lithium Project

CORE LITHIUM

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1 INTRODUCTION

This document presents the methodology and results of the 2023 post dry-season survey of riparian vegetation downstream of Observation Hill Dam (OHD) and the BP33 underground lithium mine (BP33) within the Finniss Lithium Project, based on the monitoring schedule outlined in the Riparian Vegetation Monitoring Plan (RVMP) (EcOz 2022).

Riparian vegetation monitoring is required as a condition of the following approvals and licences:

- Environmental Approval 2020/001-001 for the BP33 underground lithium mine (Condition 6).
- SWEL 8151018 (Condition 4.1).

The RVMP was developed and implemented to monitor potential impacts associated with surface water extraction from OHD under Surface Water Extraction Licence (SWEL) 8151018 and operation of the Finniss Lithium Project, located on the Cox Peninsula (Figure 1-1). Riparian vegetation health downstream of OHD and surrounding BP33 could be affected by changes to:

- surface water flows associated with extraction of water from the Observation Hill Dam (OHD); and
- groundwater drawdown associated with dewatering of the BP33 underground mine.

1.1 Background

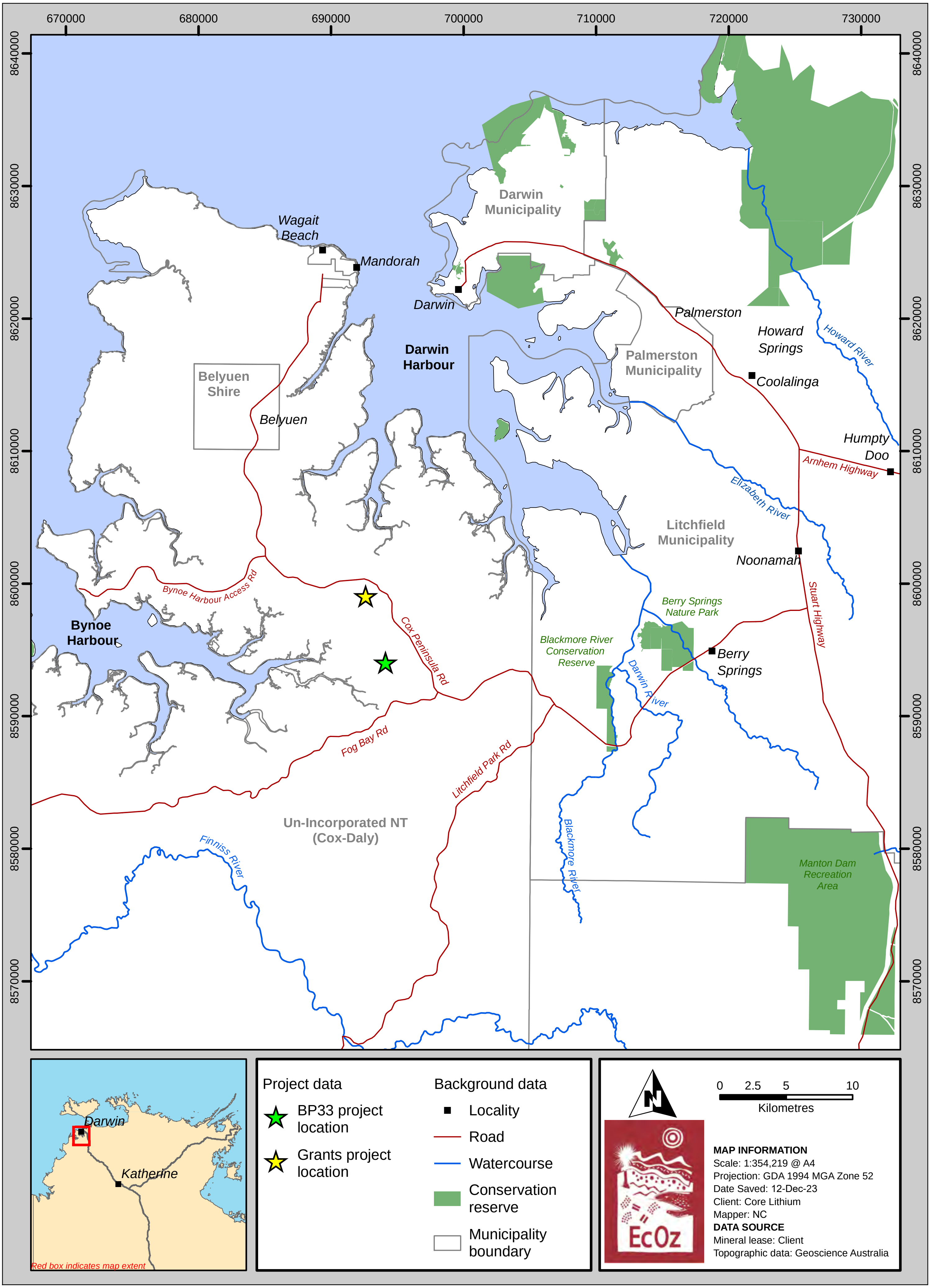
Survey and assessments undertaken for the Grants Environmental Impact Statement (EIS) identified the presence of an ephemeral drainage line downstream of OHD (drainage line BP1) which supports closed riparian vegetation identified as a potential Groundwater Dependent Ecosystem (GDEs). OHD has historically and continues to be used as a water source for exploration and mining projects in the area. BP33 is located approximately 2.5 km southwest of OHD.

BP33 has undergone significant development since the previous post-dry season monitoring event in October 2022. The excavation of the box cut commenced early August 2023 along with other early construction works including essential infrastructure - mine water dam storage, sediment basins, internal drainage and contractor area (EcOz 2022b). The entire development footprint approved under the Environmental Approval has been cleared.

Groundwater was intercepted in the box cut from late August 2023 and inflows have progressively increased as the depth of the box cut has increased, coinciding with the onset of the 2023/2024 wet-season. Dewatering of groundwater from the box cut commenced in early October 2023 when the construction of a Turkeys nest was completed. There is currently no information to indicate if dewatering activities of the box cut have resulted in groundwater drawdown. The volume of groundwater intercepted to date, has been relatively small (approximate inflow rate of 3L/s). Also of note, water from the BP33 Old Pit has been extracted to a very low level, similarly at OHD. Table 1-1 summarises the volume of water extracted from OHD. The record provided by Core Lithium (Grants) NT indicates water extraction commenced as early as 8 December 2021.

Table 1-1. Surface water extraction volume from Observation Hill Dam

Period	Water Usage (ML)
1 May 2022 - 31 October 2022	128.65
1 Nov 2022 - 30 April 2023	308.1
1 May 2022 - 30 April 2023	436.75
1 May 2023 - 31 October 2023	200.64



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19171 - BP33 NOI\01 Project Files\Report maps\Figure 1-1. Map of project location and regional setting.mxd

Figure 1-1. Location map of Finniss Lithium Project, BP33 underground lithium mine

1.2 Climate

The BP33 underground lithium mine lies within the wet-dry tropics. The wet season is typically November to March/April, and the dry season April to October. Figure 1-2 shows the average monthly rainfall generated for the area (using specific rainfall data obtained from Core Lithium site) indicating rainfall (mm) amount prior to the previous post dry-season survey in 2022, compared to the post dry-season survey in the recent 2023 results. There was greater rainfall (mm) prior to the 2022 survey (109.6 mm) combining September and October monthly rainfall, compared to rainfall amount prior to the 2023 survey (65.9 mm).

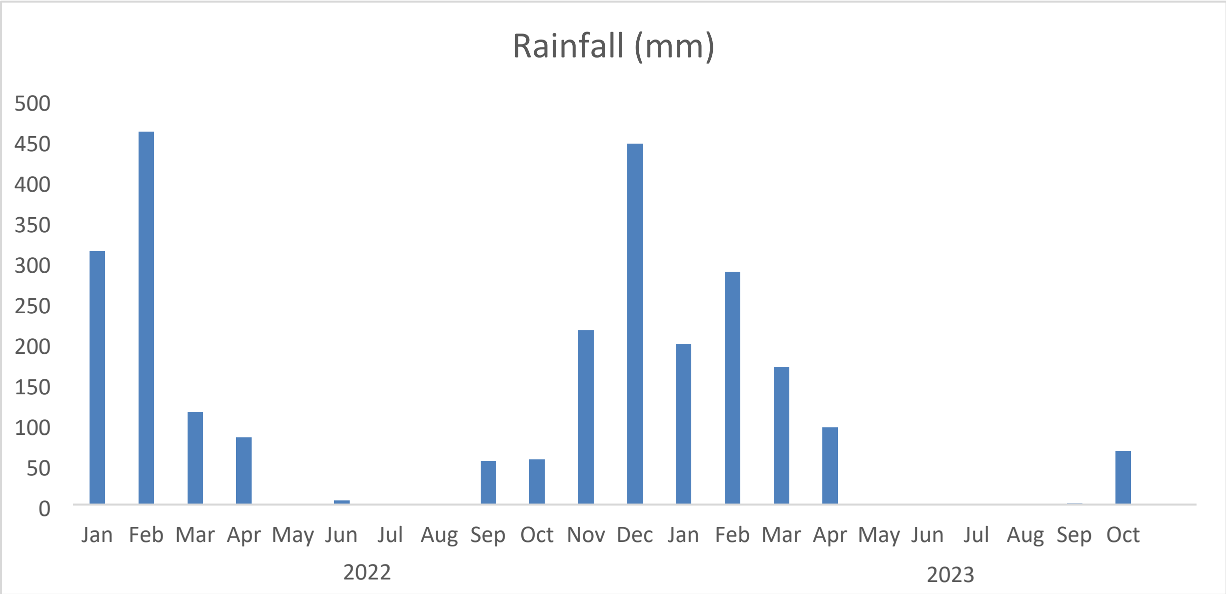


Figure 1-2. Average monthly rainfall (mm) prior to the 2022 and 2023 dry-season surveys

2 METHODS

This document compares the 2023 and 2022 post-dry season survey results using the Before After/Control Impact (BACI) approach to determine whether there are any changes in riparian health. The methodology as described in the RVMP (EcOz 2022) includes:

- post-dry season vegetation assessment; and
- a drone survey.

The survey plot locations are shown in Figure 3-18. In addition, riparian vegetation data are compared to reference site data, assisted by the use of up-to date high resolution imagery. The reason for comparing results from both post-dry season monitoring events, is because this is the time of the year riparian vegetation depend on access to groundwater to meet their water requirements.

The trigger action response plan (TARP) outlined in the RVMP will also be used to determine if any actions are required to be implemented based on results using the BACI approach.

The use of BACI is considered appropriate as it will determine if these is a significant difference between the baseline health data (prior to impact) and the riparian vegetation health based on the recent survey undertaken in 2023.

Monitoring was in accordance with best practice guidelines and standards, including *Northern Territory guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et. al. 2007) and the *NT Sampling and Processing Manual* (Llyod and Cook 1996). Details are provided below for each type of monitoring.

2.1 Vegetation Monitoring

Monitoring methods are outlined below:

- All existing riparian vegetation monitoring sites including RVS1, RVS2, RVS3, RVS4, RVS5 and the reference site along Charlotte Creek were assessed as per the previous 2022 survey) within the 20 x 20m plots.
- In each plot, the dominant layer/emergent layer species was recorded. For individual species occurring within upper and mid stratum, the height was estimated and the % cover measured. All individual plants within the plot were recorded alive or dead, whether the plant is fruiting/flowering.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) were recorded. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica*
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) were recorded. The results from this method is used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation was recorded to a standard that is equivalent to Level 6 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity was monitored through the use reviewing drone imagery and looking for any gaps in the riparian corridor.

Table 2-1 summarises monitoring methods and how they are used to measure riparian vegetation health.

Table 2-1. Summary of monitoring methods that are used to measure riparian vegetation health

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree records	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 6 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

2.2 Drone survey

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey was to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover. The 2023 post dry-season drone survey flight path was consistent with the flight path created based on the 2022 survey. The timing of the survey was undertaken post dry-season 2023. The method was as follows:

- DJI Go app and Fly Litchi app was used to capture imagery at a height of 60m (75% front overlap and 65% side overlap).
- Images were stitched it together using the WebODM app to create an orthophoto.
- Drone was flown in desirable conditions, i.e. in the morning to minimise strong winds or the middle of the day to avoid sun light interference i.e. shading. Observations were also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- Drone data analysis was undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.
- These values were categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, was then calculated.
- Vegetation boundaries were delineated at a scale of 1:500 using the 5cm pixel orthomosaic aerial images captured during the drone survey. Individual trees, vegetation cover and soil colour were identified from the imagery to inform the mapping of vegetation boundaries.

2.3 General observations

The objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is described in section 2.3.1.

2.3.1 Other environmental factors

Weeds

Weed data collection was conducted in accordance with the Northern Territory Weed Data Collection Manual (WMB 2015). The percentage cover of weed species (i.e. declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat was visually estimated for each weed species.

A GPS was used to record locations of identified weed species, and record the following information:

- Weed name.
- Distribution of patch – size (20, 50 or 100m diameter).
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1 to 5 – with 1 (absent) and 5 (>50%).
- Growth stage (seedling, juvenile, adult).
- Seeded (has the weed seeded?).
- Treatment (has the weed been treated and if so with what method of treatment?).
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data was recorded outside of the plots while traversing within the riparian area in between each monitoring site.

Fire

Northern Australia Fire Information (NAFI) website was visited to investigate frequencies and severity across the mapped riparian area.

At each plot, an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and, for recently burnt sites, the severity is be scored between 1 to 4. Categories for characterisation of fire are:

- No evidence of fire.
- Evidence of groundcover fire only.
- Evidence of burnt saplings.
- Evidence of fire in canopy layer.

Erosion

At each riparian assessment site, the presence or absence of erosion was recorded. If present, the following characteristics were recorded:

- Types of erosion – gully, sheet etc.
- The amount of bare ground.
- Tree root exposure.
- Slumping.
- Fallen trees/woody debris.
- Presence of surrounding erosion.

Water

The following assessment parameters were also collected to allow for ongoing assessment of any riparian vegetation assessment sites.

- Presence of **aquatic life** within the water was recorded. This involved recording aquatic fauna and flora at the nearest water access point from each of the vegetation assessment plots.
- Presence of **surface water flows** at the time of surveying.
- Presence of **sedimentation** within the water and on the vegetation.
- Presence of potential **contamination** (foam/scum/oils) and odour.

2.4 Trigger action response plan (TARP)

The TARP incorporates triggers and responses from the surface water monitoring program (WRM 2022) and GDE Management Plan quantitative triggers and limits and/or adaptive management actions (Table 2-2). Each riparian monitoring parameter presented in section 4 (data analysis) has been reviewed against TARP and provided a status.

Table 2-2. Trigger action response plan

Level	Trigger	Monitoring Performance Indicator	Action	Response
Level 1 (normal)	No reduction in riparian vegetation extent and/or structure/ composition compared to baseline.	Drone: • vegetation biomass using VARI analysis comparable to baseline mapping. Riparian vegetation site assessment: • No change in in general vegetation health compared to reference sites i.e. no tree mortality or physical changes to health of plants through the use of on-ground assessment and photo monitoring points.	• No action required.	• No response required.
Level 2 (early warning)	10% reduction in riparian vegetation extent and/or structure/ composition compared with baseline.	Drone: • There is no greater than a 10% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 10% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites. • Groundcover – there is no greater than 10% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites. • Tree mortality – there is no greater than 10% tree mortality of tagged plants recorded compared to the representative reference sites. • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 90% of the dominant species present within each strata). • Tree canopy continuity – there is no greater than 10% reduction in tree canopy cover (%) along transect compared to the representative reference sites.	• Continue to monitor in accordance with RVMP. • Investigate other potentially contributing environmental factors and likely reason for reduction in riparian vegetation extent. • Conduct drone monitoring in GDE reference site. • Implement action in surface water flows monitoring program (WRM 2022) TARP Level 2. • Investigate management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022).	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 2. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
Level 3a (elevated risk)	25% reduction in riparian vegetation extent and/or structure/ composition compared with baseline.	Drone: • There is no greater than a 25% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping. Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 25% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites. • Groundcover – there is no greater than 25% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites. • Tree mortality – there is no greater than 25% tree mortality of tagged plants recorded compared to the representative reference sites. • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 75% of the dominant species present within each strata). • Tree canopy continuity – there is no greater than 25% reduction in tree canopy cover (%) along transect compared to the representative reference sites.	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Further investigate extent of riparian vegetation reduction within ZOI, including assessment of the drainage line flowing east to west within the ZOI. • Conduct biannual riparian vegetation site assessment (end of wet season and end of dry season) and compare seasonal variability to 2022 baseline data.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Report on the outcomes of the investigation of riparian vegetation health within ZOI to regulator. • Report on the outcomes of the seasonal variability (additional monitoring at end of wet season and dry season) to regulator. • Report on outcomes of the investigation of management actions as outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) to the regulator.
Level 3b (imminent Risk)	50% reduction in riparian vegetation extent and/or structure/ composition compared with baseline.	Drone: • There is no greater than a 50% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping. Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 50% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites. • Groundcover – there is no greater than 50% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites. • Tree mortality – there is no greater than 50% tree mortality of tagged plants recorded compared to the representative reference sites. • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 50% of the dominant species present within each strata).	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Further investigate extent of riparian vegetation reduction outside 1m contour groundwater drawdown ZOI. • Revise BP33 mine closure plan (MCP) and rehabilitation management plan (RMP) to include reinstatement of habitat values in the affected riparian areas and monitoring of ecosystem recovery and submit to Controller or Water	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		• Tree canopy continuity – there is no greater than 50% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Resources and NT EPA CEO for approval.	
Level 4 (exceedance of approved limits)	Loss of >3.6 ha of identified GDE vegetation extent and/or structure/ composition.	Drone: • There is no greater than a 100% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping. Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 100% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites. • Groundcover – there is no greater than 100% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites. • Tree mortality – there is no greater than 100% tree mortality of tagged plants recorded compared to the representative reference sites. • General vegetation description using NVIS level 5 does not align with the representative reference site descriptions (i.e. indicating new ecosystem structures and functions have appeared). • Tree canopy continuity – there is no greater than 100% reduction in tree canopy cover (%) along transect compared to the representative reference sites.	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 4. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Implement approved RMP. • Notify NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 4. • Report on the outcomes of the actions undertaken to the regulator.

3 RESULTS POST-DRY SEASON SURVEY

The 2023 BP33 post dry-season riparian vegetation assessment (both drone survey and individual site assessments) was undertaken by Nicole Clark (Botanist) and Laura Zaharie (Ecologist) on 1 - 2 November 2023.

Generally, the condition of the vegetation was drier and limited standing water was observed. Where small bodies of water were present, no flow was detected. Site specific photo monitoring points and imagery obtained from the survey are provided for future monitoring purposes.

3.1 Vegetation site assessment

3.1.1 RVS1

Site description

The upper stratum comprised of *Xanthostemon eucalyptoides*, *Melaleuca argentea* mid open forest (12-14 m) with a sub-stratum of emerging *Syzygium armstrongii* (10-12 m). The mid stratum contained a mixed low open forest with *Leptospermum madidum* subsp. *sativum*, *Xanthostemon eucalyptoides, Pandanus spiralis* and *Barringtonia acutangula* subsp. *acutangula* and *Carallia brachiata*. *Acacia holosericea*, *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii* were sparsely represented within the mid stratum with <5% cover each. Ground cover vegetation was mostly comprised of sedges including *Scleria sp* which accounted for ~10% cover. Low grass cover (5%) with *Germania grandiflora*, *Eriachne triseta* and sparse *Pseudopogonatherum contortum* was restricted to the edges of the creek bank.

NVIS description

RSV1 comprises U1+ ^*Xanthostemon eucalyptoides*, *Melaleuca argentea* \^tree\7\c; U2 ^*Syzygium armstrongii* \^tree\7\r; M ^*Leptospermum madidum* subsp. *sativum*, *Xanthostemon eucalyptoides. Pandanus aquaticus*, *Barringtonia acutangula* subsp. *acutangula*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\c; G1 ^ *Scleria sp*, *Germania grandiflora, Pseudopogonatherum contortum, Eriachne triseta* \^tussock grass \2\i.

Vegetation height and cover

Vegetation and height cover are summarised in Table 3-1.

Table 3-1. Vegetation and height cover recorded at RVS1

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Melaleuca argentea	12-14	15	-	-	-	-
Xanthostemon eucalyptoides	12-14	15-20	5-8	10-15	-	-
Syzygium armstrongii	10-12	5 - 10	-	-	<3m	10-15
Leptospermum madidum	-	-	4-8	15-20	<3m	10-15
Barringtonia acutangula	-	-	3-5	5-10	<3m	10-15
Pandanus spiralis	-	-	3-6	5-10	<3m	10-15
Fagraea racemosa	-	-	-	-	<3m	10-15
Helicia australasica	-	-	-	-	<3m	10-15
Myrsine benthamiana	-	-	4	<1	<3m	10-15
Carallia brachiata	-	-	3-5	2-5	<3m	10-15

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Acacia holosericea	-	-	3-4	1-5	-	-
Cyclophyllum schultzii	-	-	3-4	1	<3m	10-15
Total	**10-14**	**5-20**	**3-8**	**35-40**	**0-3**	**10-15**
**Highlighted cells indicate overall % cover for combined species*						

General observations

Standing water present within the creek at the time of surveying, however, water was stagnant. Fire scars were observed north of the site in adjacent woodland. Natural biofilm was present on the water's surface. There was also evidence of pig disturbance.

Photo monitoring points

Figures 3-1 to 3-3 below provide imagery of RSV1.

North

East

South

West

Figure 3-1. Photographs of the habitat at RVS1 using cardinal-directions for riparian monitoring

Figure 3-2. Photographs of riparian corridor

Figure 3-3. Drone imagery of RVS1

3.1.1 RVS2

Site description

The upper stratum is a mid open forest (10-12 m) dominated by *Melaleuca viridiflora*, with co-dominants *Syzygium armstrongii* and *Lophostemon lactifluus*. The mid stratum consists of a low open forest (4-8 m) with *Xanthostemon eucalyptoides* and co-dominants *Leptospermum madidum* subsp. *sativum* and *Acacia holosericea*. A few species were recruiting into the mid stratum and collectively comprised ~25-30% cover.

Ground cover vegetation comprised of an open tussock grassland with *Eriachne triseta* and *Germania grandiflora*. Ferns, herbs and sedges were generally confined to the creek bank.

NVIS description

RVS2 comprises U+ ^*Melaleuca viridiflora*, *Syzygium armstrongii*, *Lophostemon lactifluus*, *Eucalyptus miniata*, *Melicope elleryana* \^tree\7\i; M ^*Xanthostemon eucalyptoides*, *Leptospermum madidum* subsp. *sativum*, *Acacia holosericea*, *Pandanus spiralis*, *Helicia australasica* \^tree, shrub\6\c; G1 ^*Eriachne triseta*, *Germania grandiflora* \^tussock grass \2\i; G2 ^ *Lindsaea ensifolia* \^fern\1\i. Other species noted: *Carpentaria acuminata*.

Vegetation cover

Vegetation and height cover are summarised in Table 3-2.

Table 3-2. Vegetation and height cover recorded at RVS2

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Eucalyptus miniata	10-12	3-5	-	-	-	-
Lophostemon lactifluus	10	5	-	-	-	-
Melaleuca viridiflora	10-12	5	-	-	-	-
Melicope elleryana	-	-	-	-	-	-
Syzygium armstrongii	10	5-10	3-6	1-2	<3	25 -30
Acacia holosericea	-	-	3-5	3-5	<3	25 -30
Carpentaria acuminata	-	-	6	1	<3	25 -30
Helicia australasica	-	-	3-5	<3	<3	25 -30
Leptospermum madidum	-	-	4-8	10-15	<3	25 -30
Pandanus spiralis	-	-	3-6	1-3	<3	25 -30
Xanthostemon eucalyptoides	-	-	4-8	10-15	<3	25 -30
Exocarpos latifolius	-	-	3-4	<1	<3	25 -30
Cyclophyllum schultzii	-	-	3-4	<1	<3	25 -30
Alphitonia excelsa	-	-	-	-	<3	25 -30
Breynia cernua	-	-	-	-	<3	25 -30
Erythrophleum chlorostachys	-	-	-	-	<3	25 -30
Total	**10-12**	**20-25**	**3-8**	**35-40**	**0-3**	**25 -30**
**Highlighted cells indicate overall % cover for combined species*						

General observations

There was no standing water present within the creek at the time of surveying. There was a moderate amount of leaf litter documented on the creek bed floor. There was evidence of a fire scar adjacent to the riparian corridor (in the Eucalypt woodland).

Photo monitoring points

Figures 3-4 to 3-6 below provide imagery of RSV2.

North

East

South

West

Figure 3-4. Photographs of the habitat at RVS2 using cardinal-directions for riparian monitoring

Figure 3-5. Photographs of riparian corridor at RVS2

Figure 3-6. Drone imagery of RVS2

3.1.2 RVS3

Site description

The upper stratum consisted of a mid woodland (12-15 m) dominated by *Xanthostemon eucalyptoides* and *Lophostemon lactifluus*, with a mix of less dominant species *Melaleuca viridiflora*, *Erythrophleum chlorostachys* and *Syzygium armstrongii*. Two mid stratums were present within the system, with the taller stratum comprising of a mixed low woodland (5-10 m) with *Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura* and *Carallia brachiata*. The lower mid stratum contained a mix of shrubs and small trees with *Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* (1-5 m). The ground stratum was mostly a tussock grassland outside of the creek line with *Eriachne triseta* and *Germania grandiflora*, and *Mnesithea rottboellioides* and ferns were typically growing along the creek bank.

NVIS description

RVS3 comprises U+ ^*Xanthostemon eucalyptoides*, *Lophostemon lactifluus*, *Melaleuca viridiflora*, *Erythrophleum chlorostachys*, *Syzygium armstrongii* \^tree\7\i; M1 ^*Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura*, *Carallia brachiata* \^tree\6\c; M2 ^*Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* \^shrub, tree\6\i; G1 ^*Eriachne triseta*, *Germania grandiflora, Mnesithea rottboellioides* \^Sorghum intrans \2\c; G2 ^ *Lindsaea ensifolia* \ ^fern\1\i.

Vegetation height and cover

Vegetation and height cover are summarised in Table 3-3.

Table 3-3. Vegetation and height cover recorded at RVS3

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Erythrophleum chlorostachys	12-14	5-10	3-5	<1	<3	10-15
Melaleuca viridiflora	12-15	5-10	4-6	<1	<3	10-15
Syzygium armstrongii	12-15	5	-	-	<3	10-15
Xanthostemon eucalyptoides	10-14	5	3-10	10-15	<3	10-15
Leptospermum madidum	10-12	<5	5-8	5-10	-	-
Acacia auriculiformis	-	-	8-10	1-5	-	-
Acacia holosericea	-	-	3-5	5	<3	10-15
Alphitonia excelsa	-	-	4-5	<1	<3	10-15
Carallia brachiata	-	-	3-4	<1	<3	10-15
Cyclophyllum schultzii	-	-	3-4	1	<3	10-15
Denhamia obscura	-	-	6-8	1-3	-	-
Livistona humilis	-	-	3-4	1	<3	10-15
Pandanus aquaticus	-	-	1-4	2-5	-	-
Pandanus spiralis	-	-	1-4	1	<3	10-15
Breynia cernua	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Total	**10-15**	**25-30**	**3-10**	**25-30**	**<3**	**10-15**
**Highlighted cells indicate overall % cover for combined species*						

General observations

There was no standing water present within the plot at the time of survey. There was one small puddle present downstream of the creek at the time of survey. Some pig damage was observed.

Photo monitoring points

Figures 3-7 to 3-9 below provide imagery of RSV3.

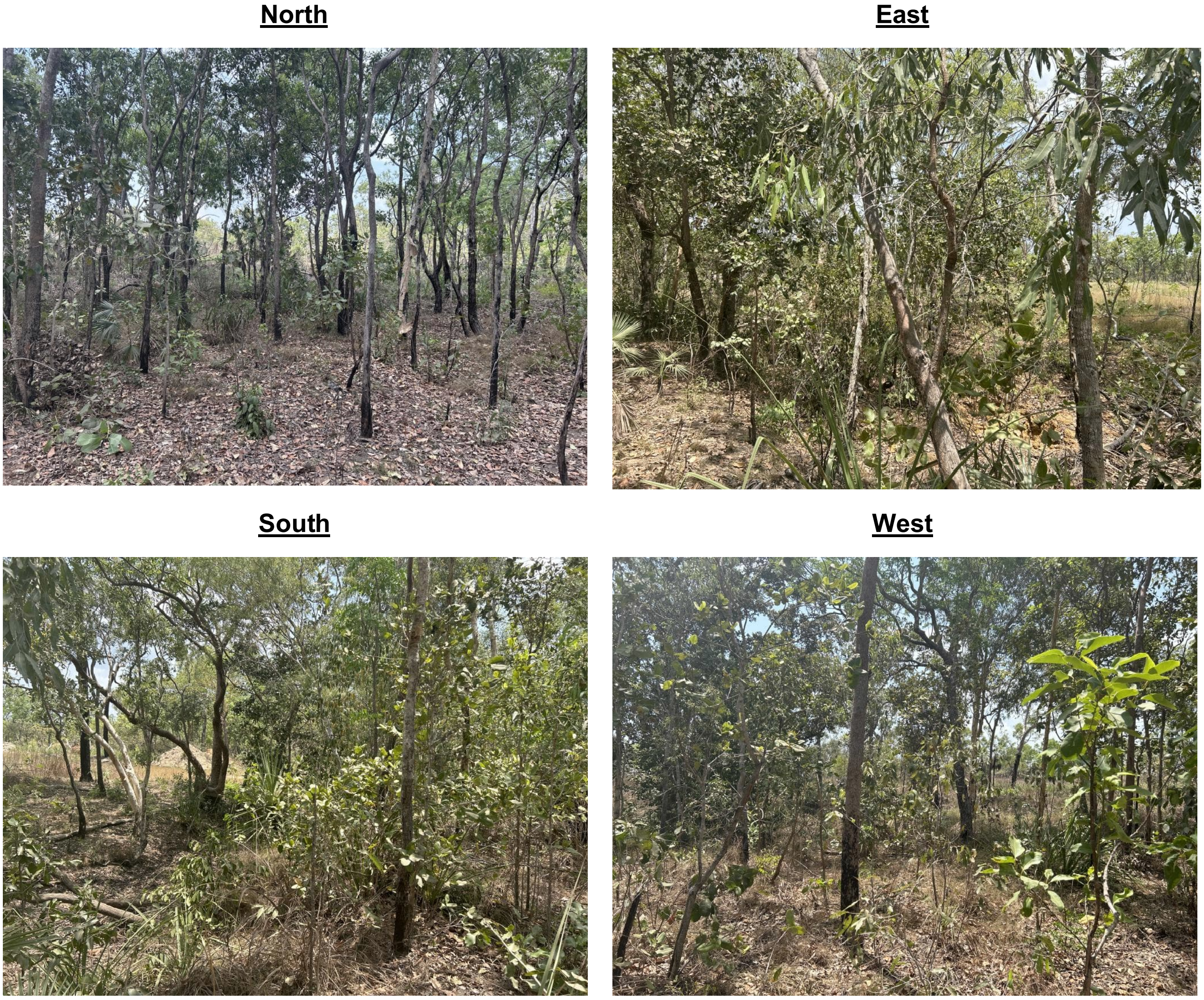


Figure 3-7. Photographs of the habitat at RVS3 using cardinal-directions for riparian monitoring

Figure 3-8. Photographs of the riparian corridor at RVS3

Figure 3-9. Drone imagery of RVS3

3.1.3 RVS4

Site description

The upper stratum consisted of a mid open forest (8-16 m) with *Syzygium armstrongii* and *Xanthostemon eucalyptoides*, with emerging *Corymbia polycarpa* (10-12 m). The mid stratum was fairly complex with two distinct height ranges. The taller of the mid stratums comprised of low open forest (5-10 m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Melaleuca viridiflora, Syzygium angophoroides*, *Gmelina schlechteri* and *Pandanus spiralis*. The lower mid stratum (3-5 m) contained a mix of small trees comprising of *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii* and *Carallia brachiata*. *Acacia holosericea* was also present and formed a small component of the lower mid stratum. The ground cover vegetation was a tussock grassland containing *Eriachne triseta*, *Chrysopogon latifolia* and *Germania grandiflora*. Smaller ferns and sedges were typically confined to the creek bank, and *Dianella odorata* and *Flagellaria indica* were also present within the creek.

NVIS description

RVS4 comprises U+ ^*Syzygium armstrongii*, *Xanthostemon eucalyptoides*, *Corymbia polycarpa, Syzygium angophoroides* \^tree\7\c; M1 ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Melaleuca viridiflora*, *Gmelina schlechteri*, *Pandanus spiralis* \^tree\6\c; M2 ^*Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\c; G2 ^ Sedge sp. \ ^ sedge\1\i. Other species noted: *Flagellaria indica*, *Dianella odorata*. Ferns were still present, but not as prominent.

Vegetation heights and cover

Vegetation and height cover are summarised in Table 3-4.

Table 3-4. Vegetation and height cover recorded at RVS4

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Corymbia polycarpa	10-12	5	-	-	-	-
Syzygium armstrongii	14-16	20	6-8	10	<3	10-15
Xanthostemon eucalyptoides	12-14	15	4-8	25	-	-
Syzygium angophoroides	8-10	5	-	-	-	-
Acacia holosericea	-	-	4-5	15	-	-
Carallia brachiata	-	-	3-5	15	-	-
Cyclophyllum schultzii	-	-	3-5	15	<3	10-15
Flagellaria indica	-	-	8-10	15	-	-
Gmelina schlechteri	-	-	5-8	15	-	-
Melaleuca viridiflora	-	-	8-10	15	-	-
Myrsine benthamiana	-	-	3-6	15	<3	10-15
Pandanus spiralis	-	-	4-6	15	<3	10-15
Syzygium angophoroides	-	-	6-8	15	<3	10-15
Ilex arnhemensis	-	-	6-8	15	-	-
Helicia australasica	-	-	-	-	<3	10-15
Melicope elleryana	-	-	-	-	<3	10-15
Total	**8-16**	**45**	**3-10**	**50**	**<3**	**10-15**
**Highlighted cells indicate overall % cover for combined species*						

General observations

A small/shallow pool present; water was milky brown in colour and not flowing at the time of survey. No surface scum or odours present. The last fire was observed <1 year ago.

Photo monitoring point

Figures 3-10 to 3-12 below provide imagery of RSV4.

North

East

South

West

Figure 3-10. Photographs of the habitat at RVS4 using cardinal-directions for riparian monitoring

Figure 3-11. Photographs of riparian corridor

Figure 3-12. Drone imagery of RVS4

3.1.4 RVS5

Site description

The upper stratum is comprised of a mid open forest (12-14m tall) with *Xanthostemon eucalyptoides*, over low woodland (8-12 m) of *Syzygium armstrongii, Melaleuca viridiflora* and *Lophostemon lactifluus*. The mid stratum was a mixed low open forest (3-8m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus*. Under this was a lower mid stratum (2-5 m) of the same structure with *Helicia australasica*, *Acacia holosericea* and *Pandanus spiralis*. The ground stratum is a tussock grassland with *Eriachne triseta*, *Chrysopogon latifolia*. Ferns were not present at the time of survey.

NVIS description

RVS5 comprises U1 ^ *Xanthostemon eucalyptoides* \^tree\7\i; U2 ^*Melaleuca viridiflora*, *Syzygium armstrongii, Lophostemon lactifluus* \^tree\6\i; M1+ ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus* \^tree\6\c; M2 ^*Helicia australasica*, *Acacia holosericea*, *Pandanus spiralis* \^tree\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia, Themeda triandra* \^tussock grass\2\i; Other species noted: *Cyclophyllum schultzii* f. *schultzii*.

Vegetation cover

Vegetation and height cover are summarised in Table 3-5.

Table 3-5. Vegetation and height cover recorded at RVS5

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-10	5-10	6-7	<5	<3	1-5
Melaleuca viridiflora	10-12	10-15	6	<1	-	-
Syzygium armstrongii	10-12	10-15	6-8	5	<3	1-5
Xanthostemon eucalyptoides	12-14	15	4-8	15	<3	1-5
Acacia holosericea	-	-	3-5	1-3	<3	1-5
Carallia brachiata	-	-	6-8	5	<3	1-5
Cyclophyllum schultzii	-	-	3-6	1-2	<3	1-5
Helicia australasica	-	-	3-6	10-15	<3	1-5
Leptospermum madidum	-	-	4-6	5-10	<3	1-5
Pandanus spiralis	-	-	4-5	1-2	<3	1-5
Myrsine benthamiana	-	-	3-4	<1	<3	1-5
Erythrophleum chlorostachys	-	-	-	-	<3	1-5
Melicope elleryana	-	-	-	-	<3	1-5
Total	**8-14**	**45-50**	**3-8**	**50-55**	**0-3**	**5-10**
**Highlighted cells indicate overall % cover for combined species*						

General observations

No standing water present within creek. The last fire was observed <1 year ago.

Photo monitoring point

Figures 3-13 to 3-15 below provide imagery of RSV5.

North **East**

Figure 3-13. Photographs of the habitat at RVS5 using cardinal-directions for riparian monitoring

Figure 3-14. Photographs of riparian corridor

Figure 3-15. Drone imagery of RVS5

3.1.5 Reference site

Site description

The upper stratum was a mid open forest (14-18 m) of *Melaleuca argentea* and *Syzygium armstrongii*, over a low-mid woodland (8-12 m) with *Xanthostemon eucalyptoides*, *Lophostemon lactifluus* and *Melicope elleryana*. The mid stratum comprised of a low open forest (3-8 m) with *Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides* and *Cyclophyllum schultzii* f. *schultzii*. The ground stratum comprised of a tussock grassland dominated by *Chrysopogon fallax, Eulalia mackinlayi* and *Eriachne triseta* which was dominant on the embankment, with sedges and herbs growing closer to the waters' edge.

NVIS description

The Reference site comprises U+ ^*Melaleuca argentea*, *Syzygium armstrongii*, *Xanthostemon eucalyptoides* \^tree\7\c; U2 ^*Lophostemon lactifluus*, *Melicope elleryana* \^tree\6\i; M ^*Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiate*, *Xanthostemon eucalyptoides*, *Cyclophyllum schultzii* f. *schultzii* \^tree, shrub\6\i; G1 ^*Chrysopogon fallax*, *Eulalia mackinlayi, Eriachne triseta* \^tussock grass \2\i; G2 ^Sedge sp., Herb sp. \sedge, forb\1\i.

Vegetation cover

Vegetation and height cover are summarised in Table 3-6.

Table 3-6. Vegetation and height cover recorded at the reference site

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-12	5	-	-	-	-
Melaleuca argentea	16-18	15	-	-	-	-
Syzygium armstrongii	14-16	15	-	-	<3	5-10
Xanthostemon eucalyptoides	10-12	5-10	3-8	5-10	<3	5-10
Carallia brachiata	-	-	4-6	5	-	-
Cyclophyllum schultzii	-	-	3-6	1	<3	5-10
Melicope elleryana	-	-	8-10	5	<3	5-10
Myrsine benthamiana	-	-	3-6	1	<3	5-10
Pandanus aquaticus	-	-	3-6	5-10	-	-
Fagraea racemosa	-	-	6	<5	-	-
Corymbia polycarpa	-	-	4	<1	-	-
Barringtonia acutangula	-	-	-	-	<3	5-10
Carpentaria acuminata	-	-	-	-	<3	5-10
Helicia australasica	-	-	-	-	<3	5-10
Pandanus spiralis	-	-	-	-	<3	5-10
Total	**8-18**	**4-45**	**3-10**	**25-30**	**<3**	**5-10**
**Highlighted cells indicate overall % cover for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Standing water was stagnant and milky brown colour, with no apparent sedimentation present.

Photo monitoring point

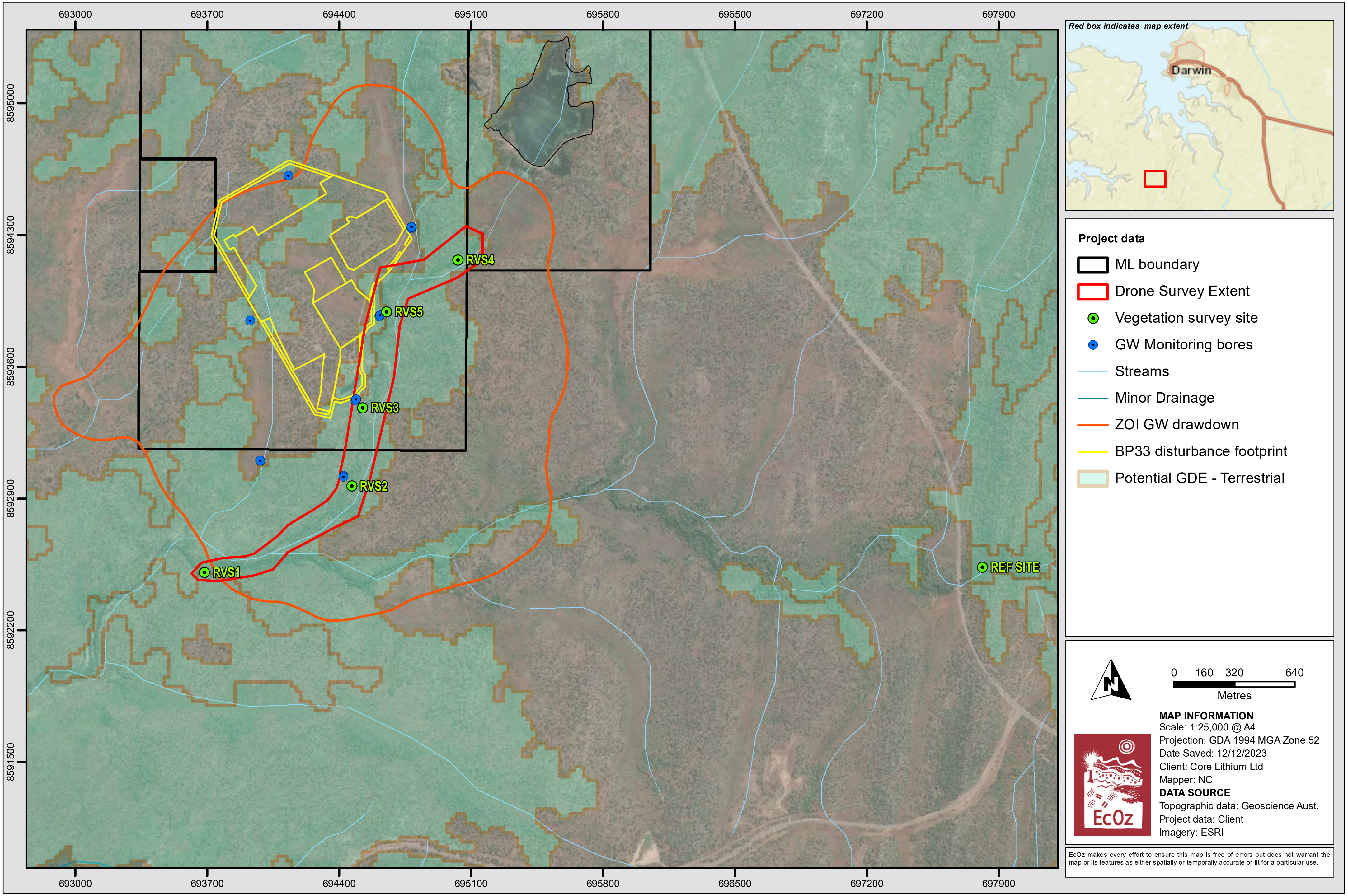
Figures 3-16 to 3-18 below provide imagery of the Reference site.

North | **East**

South | **West**

Figure 3-16. Photographs of the habitat at the reference site using cardinal-directions for riparian monitoring

Figure 3-17. Photographs of the riparian corridor



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ23048 - Finniss Lithium Project Riparian Vegetation Monitoring 2023\1. Project Files\2. Report Maps\Riparian vegetation sites monitored (November 2023).mxd

Figure 3-18. Riparian vegetation sites monitored in the post dry-season survey (November 2023)

3.2 NAFI results

The NAFI website was visited to investigate frequencies and severity across the mapped riparian area (specifically the vegetation). Though not all riparian sites recorded fire during field investigations, NAFI indicates early burns occurred in May across most of the study area, for both years (Figure 3-19).

Figure 3-19. Fire scar mapping based on 2022 and 2023 monthly data (NAFI 2023)

3.3 Drone survey

3.3.1 Riparian vegetation boundary

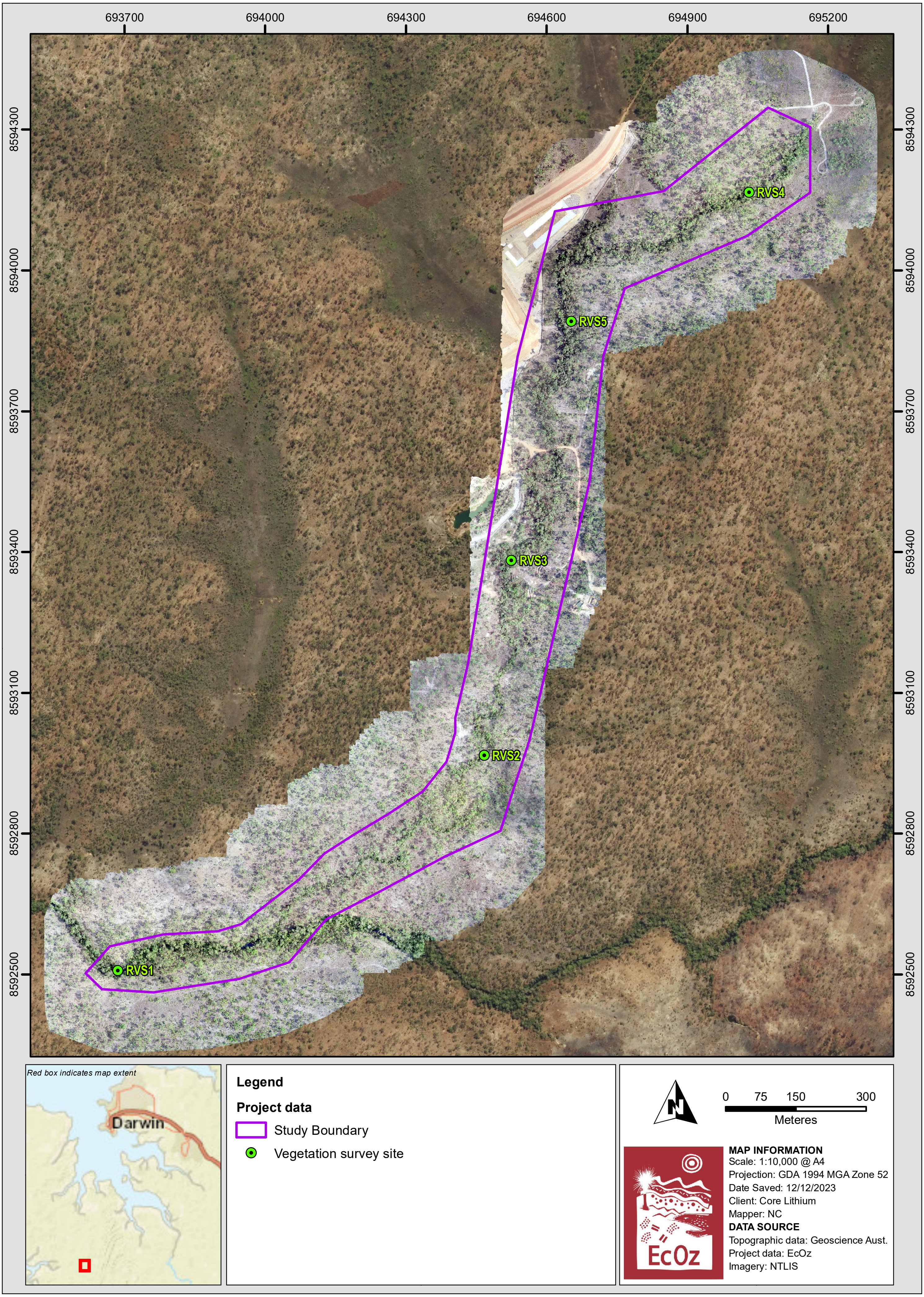
The riparian study site is approximately 2.5 km long and 150 m wide, with an area of 5 ha (Figure 3-20). The boundary of the GDE riparian vegetation community type was delineated within the study site (Figure 3-20). The vegetation site assessments all lie within the GDE riparian corridor. The riparian corridor area size recorded this year was consistent with previous years' results based on the 2022 survey. Zoomed in images are provided for each site are also provided for future monitoring.

3.3.2 VARI analysis

Based on the VARI analysis, a total area of 2.6 ha of the raster data falls within class intervals 1 & 2 (green band colour) indicating healthy vegetation - this equates to 6.33% of the total study area is considered healthy vegetation (Table 3-7). There was a decrease of the portion (%) of raster cells that fell within the healthy vegetation classes (1 & 2) recorded in the recent survey results, compared to the 2022 survey. It appears the healthy vegetation lies within the main riparian corridor (see Figure 3-21).

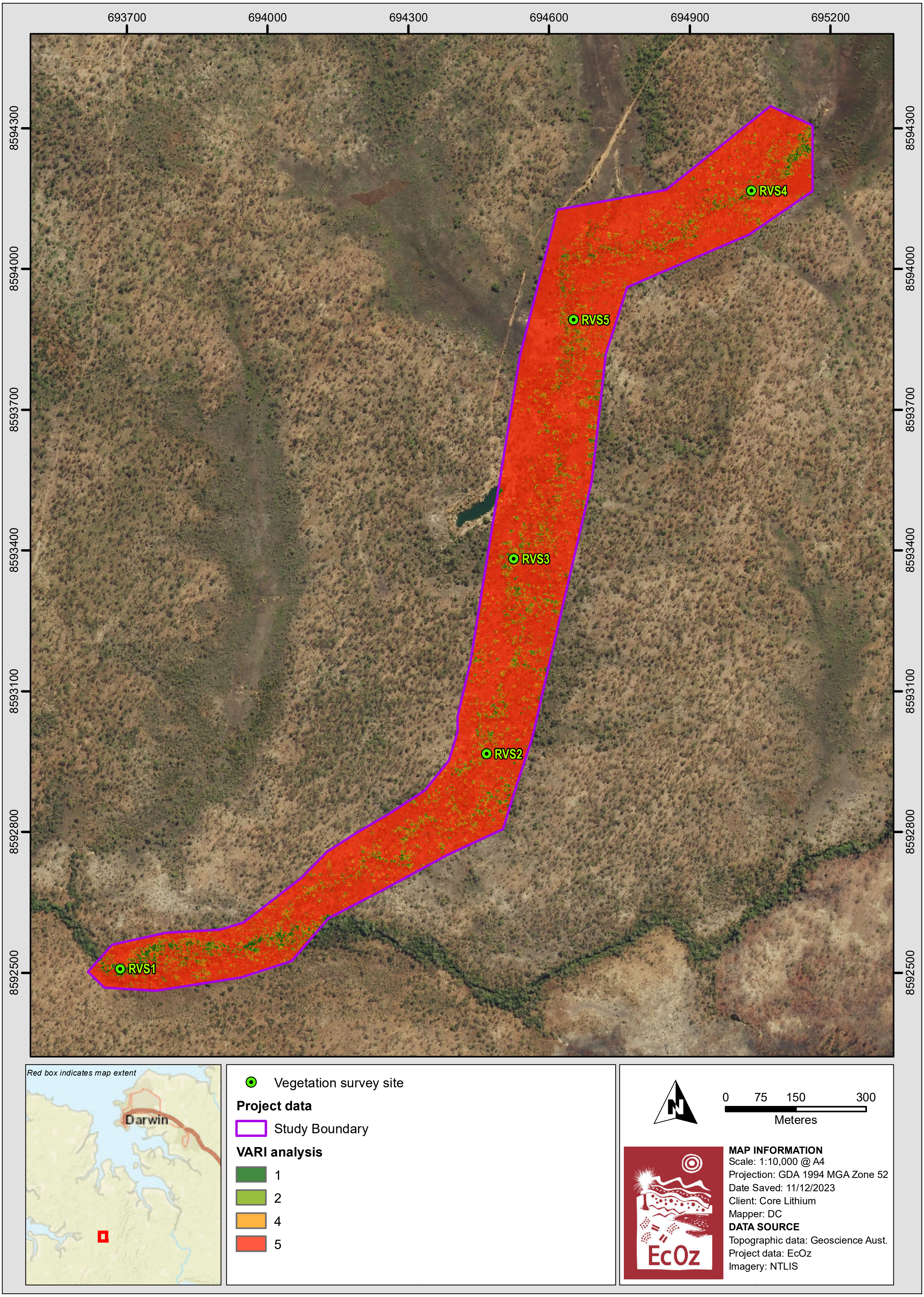
Table 3-7. VARI analysis results summary

Colour	Class	Class intervals	2023 survey results Percentage %	2023 survey results Area (ha)	2022 survey results Percentage %	2022 survey results Area (ha)	Overall trend since 2022 survey
	1	0.23 to 0.6	2.92	1.2	5.98	2.42	Decrease
	2	0.17 to 0.23	3.41	1.4	7.86	3.18	Decrease
	3	0.1 to 0.17	9.5	3.9	18.85	7.63	Decrease
	4	0.01 to 0.1	25.6	10.5	35.87	14.51	Decrease
	5	-0.21 to 0.01	58.53	24	31.41	12.71	Increase



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ23048 - Finniss Lithium Project Riparian Vegetation Monitoring 2023\1. Project Files\2. Report Maps\Drone imagery map (November 2023).mxd

Figure 3-20. Riparian vegetation drone imagery (post dry-season, November 2023)



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ23048 - Finniss Lithium Project Riparian Vegetation Monitoring 2023\1. Project Files\2. Report Maps\VARI anaylsis map (November 2023).mxd

Figure 3-21. Map of riparian corridor using using VARI raster data

4 DATA ANALYSIS

This section presents the BACI analysis outlined in the RVMP (EcOz 2022) and data analysis for both the 2022 and 2023 post dry-season survey 2023 survey results. See Appendix A for full tree dataset, and Appendix B & Appendix C for full groundcover dataset. Appendix D provides all monitoring point photographs for each site across both years.

4.1 Species composition

All dominant upper canopy and mid stratum species recorded in the post dry-season survey in 2023 were similar to the 2022 post dry-season survey results (see Table 4-1).

Table 4-1. Overall species composition within varying stratums for 2022 and 2023 dry-season survey

Site	Upper		Middle		Recruit		Overall TARP summary
	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	
Species composition	*Syzygium armstrongii* was at all of the monitoring sites, including the reference site. *Xanthostemon eucalyptoides* was observed as the next abundant species, followed by *Melaleuca viridiflora.*	Species composition consistent with 2022 results.	*Cyclophyllum schultzii f. schultzii* and *Xanthostemon eucalyptoides* were all represented in the mid stratum across all of the monitoring sites, including the reference site. *Pandanus spiralis* and *Acacia holosericea* were observed as the next abundant mid strata species, all occurring at five monitoring sites, excluding the reference site, *Carallia brachiate* was also recorded at five monitoring sites, including the reference site.	Species composition consistent with 2022 results.	Many of the species occurring within the upper and mid strata are showing signs of recruitment, *Syzygium armstrongii, Helicia australasica, Cyclophyllum schultzii f. schultzii* and *Pandanus* spiralis were represented in the understorey across all of the monitoring sites, and the reference site. *Acacia holosericea, Myrsine benthamiana* and *Xanthostemon eucalyptoides* were observed as the next abundant species.	Species composition consistent with 2022 results.	TARP Level 1 (normal) – No changes in species composition detected; no action required

4.2 Overall plant height

Table 4-2 represents overall plant height for each site within varying stratums for the post dry-season 2022 and post dry-season 2023 surveys. Site RVS4 and the reference site contained the tallest trees ~16m. The mid strata is relatively consistent across the sites, ranging from 3-10 m tall. All recruits were <3 m tall. The data represented similar height data in the post dry-season 2023 survey, compared to the post dry-season 2022 survey (Table 4-2).

Table 4-2. Overall plant height for each site within varying stratums for 2022 and 2023 post-dry season survey

Site	Upper		Middle		Recruit		Overall TARP Summary
	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	
RVS1	10-14	10-14	3-8	3-8	0-3	0-3	TARP Level 1 (normal); no changes to plant height; no action required.
RVS2	10-12	10-12	3-8	3-8	0-3	0-3	
RVS3	12-14	12-14	3-10	3-10	0-3	0-3	
RVS4	12-16	12-16	3-8	3-10	0-3	0-3	
RVS5	10-14	10-14	3-8	3-8	0-3	0-3	
Reference site	8-16	8-16	3-10	3-10	0-3	0-3	

4.3 Canopy cover and recruit cover

Table 4-3 represents overall % cover of each stratum for the post dry-season survey 2022 and post dry-season survey 2023. Overall, the data represented similar structure between the two post-dry season monitoring events, although the % covers relating to the recruit data was slightly lower in the post dry-season survey in 2023 (Table 4-3).

Table 4-3. Canopy cover (%) and % cover of recruits for each site within varying stratums for 2022 and 2023 post-dry season survey

Site	Upper		Middle		Recruit		Overall TARP Summary
	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	
RVS1	5-20	5-20	35-40	35-40	10-15	10-15	TARP Level 1 (normal); no changes to structure; except a small reduction in % cover of recruits at RVS1, RVS2 and RVS5. No action required.
RVS2	20-25	20-25	35-40	35-40	35	25-30	
RVS3	25-30	25-30	25-30	25-30	10-15	10-15	
RVS4	45	45	50	50	10-15	10-15	
RVS5	45-50	45-50	50-55	50-55	5-10	1-5	
Reference site	40-45	40-45	25-30	25-30	10-15	10-15	

4.4 Plant health

Table 4-4 summarises plant health data for both post wet-season survey and post dry season survey results. There was an increase in tree mortality recorded in the 2023 post dry-season survey compared to the 2022 survey results (see Table 4-4). The likely cause was due to fire impact.

Table 4-4. Summary of plant health for 2022 and 2023 post dry-season survey

Plant health	Post dry-season 2022	Post dry-season 2023	Overall TARP Summary
Tree mortality	All plants were recorded alive, except for one unidentified tree stump recorded at RVS3 and one individual Melaleuca viridiflora recorded at RVS5.	Two dead *Pandanus spiralis* and one identified dead stump recorded at RVS1. One dead unknown stump, one dead *Livistona humilis* (2 m tall) and one dead Ironwood (4 m tall) recorded at RVS2, one unidentified tree stump recorded at RVS3 and one individual *Melaleuca viridiflora* recorded at RVS5. No tree mortality recorded at RVS4 in both years.	Level 2 (early warning) - increase in tree mortality with six additional plants recorded dead at RVS1 and RVS2 respectively in the post dry-season survey 2023 compared to 2022 results. Tree mortality numbers remained the same at sites RVS3 and RVS5 when compared to post dry-season 2022 survey.
Flowering plants	25% of the total plants recorded within upper and mid stratums were flowering, and 17% were fruiting.	6% of the total plants recorded within upper and mid stratums were flowering, and 18% were fruiting.	

4.5 Groundwater sensitive species

4.5.1 Upper and mid strata

The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site are presented in Table 4-5. It is noted this data was analysed by combing the upper and mid strata data. The results presented in the post dry-season survey compared to the post dry-season survey results in 2023 (Table 4-5).

Table 4-5. Portion (%) of sensitive species recorded at monitoring sites for 2022 and 2023 post dry-season survey

Site	*Melicope elleryana*		*Cyclophyllum schultzii*		*Helicia australasica*		Overall TARP summary
	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	
RVS1	-	-	9.1	9.1	-	-	TARP Level 1 (normal); no changes to plant height; no action required
RVS2	-	-	7.7	7.7	7.6	7.6	
RVS3	-	-	5.3	5.3	-	-	
RVS4	-	-	6.7	6.7	-	-	
RVS5	-	-	6.7	6.7	6.6	6.6	
Reference site	8.3	8.3	8.3	8.3	-	-	

4.5.2 Recruits

The portion (%) of groundwater sensitive species observed in the recruit data across all riparian vegetation sites and the references site are presented in Table 4-6. The data indicates groundwater sensitive species are re-sprouting and there are similar potions of recruits present as there are in the canopy riparian vegetation.

Table 4-6. Portion (%) of sensitive species recorded at monitoring sites

Site	*Melicope elleryana*		*Cyclophyllum schultzii*		*Helicia australasica*		Overall TARP summary
	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	Post dry-season 2022	Post dry-season 2023	
RVS1	-	-	11.1	11.1	11.1	11.1	TARP Level 1 (normal); no changes to plant height; no action required
RVS2	-	-	9.1	9.1	9.1	9.1	
RVS3	-	-	8.3	8.3	8.3	8.3	
RVS4	12.5	12.5	12.5	12.5	12.5	12.5	
RVS5	8.3	8.3	8.3	8.3	8.3	8.3	
Reference site	11.1	11.1	11.1	11.1	11.1	11.1	

4.6 Ground covers

Figure 4-1 represents the overall ground cover across monitoring plots for both the 2022 and 2023 post dry-season surveys. Litter was the dominant ground cover material across monitoring plots based on the 2023 survey results, followed by vegetation, soil, other (water) and rocks. This was compared to the 2022 survey results with vegetation being the dominant ground cover across monitoring plots, followed by leaf litter (or dead vegetative material), soil and other (water), and rocks. Of the total vegetation percent cover, grass was the dominant ground cover vegetation recorded for both the 2023 and 2022 survey results (Figure 4-2).

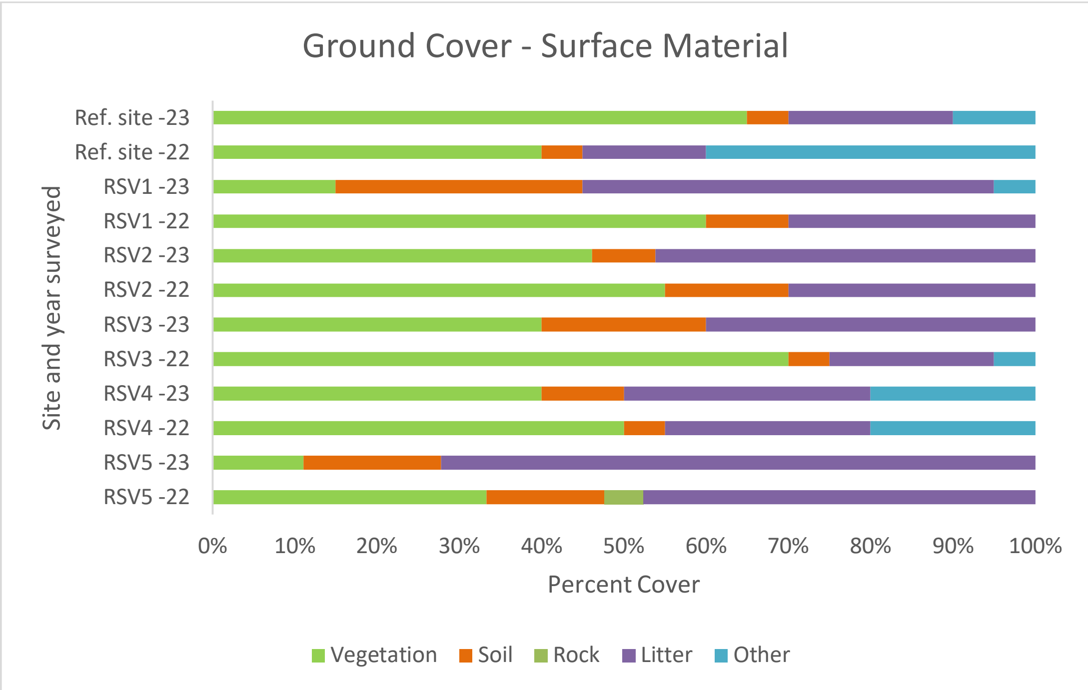


Figure 4-1. Percentage ground cover by material type for 2022 and 2023 post dry-season survey

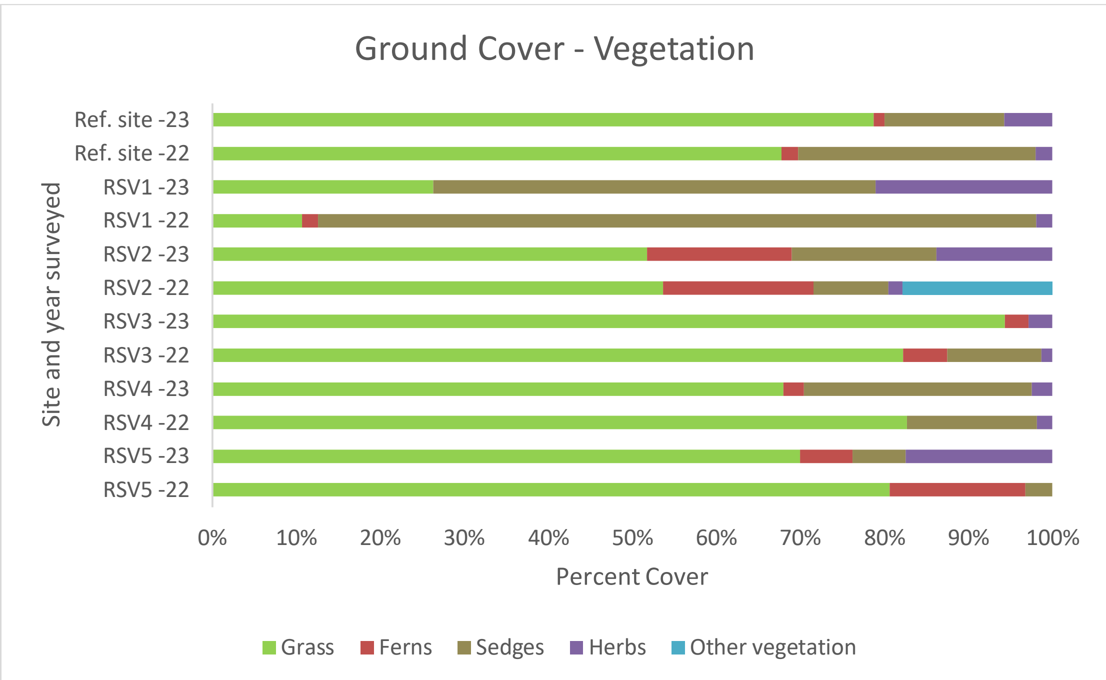


Figure 4-2. Percentage ground cover by vegetation for 2022 and 2023 post dry-season survey

Appendix B & C provides a full summary of ground cover results.

4.7 General observations

Table 4-7 provides a summary of all general observations made during field investigations for both post dry-season 2022 and post-dry season 2023.

Table 4-7. Summary table of general observations for 2022 and 2023 post-dry season survey

Observation	Post dry-season 2022	Post dry-season 2023
Standing water level	The creek was mostly dry, with standing water only observed at some sites (RVS1, RVS3, RVS4 and the reference site).	The creek was mostly dry, with standing water only observed at some sites (RVS1, and RVS4 and the reference site).
Erosion	No erosion recorded	Minor erosion recorded at RVS1 likely caused by increased pig activity
Weeds	None within plot; some Mission Grass and Gamba Grass plants recorded adjacent to site	None within plot; some Mission Grass and Gamba Grass plants recorded adjacent to site

5 CONCLUSION AND RECOMMENDATIONS

There was negligible change in riparian vegetation health based on the 2023 post dry-season survey compared to the 2022 survey using the BACI analysis approach.

The riparian study boundary was consistent with the 2022 survey results; 2.5 km long and 150 m wide, with an area of 5 ha.

The VARI analysis results indicated there was a decrease in the portion (%) of raster cells that fell within the two 'healthy vegetation' classes (classes 1 & 2). It is likely the decrease may be a result of some of the limitations involved when using the VARI analysis tools i.e. can be sensitive to variations in atmospheric conditions, such as clouds and haze which can lead to errors in the values and make it difficult to accurately interpret images. Other considerations may be associated to the restricted data obtained to date, with only two years of data utilised for comparison. Additionally, the decrease may also be due to natural causes i.e. combination of drier conditions and increased fire activity across the study area.

Since the riparian vegetation boundary size (ha) did not retract based on the up-to date ortho imagery obtained, the VARI analysis 2023 results are not a concern. It is recommended to continue monitoring as the project progresses to build on the existing database.

No changes were detected in terms of species composition/structure. RVS4 and the reference site contained the tallest trees ~16m. Most plants were in good health, despite the rise in the number of dead individuals recorded in the recent survey compared to the 2022 survey results. The cause of mortality was attributed to natural cause i.e. fire impacted and not related to mining activities. There was a decrease in percent groundcover (vegetation) recorded in the recent 2023 post-dry season survey, compared to the 2022 survey. This may be due to drier conditions prior to monitoring in 2023 compared to the 2022 survey i.e. lack of early on-set rainfall events in 2023, compared to rainfall data in 2022. There was also slight decrease in overall % cover of recruits.

No immediate actions are required at this stage based on the TARP, however, it is recommended to continue annual monitoring according to the RVMP (EcOz 2022) as development continues.

It is also recommended to conducted analysis of comparison of standing water levels in the groundwater bores. It is noted this work has not been undertaken post dry-season in 2023, in comparison to the same time last year.

6 REFERENCES

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APPENDIX A PLANT HEALTH ASSESSMENT DATA 2023 POST DRY-SEASON

Site	Species	Stratum	Height	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. Yes-1
RSV1	*Melaleuca argentea*	U	12-14	15	1	0	0	0
RSV1	*Xanthostemon eucalyptoides*	U	12-14	15-20	1	0	0	0
RSV1	*Syzygium armstrongii*	U	10-12	5-10	1	0	0	0
RSV1	*Xanthostemon eucalyptoides*	M	5-8	10-15	1	0	0	0
RSV1	*Barringtonia acutangula subsp. acutangula*	M	3-5	5-10	1	1	1	0
RSV1	*Leptospermum madidum subsp. sativum*	M	4-8	15-20	1	0	0	0
RSV1	*Pandanus spiralis*	M	3-6	5-10	1	0	0	0
RSV1	*Acacia holosericea*	M	3-4	1-5	1	0	0	0
RSV1	*Cyclophyllum schultzii f. schultzii*	M	3-4	1	1	0	0	1
RSV1	*Myrsine benthamiana*	M	4	<1	1	0	0	1
RSV1	*Carallia brachiata*	M	3-5	2-5	1	0	0	0
RVS1	*Pandanus spiralis*	M	<1	3	0	0	0	0
RVS1	*Pandanus spiralis*	M	<1	3	0	0	0	0
RVS1	*x1 dead unknown*	M	<1	-	0	0	0	0
RSV1	*Barringtonia acutangula subsp. acutangula*	R	<3	10-15	1	0	0	0
RSV1	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
RSV1	*Carallia brachiata*	R	<3	10-15	1	0	0	0
RSV1	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
RSV1	*Helicia australasica*	R	<3	10-15	1	0	0	1
RSV1	*Fagraea racemosa*	R	<3	10-15	1	0	0	1
RSV1	*Leptospermum madidum subsp. Sativum*	R	<3	10-15	1	0	0	0
RSV1	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RSV1	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS2	*Syzygium armstrongii*	U	10	5-10	1	0	0	0
RVS2	*Melaleuca viridiflora*	U	10-12	5	1	0	0	0
RVS2	*Eucalyptus miniata*	U	10-12	3-5	1	0	0	0
RVS2	*Lophostemon lactifluus*	U	10	5	1	0	0	0
RVS2	*Leptospermum madidum subsp. sativum*	M	4-8	10-15	1	0	0	0

Site	Species	Stratum	Height	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. Yes-1
RVS2	*Xanthostemon eucalyptoides*	M	4-8	10-15	1	0	0	0
RVS2	*Pandanus spiralis*	M	3-6	1-3	1	0	0	0
RVS2	*Carpentaria acuminata*	M	6	1	1	0	0	0
RVS2	*Helicia australasica*	M	3-5	<3	1	0	0	1
RVS2	*Syzygium armstrongii*	M	3-6	1-2	1	0	0	0
RVS2	*Acacia holosericea*	M	3-5	3-5	1	0	0	0
RVS2	*Exocarpos latifolius*	M	3-4	<1	1	0	0	0
RVS2	*Cyclophyllum schultzii f. schultzii*	M	3-4	<1	1	0	0	1
RVS2	*Dead stump - unknown tree*	M	-	<1	0	0	0	0
RVS2	*x1 dead Livistona stump - cause of death fire*	M	-	<1	0	0	0	0
RVS2	*x1 dead ironwood*	M	4	<1	0	0	0	0
RVS2	*Helicia australasica*	R	<3	25-30	1	0	1	1
RVS2	*Cyclophyllum schultzii f. schultzii*	R	<3	25-30	1	0	0	1
RVS2	*Pandanus spiralis*	R	<3	25-30	1	0	0	0
RVS2	*Breynia cernua*	R	<3	25-30	1	0	0	0
RVS2	*Exocarpos latifolius*	R	<3	25-30	1	0	0	0
RVS2	*Acacia holosericea*	R	<3	25-30	1	0	1	0
RVS2	*Leptospermum madidum subsp. sativum*	R	<3	25-30	1	0	0	0
RVS2	*Syzygium armstrongii*	R	<3	25-30	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	R	<3	25-30	1	0	0	0
RVS2	*Alphitonia excelsa*	R	<3	25-30	1	0	0	0
RVS2	*Carpentaria acuminata*	R	<3	25-30	1	0	0	0
RVS3	*Syzygium armstrongii*	U	12-15	5	1	0	0	0
RVS3	*Melaleuca viridiflora*	U	12-15	5-10	1	0	0	0
RVS3	*Erythrophleum chlorostachys*	U	12-14	5-10	1	0	0	0
RVS3	*Leptospermum madidum subsp. sativum*	U	10-12	<5	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	U	10-14	5	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	M	3-10	10-15	1	0	0	0
RVS3	*Leptospermum madidum subsp. sativum*	M	5-8	5-10	1	0	0	0
RVS3	*Alphitonia excelsa*	M	4-5	<1	1	0	0	0

Site	Species	Stratum	Height	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. Yes-1
RVS3	*Acacia auriculiformis*	M	8-10	1-5	1	0	0	0
RVS3	*Denhamia obscura*	M	6-8	1-3	1	0	0	1
RVS3	*Erythrophleum chlorostachys*	M	3-5	<1	1	0	0	0
RVS3	*Pandanus spiralis*	M	1-4	1	1	0	0	0
RVS3	*Pandanus aquaticus*	M	1-4	2-5	1	0	0	0
RVS3	*Livistona humilis*	M	3-4	1	1	0	0	0
RVS3	*Cyclophyllum schultzii f. schultzii*	M	3-4	1	1	0	0	1
RVS3	*Acacia holosericea*	M	3-5	5	1	1	1	0
RVS3	*Carallia brachiata*	M	3-4	<1	1	1	1	0
RVS3	*Melaleuca viridiflora*	M	4-6	<1	1	0	0	0
RVS3	*Dead stump - unknown tree*	M	10	<1	0	0	0	0
RVS3	*Erythrophleum chlorostachys*	R	<3	10-15	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS3	*Alphitonia excelsa*	R	<3	10-15	1	0	0	0
RVS3	*Breynia cernua*	R	<3	10-15	1	0	0	0
RVS3	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
RVS3	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS3	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS3	*Acacia holosericea*	R	<3	10-15	1	0	0	0
RVS3	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS3	*Carallia brachiata*	R	<3	10-15	1	0	0	0
RVS3	*Livistona humilis*	R	<3	10-15	1	0	0	0
RVS3	*Melaleuca viridiflora*	R	<3	10-15	1	0	0	0
RSV4	*Syzygium armstrongii*	U	14-16	20	1	0	1	0
RSV4	*Xanthostemon eucalyptoides*	U	12-14	15	1	0	0	0
RSV4	*Corymbia polycarpa*	U	10-12	5	1	0	0	0
RSV4	*Syzygium angophoroides*	U	8-10	5	1	0	0	0
RSV4	*Xanthostemon eucalyptoides*	M	4-8	25	1	0	0	0
RSV4	*Syzygium armstrongii*	M	6-8	10	1	0	0	0
RSV4	*Myrsine benthamiana*	M	3-6	10	1	0	0	1

Site	Species	Stratum	Height	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. Yes-1
RSV4	*Cyclophyllum schultzii f. schultzii*	M	3-5	15	1	1	1	1
RSV4	*Gmelina scherlii*	M	5-8	15	1	0	0	0
RSV4	*Carallia brachiata*	M	3-5	15	1	0	0	0
RSV4	*Acacia holosericea*	M	4-5	15	1	0	0	0
RSV4	*Pandanus spiralis*	M	4-6	15	1	0	0	0
RSV4	*iilex armenichas*	M	6-8	15	1	0	0	1
RSV4	*Flagellaria indica*	M	8-10	15	1	0	0	0
RSV4	*Melaleuca viridiflora*	M	8-10	15	1	0	0	0
RSV4	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
RSV4	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
RSV4	*Helicia australasica*	R	<3	10-15	1	0	0	1
RSV4	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RSV4	*Melicope elleryana*	R	<3	10-15	1	0	0	1
RSV4	*Acacia holosericea*	R	<3	10-15	1	0	0	0
RSV4	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RSV4	*Syzygium angophoroides*	R	<3	10-15	1	0	0	0
RSV5	*Syzygium armstrongii*	U	10-12	10-15	1	0	0	0
RSV5	*Xanthostemon eucalyptoides*	U	12-14	15	1	0	0	0
RSV5	*Melaleuca viridiflora*	U	10-12	10-15	1	0	0	0
RSV5	*Lophostemon lactifluus*	U	8-10	5-10	1	1	1	0
RSV5	*Leptospermum madidum subsp. sativum*	M	4-6	5-10	1	0	0	0
RSV5	*Helicia australasica*	M	3-6	10-15	1	0	0	1
RSV5	*Xanthostemon eucalyptoides*	M	4-10	15	1	0	0	0
RSV5	*Pandanus spiralis*	M	4-5	1-2	1	0	0	0
RSV5	*Syzygium armstrongii*	M	6-8	5	1	0	0	0
RSV5	*Melaleuca viridiflora*	M	6	<1	0	0	0	0
RSV5	*Cyclophyllum schultzii f. schultzii*	M	3-6	1-2	1	1	1	0
RSV5	*Lophostemon lactifluus*	M	6-7	<5	1	0	0	0
RSV5	*Carallia brachiata*	M	6-8	5	1	0	0	0
RSV5	*Acacia holosericea*	M	3-5	1-3	1	0	0	0

Site	Species	Stratum	Height	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. Yes-1
RSV5	*Myrsine benthamiana*	M	3-4	<1	1	0	0	1
RSV5	*Pandanus spiralis*	R	<3	1-5	1	0	0	0
RSV5	*Syzygium armstrongii*	R	<3	1-5	1	0	0	0
RSV5	*Helicia australasica*	R	<3	1-5	1	0	0	1
RSV5	*Acacia holosericea*	R	<3	1-5	1	0	0	0
RSV5	*Leptospermum madidum subsp. Sativum*	R	<3	1-5	1	0	0	0
RSV5	*Melicope elleryana*	R	<3	1-5	1	0	0	1
RSV5	*Xanthostemon eucalyptoides*	R	<3	1-5	1	0	0	0
RSV5	*Livistona humilis*	R	<3	1-5	1	0	0	0
RSV5	*Carallia brachiata*	R	<3	1-5	1	0	0	0
RSV5	*Cyclophyllum schultzii f. schultzii*	R	<3	1-5	1	0	0	1
RSV5	*Melaleuca viridiflora*	R	<3	1-5	1	0	0	0
RSV5	*Myrsine benthamiana*	R	<3	1-5	1	0	0	1
Ref	*Syzygium armstrongii*	U	14-16	15	0	0	0	0
Ref	*Melaleuca viridiflora*	U	16-18	15	1	0	0	0
Ref	*Lophostemon lactifluus*	U	8-10	5	1	0	0	0
Ref	*Xanthostemon eucalyptoides*	U	10-12	5-10	1	0	0	0
Ref	*Melicope elleryana*	M	8-10	5	1	0	0	1
Ref	*Carallia brachiata*	M	4-6	5	1	0	0	0
Ref	*Pandanus aquaticus*	M	3-6	5-10	1	0	0	0
Ref	*Xanthostemon eucalyptoides*	M	3-8	5-10	1	0	0	0
Ref	*Myrsine benthamiana*	M	3-6	5	1	0	0	1
Ref	*Cyclophyllum schultzii f. schultzii*	M	3-6	1	1	1	1	1
Ref	*Fagraea racemosa*	M	6	<5	1	0	0	1
Ref	*Corymbia polycarpa*	M	4	<1	1	0	0	0
Ref	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
Ref	*Barringtonia acutangula subsp. acutangula*	R	<3	10-15	1	0	0	0
Ref	*Carpentaria acuminata*	R	<3	10-15	1	0	0	0
Ref	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
Ref	*Pandanus spiralis*	R	<3	10-15	1	0	0	0

Site	Species	Stratum	Height	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. Yes-1
Ref	*Helicia australasica*	R	<3	10-15	1	0	0	1
Ref	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
Ref	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
Ref	*Melicope elleryana*	R	<3	10-15	1	0	0	1

APPENDIX B GROUND COVER DATA 2023 POST DRY-SEASON

Site name	Ground cover type	% cover
RVS1	Vegetation	15
RVS1	Soil	30
RVS1	Rock	0
RVS1	Litter	50
RVS1	Other	5
RVS2	Vegetation	45
RVS2	Soil	7.5
RVS2	Rock	0
RVS2	Litter	45
RVS2	Other	0
RVS3	Vegetation	40
RVS3	Soil	20
RVS3	Rock	0
RVS3	Litter	40
RVS3	Other	0
RSV4	Vegetation	40
RSV4	Soil	10
RSV4	Rock	0
RSV4	Litter	30
RSV4	Other	20
RSV5	Vegetation	10
RSV5	Soil	15
RSV5	Rock	0
RSV5	Litter	65
RSV5	Other	0
Reference site	Vegetation	65
Reference site	Soil	5
Reference site	Rock	0
Reference site	Litter	20
Reference site	Other	10

APPENDIX C VEGEATATION COVER DATA 2023 POST DRY-SEASON

Vegetation type	Vegetation type	% cover
RVS1	Grass	5
RVS1	Ferns	0
RVS1	Sedges	10
RVS1	Herbs	<5
RVS1	Other vegetation	0
RVS2	Grass	15
RVS2	Ferns	5
RVS2	Sedges	5
RVS2	Herbs	<5
RVS2	Other vegetation	0
RVS3	Grass	30
RVS3	Ferns	<1
RVS3	Sedges	5
RVS3	Herbs	<1
RVS3	Other vegetation	0
RSV4	Grass	25
RSV4	Ferns	<1
RSV4	Sedges	10
RSV4	Herbs	<1
RSV4	Other vegetation	0
RSV5	Grass	0
RSV5	Ferns	10
RSV5	Sedges	<1
RSV5	Herbs	<1
RSV5	Other vegetation	1-5
Reference site	Grass	55
Reference site	Ferns	0.9
Reference site	Sedges	10
Reference site	Herbs	4
Reference site	Other vegetation	0

APPENDIX D PHOTO MONITORING POINT – 2022 AND 2023

Photo monitoring point RSV1

<u>Post wet season 2022</u>	
<u>North</u>	**<u>East</u>**
	
<u>South</u>	**<u>West</u>**
	

Drone imagery post wet season 2022

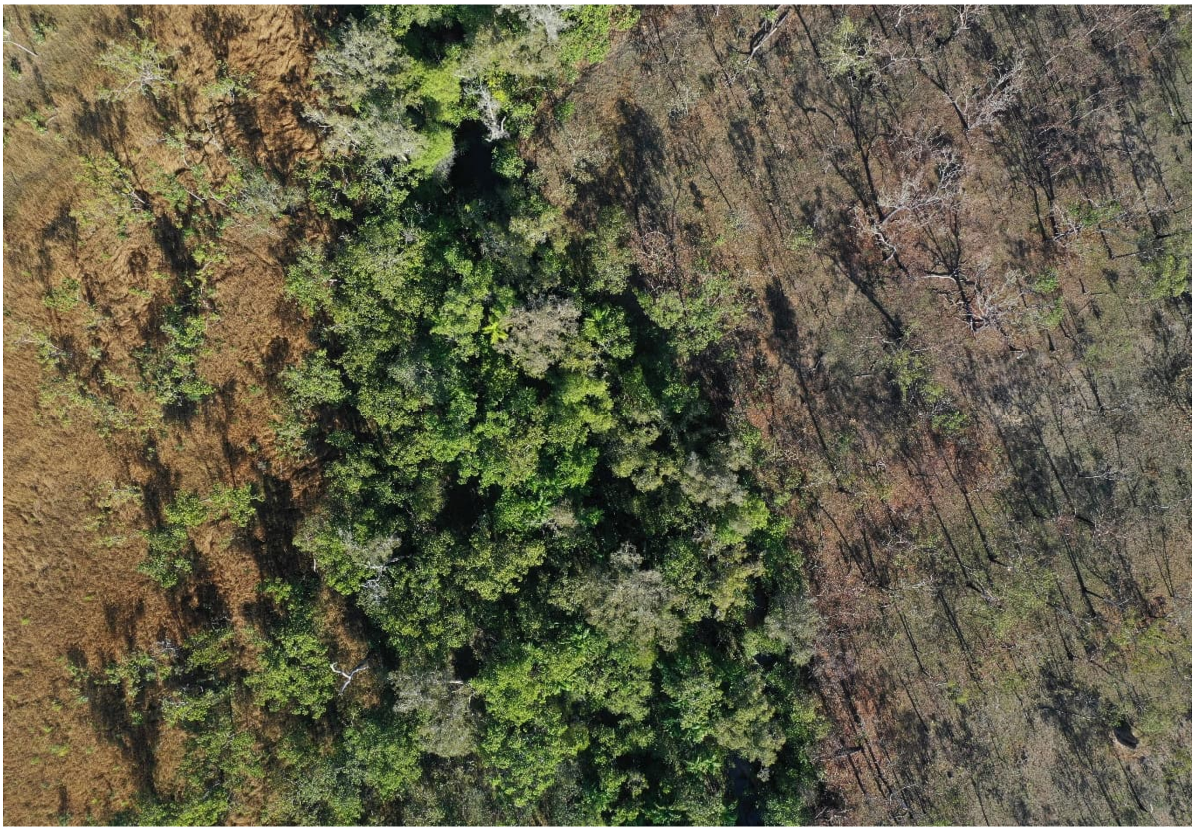
Post dry season 2022

North | **East**

South

West

Drone imagery post dry season 2022



Post-dry season 2023

North

East

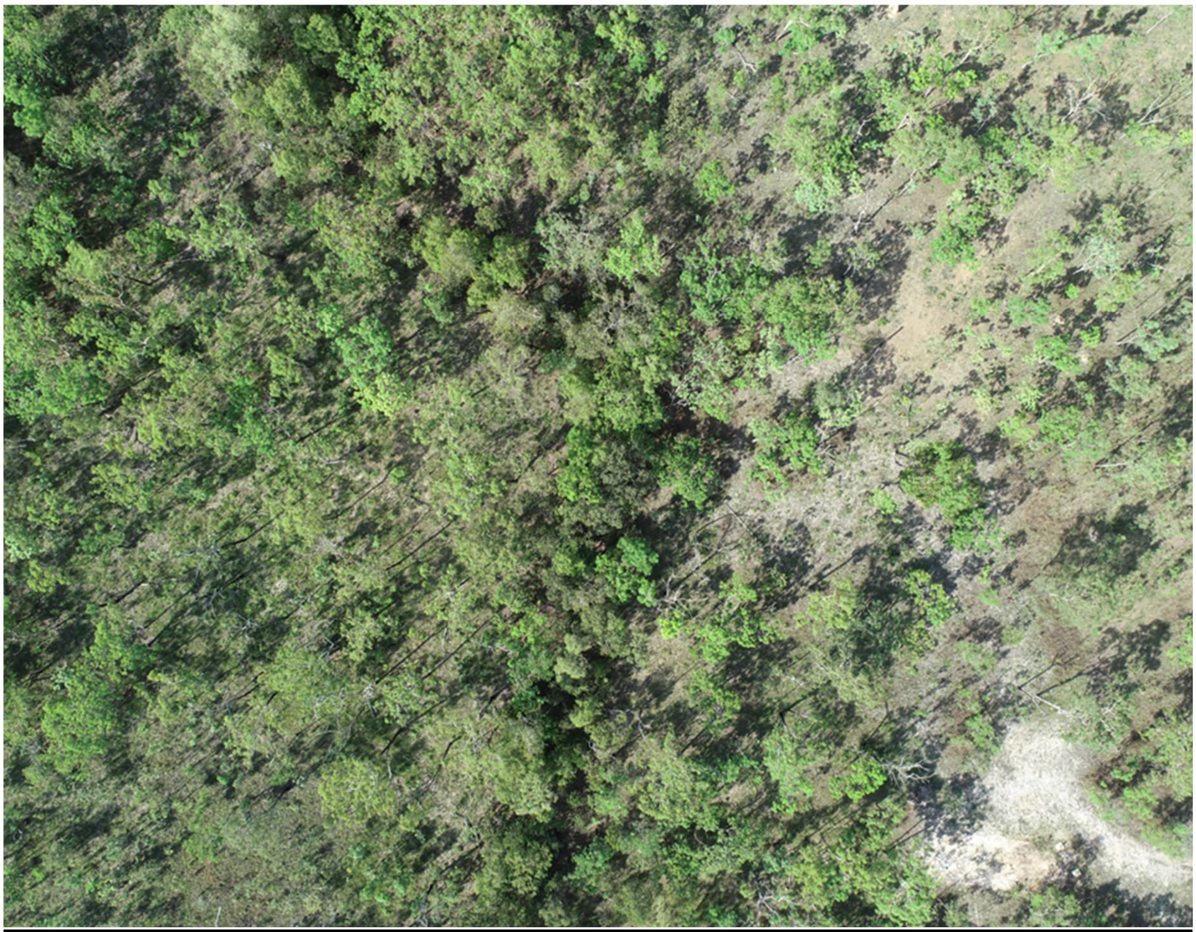
South

West

RSV2

Post wet season 2022	
North	**East**
	
South	**West**
	

Drone imagery post wet season 2022



Post dry season 2022

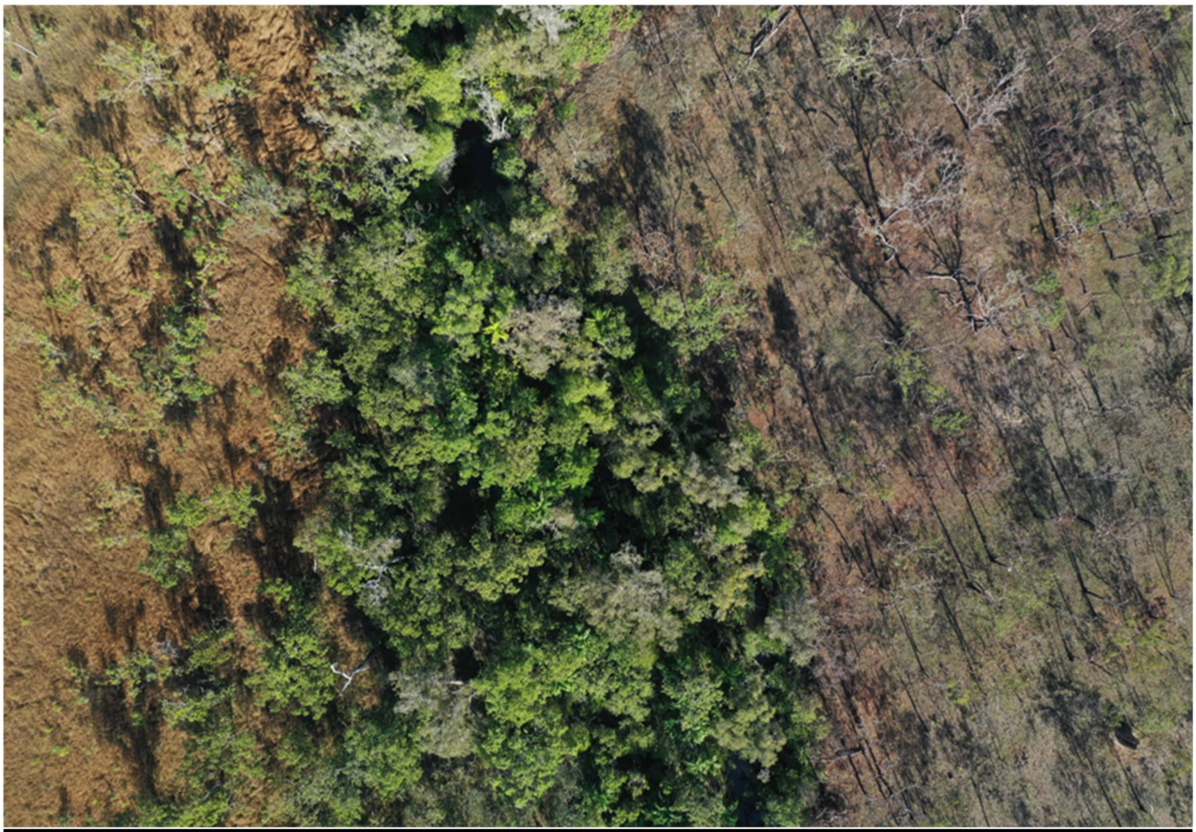
North

East

South

West

Drone imagery post dry season 2022



Post-dry season 2023

North

East

South

West

RSV3

Post wet season 2022	
North	**East**
	
South	**West**
	

Drone imagery post wet season 2022

Post dry season 2022

North

East

South

West

Drone imagery post dry season 2022

Post dry season 2023

North

East

South

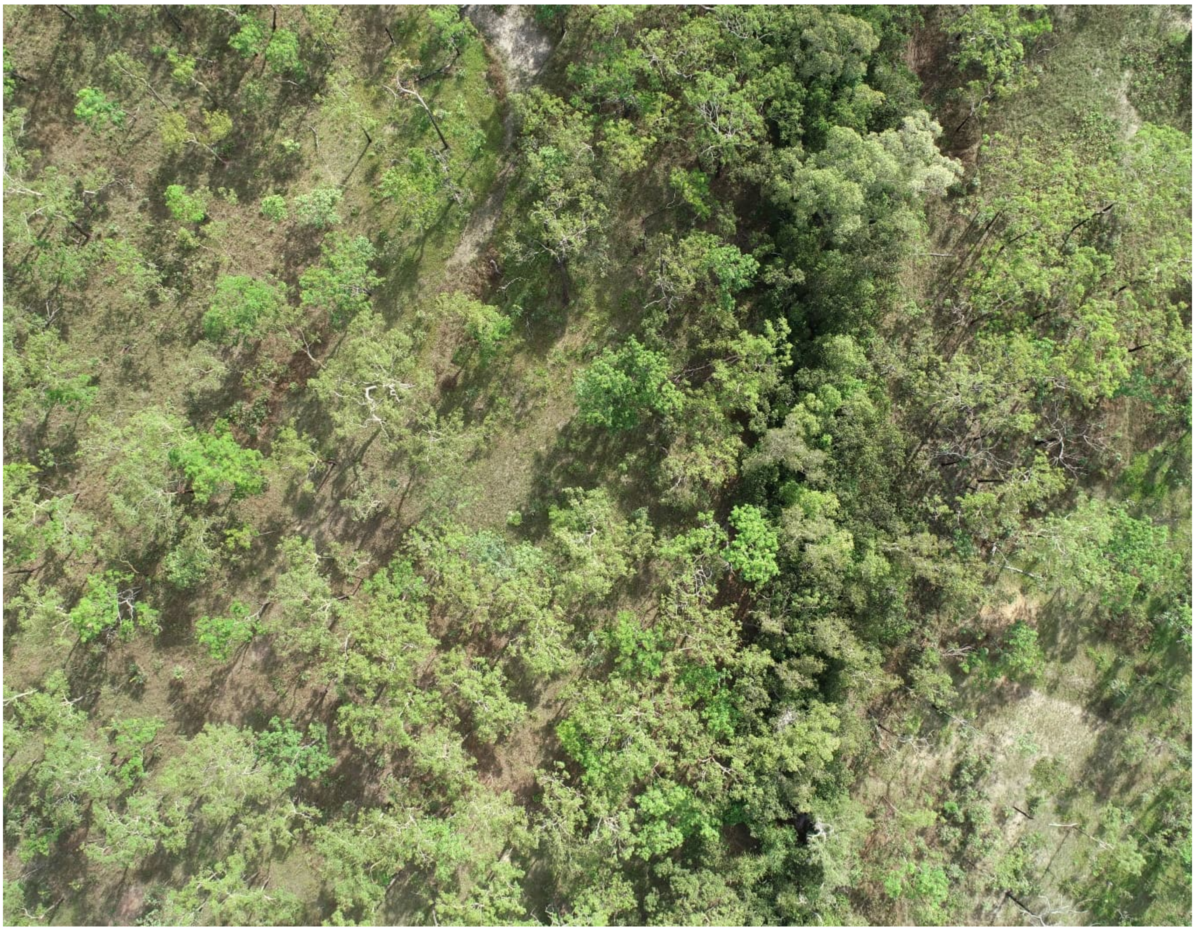
West

RSV4

Post wet season 2022

North	**East**
	
South	**West**
	

Drone imagery post wet season 2022



Post dry season 2022

North

East

South **West**

Drone imagery post dry season 2022

Post dry season 2023

North

East

South

West

RSV5

Post wet season 2022

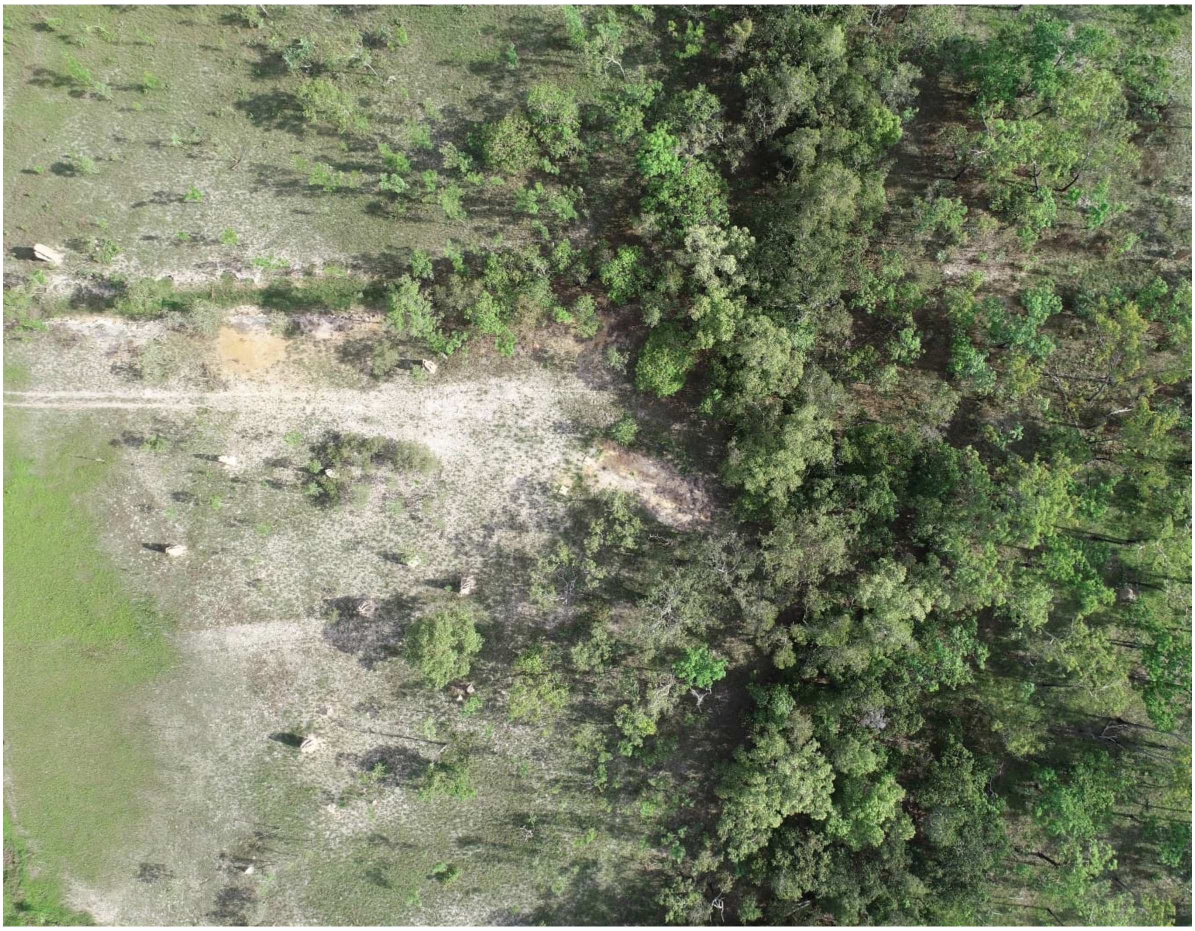
North

East

South

West

Drone imagery post wet season 2022



Post dry season 2022

North

East

South **West**

Drone imagery post dry season 2022

Post dry season 2023

North

East

South

West

Reference site

Post wet season 2022

North	East
	
South	**West**
	

Post dry season 2022

North	East
	

South

West

Post dry season 2023

North

East

South

West

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Finniss Lithium Project

Observation Hill Dam Surface Water Monitoring Program

EcOz Environmental Consultants
1727-03-B2, 13 April 2022

Report Title	Finniss Lithium Project, Observation Hill Dam Surface Water Monitoring Program
Client	EcOz Environmental Consultants Level 1 70 Cavenagh Street, Darwin NT 0800
Report Number	1727-03-B2

Revision Number	Report Date	Report Author	Reviewer
1	9/03/2022	AMC	JDO
2	1/04/2022	AMC	JDO
3	13/04/2022	AMC	JDO

For and on behalf of WRM Water & Environment Pty Ltd
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Tel 07 3225 0200

Julian Orth

Principal Engineer

Contents

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1 Introduction

1.1 BACKGROUND

The Finniss Lithium Project (the Project) is located in the Northern Territory approximately 25 km southwest of Darwin. The product will be hauled to the East Arm Port for distribution. A locality plan of the Finniss Lithium Project is shown in Figure 1.1. The Project currently includes the approved Grants Lithium Project (Grants) and the proposed adjacent underground operation, BP33. The Finniss Lithium Project is managed by Core Lithium Ltd (Core).

WRM Water & Environment (WRM) have been commissioned by EcOz Environmental Consultants (EcOz) on the behalf of Core to develop an Observation Hill Dam (OHD) Surface Water Monitoring Program (SWMP) for the Project. This SWMP will address special conditions 4.1 and 4.2 of Core's Water Extraction Licence (WEL) (no. 8151018):

- measures to monitor impacts on surface water conditions (volumes and flows) downstream of the waterway;
- trigger values for changes in surface water which indicate that impacts to flows downstream of the waterway significantly vary from those predicted in Core Exploration Ltd, Cox Peninsula Supplementary Report prepared by EnviroConsult Pty Ltd dated February 2019 (relevant section/s provided in Appendix A of this report); and
- measures to undertake further assessment to characterise the nature of impacts to surface water conditions and riparian vegetation if the trigger values identified above are reached.

1.2 PROJECT DESCRIPTION

The targeted ore body is a near-vertical pegmatite intrusion, rich in the lithium-bearing mineral spodumene. The ore body will be mined via an open-cut (OC) pit using drill and blast methods, and processed on site by crushing, screening and water-based dense medium separation (DMS), to produce a concentrate for transport via road to Darwin Port for export. Waste rock from the pit will placed in an onsite waste rock dump (WRD), and waste from processing will be placed in a tailings storage facility (TSF) contained within the WRD. The Grants open cut mine life is expected to be two to three years. The proposed mine layout for Grants, including all major surface water infrastructure elements required during operations, is shown in Figure 1.2.

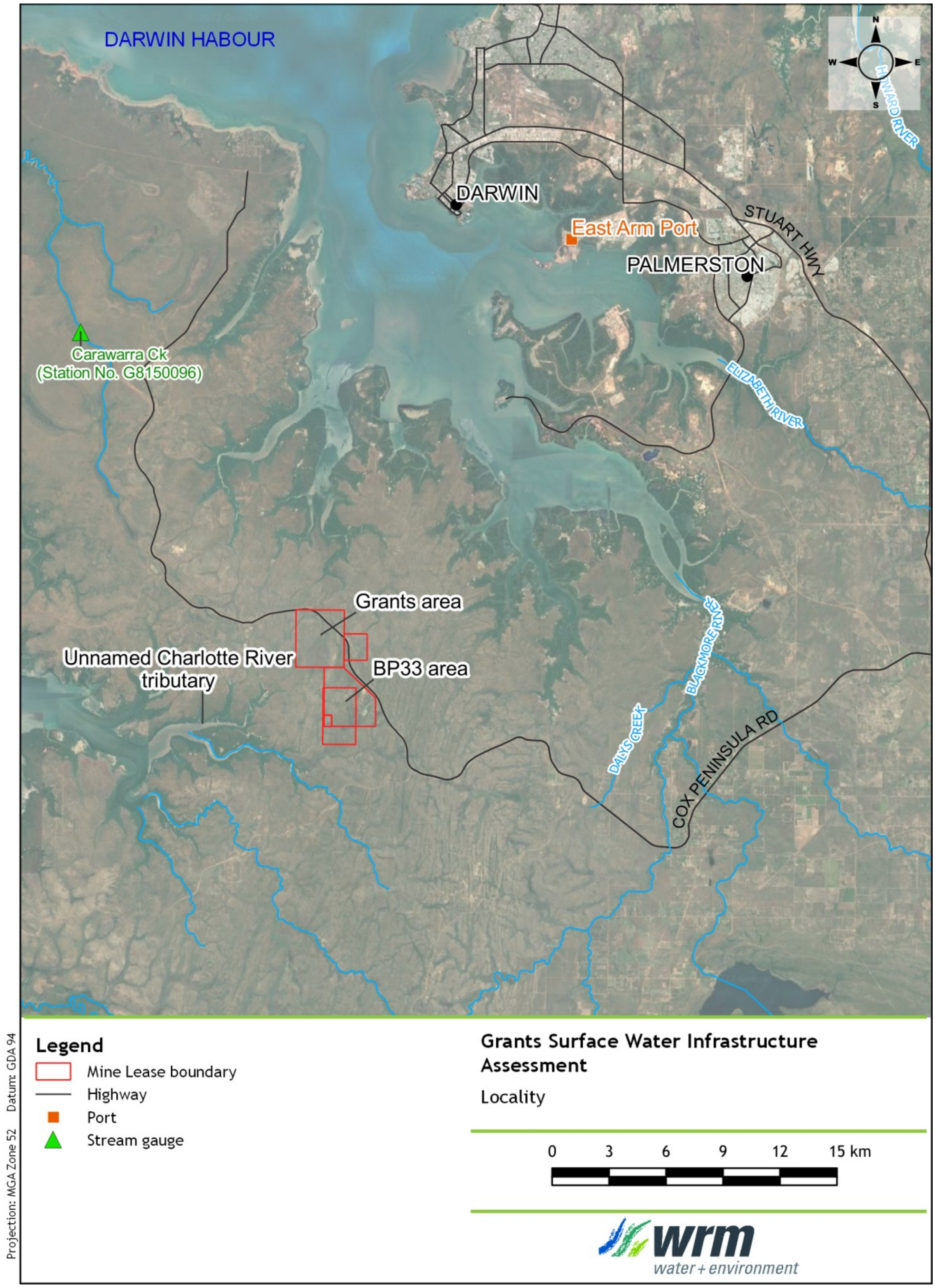


Figure 1.1 – Project locality

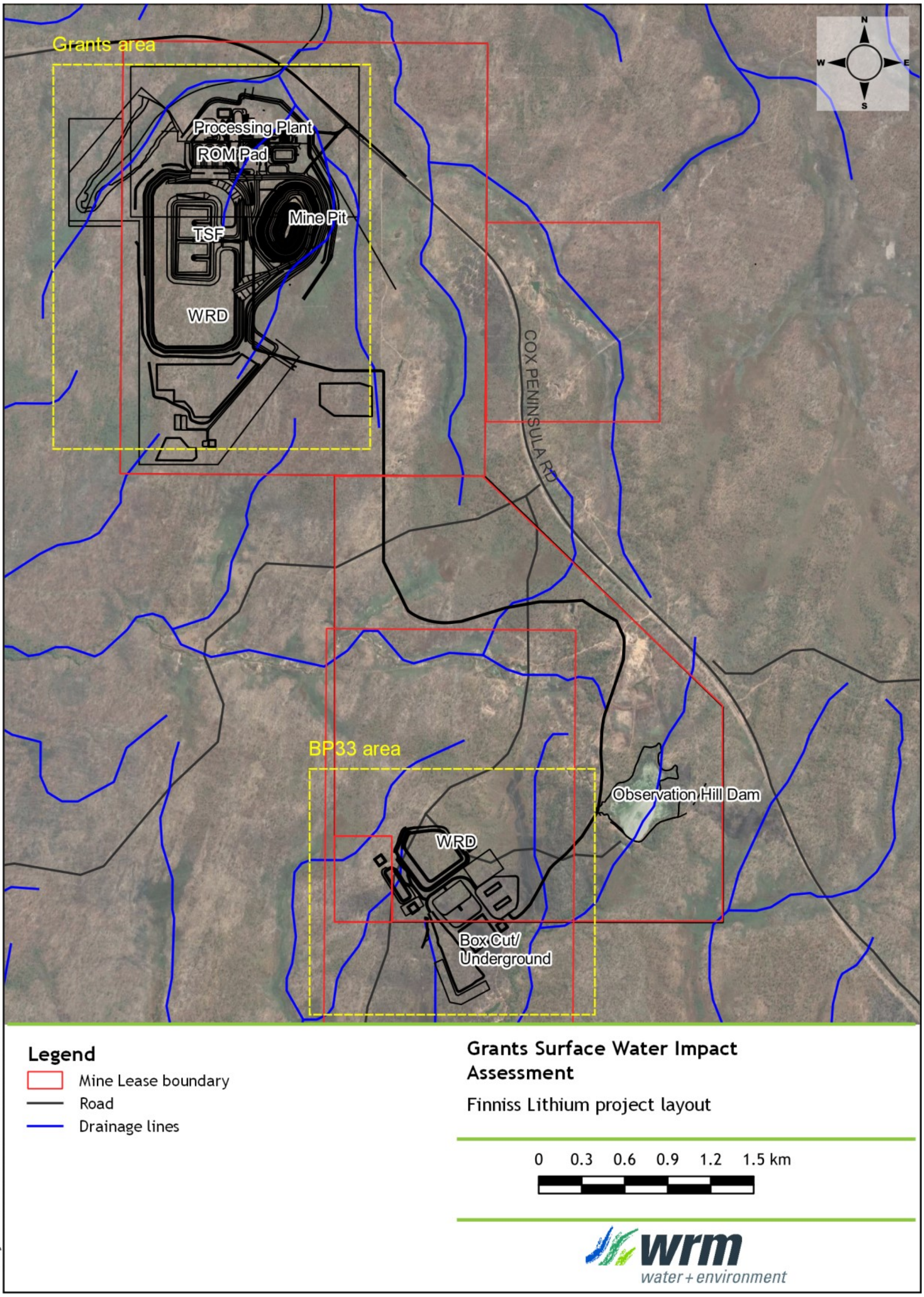


Figure 1.2 – Project layout

1.3 WATER EXTRACTION LICENCE

The Core WEL (8151018) commenced on 1 December 2021 and would allow for the extraction of up to 620 ML per annual period from OHD. The location of OHD is shown in Figure 1.2. Table 1 of WEL 8151018 (reproduced in Table 1.1) shows the total extraction volumes permitted from OHD over a set period. For each period specified in Table 1 of WEL 8151018, Core must ensure that the total extraction from OHD does not exceed the Entitlement.

The Core WEL also defines a security level of Low, Medium or High. The security level is the order in which announced allocations are applied to licences. The Core WEL security level is undefined.

Table 1.1 – Entitlement volumes for the Project, per the WEL (from Table 1 of WEL 8151018)

Entitlement (ML)	Period
310	Commencement date to 30 April 2022
310	1 May 2022 to 31 October 2022
61	1 November 2022 to 30 April 2023
121	1 May 2023 to 30 April 2024
121	1 May 2024 to 30 April 2025

1.4 REPORT STRUCTURE

This report is structured as follows:

- Section 2: A description of the current and proposed water management infrastructure at Grants.
- Section 3: A description of the existing surface water environment at Grants, including recorded water quality data.
- Section 4: An assessment of the potential downstream impacts of extraction from OHD.
- Section 5: A description of the proposed surface water monitoring plan.
- Section 6: The preliminary Downstream Risk Matrix for the operation of OHD.
- Section 7: The draft Trigger Action Response Plan for the WEL.
- Section 8: Review requirements of the SWMP.
- Section 9: Limitations of the information used to prepare the SWMP.
- Section 10: Provides a list of references.

2 Observation Hill Dam characteristics

2.1 OVERVIEW

The project plans to utilise the existing OHD as a makeup water supply storage. Water from OHD would be transferred to RWD via a 6 km underground pipeline, if required to meet onsite demands. This dam was constructed to supply water for tin and tantalite mining and ore processing that occurred in the 1980's and 1990's.

2.2 CATCHMENT AREA

OHD receives a runoff from a 93.9 ha catchment generally south of Cox Peninsula Road, as pictured in Figure 2.2. This catchment is based on the LiDAR collected by Core in 2021.

2.3 EMBANKMENT

The location of the existing OHD embankment is shown in Figure 2.2. The minimum embankment crest level is currently at 31.5 mAHD.

Foundations under the OHD existing embankment were found to be low to very low strength clays and silts, up to 9 m below the embankment. Phyllite and/or metasandstone was encountered below the low strength foundations.

2.4 STORAGE CAPACITY

The current estimated FSV for OHD is 364 ML. Core propose to raise the dam wall by approximately 1.5 m to increase storage capacity to around 620 ML. It is expected that the dam wall raise would be completed by the 2022 dry season.

The stage-storage curve developed by GHD (2021) for OHD (including the raised capacity) is presented in Figure 2.1.

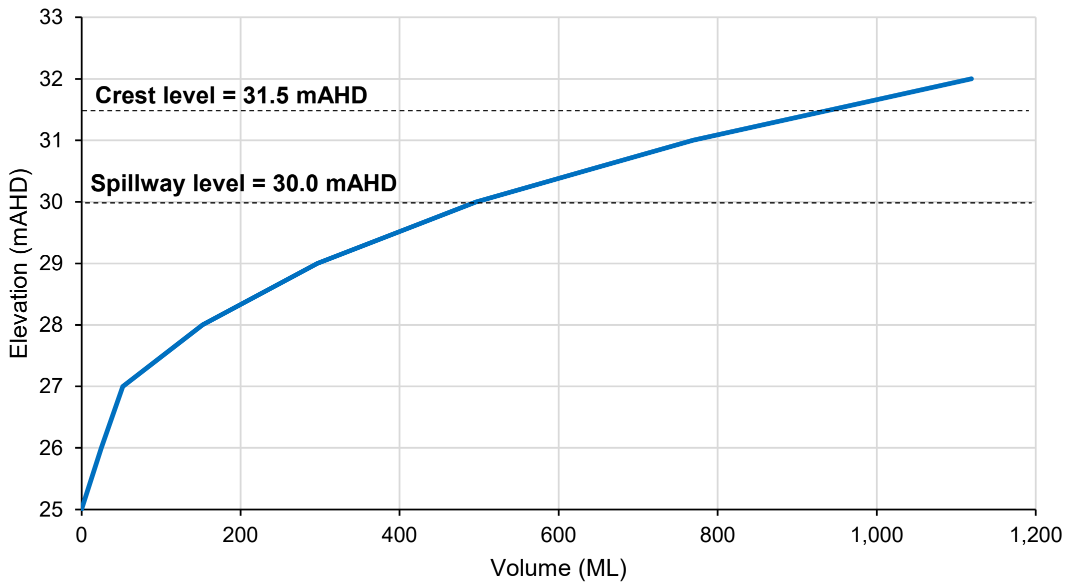
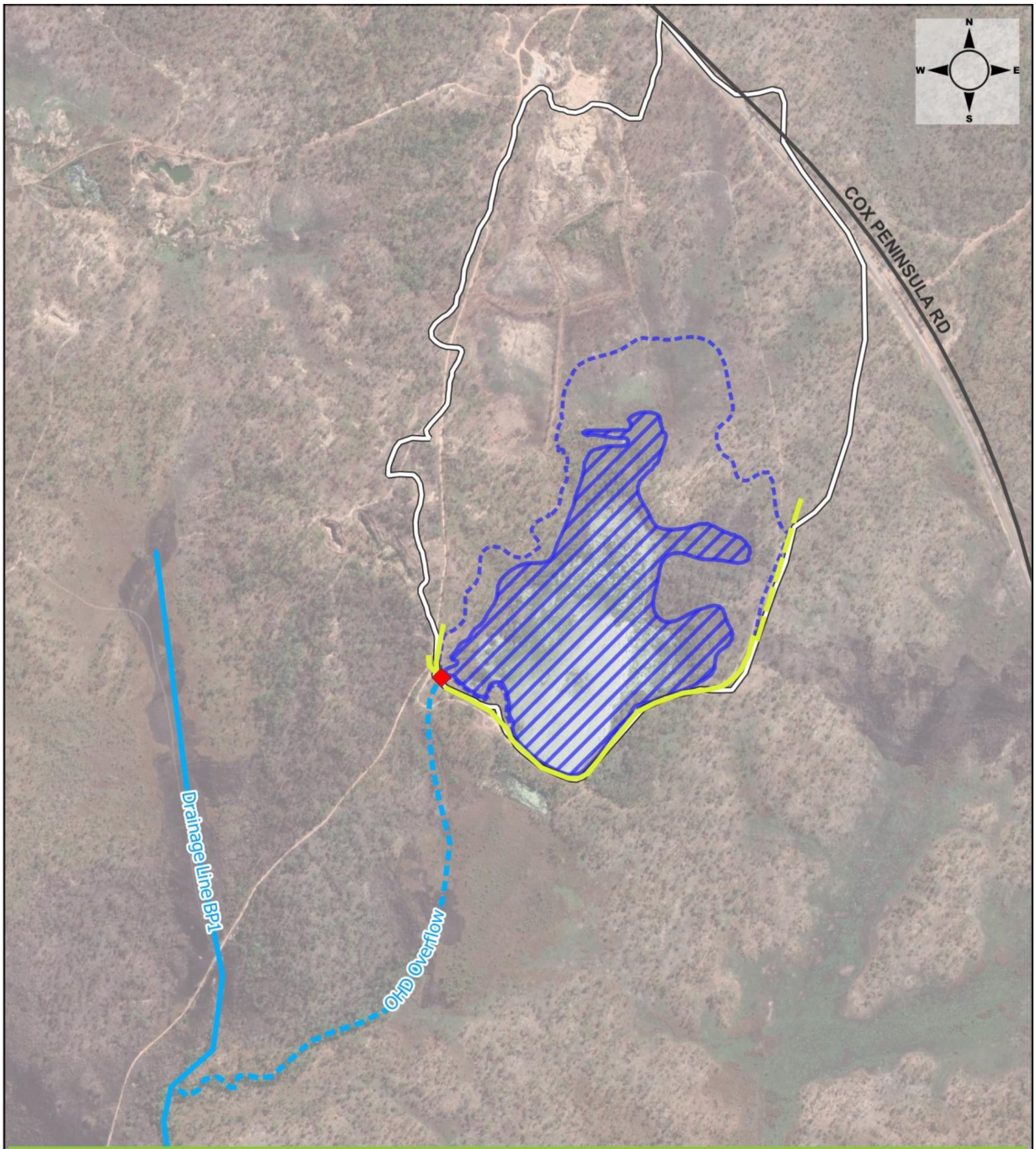


Figure 2.1 – Observation Hill Dam stage-storage curve (GHD, 2021)



Projection: MGA Zone 52 Datum: GDA 94

Legend

- Mine Lease boundary
- Road
- Drainage Lines
- OHD overflow path
- Current OHD footprint
- Upgraded OHD footprint (proposed)
- OHD embankment alignment
- OHD proposed embankment alignment
- OHD spillway location
- Catchment area

Grants Surface Water Monitoring Plan

Observation Hill Dam location and layout

0 200 400 600 800 m

wrm water + environment

Figure 2.2 – OHD location and catchment area

2.5 SPILLWAY

The existing OHD spillway is located on the north western edge of the dam embankment (see Figure 2.2) and would direct flows into Drainage Line BP1. The spillway has an elevation of approximately 30 mAHD and a width of approximately 5 m. Figure 2.2 also shows the maximum OHD footprint, based on the current spillway level.

2.6 DAM WALL RAISING

In order to increase the storage capacity of OHD, and hence the volume of water available to supply site demands, Core propose to raise the OHD embankment and spillway. The embankment would be raised by 1.4 m and the spillway would be raised by 1.5 m, increasing the total capacity from 364 ML to 620 ML. The upgraded OHD spillway would be designed to have a 1% AEP capacity, based on a ‘Low’ Dam Failure Consequence Category (GHD, 2021; ANCOLD, 2012). The proposed OHD upgraded spillway and embankment design is presented in

Table 2.1. A typical section of the proposed raise is shown in Figure 2.3

Table 2.1 – Summary of OHD upgrade specifications

Parameter	Value
Storage type	Valley Dam
Embankment type	Zoned earthfill
Crest level	RL 32.9 mAHD
Height (max)	11.2 m
Crest width	6 m
Upstream batter slope (H:V)	3:1
Downstream batter	4:1

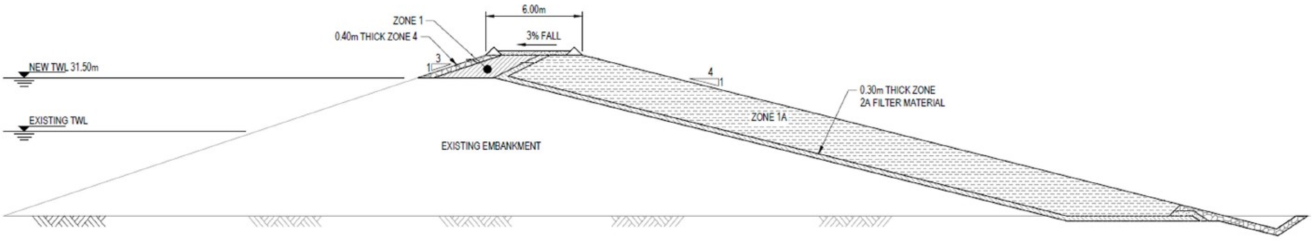


Figure 2.3 – OHD upgrade typical section (GHD, 2021)

The majority of the proposed raise consists of a general earthfill zone back sloping from the existing embankment, which would likely be sourced from previously disturbed mining areas adjacent to the storage. The embankment would be overlain with an erosion protection layer.

A sand filter would also be included on the downstream side of the existing embankment, tying into a blanket filter on the new foundations before reporting to the downstream rock toe. The purpose of the sand filter would be to reduce the risk of piping failure.

3 Catchment hydrology and environmental values

3.1 GENERAL

This section describes the drainage characteristics in the vicinity of the Project and the key water storages. The environmental values as defined by the NT Water Act, Environmental Protection Policies (EPPs), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) and regulations of these waterways are also described.

3.2 CATCHMENT HYDROLOGY

3.2.1 Project

Figure 3.6 shows the local drainage features within the vicinity of Grants. Drainage features that cross the Project area eventually drain to the Timor Sea. The tributaries connecting with the Timor Sea which intersect the Grants area include (Figure 3.6):

- Drainage Line 1;
- Drainage Line 2;
- Drainage Line 3;
- Drainage Line BP1; and
- Drainage Line BP2.

3.2.2 OHD

OHD is located adjacent to the proposed BP33 area and receives runoff from a largely undisturbed catchment area of 94 ha. There are no defined drainage lines in the upper OHD catchment. The upper catchment has a slope between 1% to 2%. Figure 3.1 shows the upper OHD catchment area, which appears to be well vegetated.

Figure 3.2 shows the OHD water surface and surrounding vegetation. This photograph shows that the area around OHD is well vegetated.

OHD would overflow via its spillway, during wet weather events, into Drainage Line BP1.

Figure 3.1 – OHD upper catchment

Figure 3.2 – OHD water surface

3.2.3 Drainage Line BP1

Drainage Line BP1 has a catchment area of approximately 298 ha and 365 ha to the BPUS SW1 and BPDS SW2 monitoring locations respectively (shown in Figure 3.6). Of this catchment area, 93.8 ha would be impounded by OHD. The catchment is mostly natural with some grassed areas that were cleared by preliminary exploration activities. The channel is poorly defined, particularly in the upper section of the reach. The channel banks are vegetated with grasses, shrubs and small trees, as shown in Figure 3.4.

There is a small exploration pit void adjacent to the Drainage Line BP1 channel, downstream of BPUS SW1 (shown in Figure 3.5). The void has filled with water. The void is surrounded by an embankment approximately 1 m high, which may constrict flows in this location.

Cross-sections taken across the Drainage Line BP1 channel are shown in Figure 3.3 and are based on available LiDAR ground survey. The cross sections show the following regarding the Drainage Line BP1 channel:

- Drainage Line BP1 is a broad overland flowpath with no defined channel at DL2XS1.
- At DL2XS2, DL2XS3 and DL2XS4, the channel has the following characteristics:
  - 4-5 m channel base width; and
  - 1V:4H to 1V:6H channel side slopes.

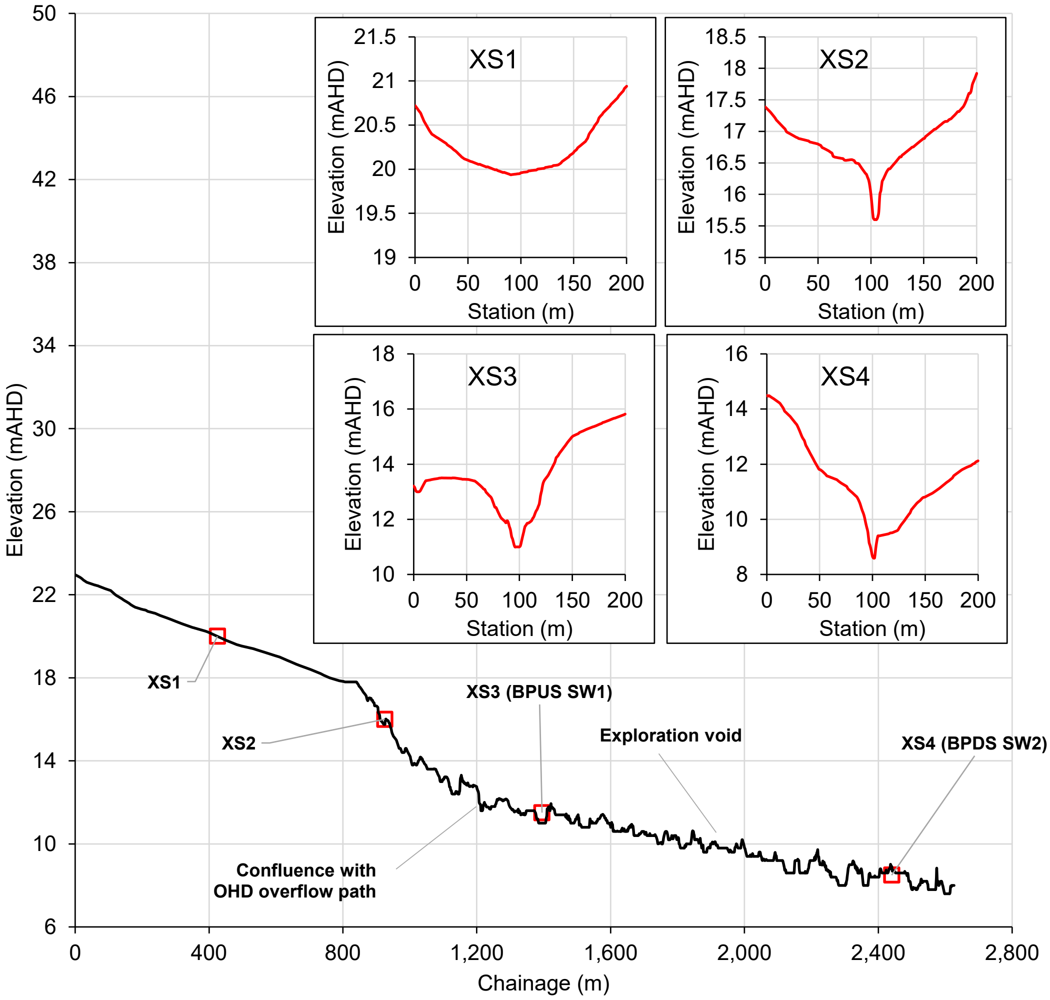


Figure 3.3 – Drainage Line 2 representative cross sections

Figure 3.4 – Drainage Line BP1 channel

Figure 3.5 – Drainage Line BP1 exploration void

3.3 WATER QUALITY

EcOz undertook surface water quality sampling during 2016 and 2017 at the monitoring locations presented in Figure 3.6. Core personnel collected water quality samples between 2017 and 2021. A statistical analysis of the water quality sampling results for key analytes is presented in Table 3.1. The following is of note regarding the water quality sampling results:

- OHD generally exhibited low concentrations of metals, however nutrients (nitrogen and phosphorus) were slightly elevated. The elevated nutrient concentrations are likely the result of biological processes (i.e. algal blooms);
- The receiving water locations generally tend to have lower pH level (slightly acidic);
- The dissolved metal concentration in the receiving water locations is generally low, with some exceptions for aluminium and iron; and
- Overall, the water quality in OHD and at the receiving water locations is generally similar.

Table 3.1 – Surface water quality monitoring results

Parameter	Units	OHD				BPUS SW1				BPDS SW2			
		count	20%ile	50%ile	80%ile	count	20%ile	50%ile	80%ile	count	20%ile	50%ile	80%ile
pH	pH unit	13	5.9	6.6	6.9	13	5.1	5.5	7.3	13	5.3	5.5	7.3
EC	µS/cm	13	15	19.5	23.4	13	14.6	18.2	26.6	13	15.9	17.7	25.9
DO	%sat	13	56.1	79.2	89.7	13	59.3	75.2	83.5	13	51.1	74.9	83.2
Turbidity	NTU	12	1.8	4.5	9.7	12	3	4.6	11.8	13	3	5.6	21
Aluminium	mg/L	12	0.01	0.01	0.012	13	0.02	0.06	0.146	13	0.02	0.04	0.116
Arsenic	mg/L	12	0.002	0.003	0.0042	13	<0.001	<0.001	0.002	13	<0.001	<0.001	0.0022
Cadmium	mg/L	13	<0.0001	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0001
Chromium	mg/L	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Copper	mg/L	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Lead	mg/L	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Nickel	mg/L	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Selenium	mg/L	9	<0.01	<0.01	<0.01	10	<0.01	<0.01	<0.01	10	<0.01	<0.01	<0.01
Zinc	mg/L	13	<0.005	<0.005	<0.005	13	<0.005	<0.005	<0.005	13	<0.005	<0.005	<0.005
Lithium	mg/L	13	<0.001	<0.001	0.0022	11	<0.001	0.003	0.0072	11	<0.001	0.003	0.0068
Iron	mg/L	12	0.05	0.06	0.182	13	0.09	0.17	0.306	13	0.094	0.16	0.428
Mercury	mg/L	13	<0.0001	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0001	13	<0.0001	<0.0001	<0.0001
Ammonia as N	mg/L	13	<0.01	0.02	0.07	13	<0.01	0.03	0.074	13	<0.01	0.02	0.096
NOx as N	mg/L	13	<0.01	0.02	0.04	13	<0.01	<0.01	0.03	13	<0.01	<0.01	0.03
TN as N	mg/L	13	0.2	0.3	0.5	13	<0.1	0.2	0.22	13	<0.1	0.2	0.34
TP as P	mg/L	13	<0.01	<0.01	0.02	13	<0.01	<0.01	0.016	13	<0.01	<0.01	0.022
TRP as P	mg/L	12	<0.001	0.002	0.0052	13	0.001	0.003	0.01	13	<0.001	0.003	<0.01

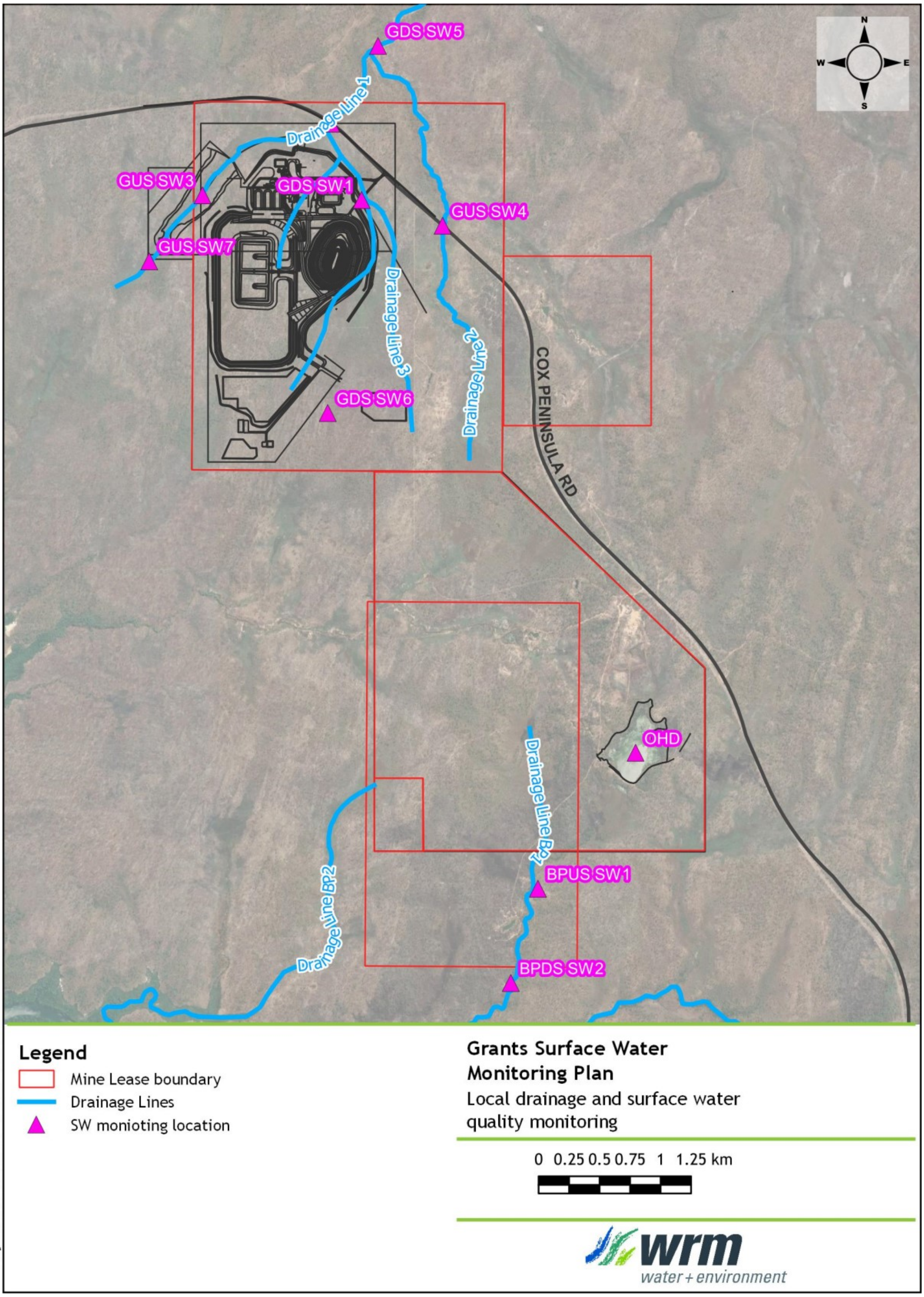


Figure 3.6 – Surface water quality monitoring location

4 Assessment of potential downstream impacts

4.1 OVERVIEW

An assessment of the maximum potential impacts due to water extraction from OHD was assessed as part of Grant's Mining Management Plan (Enviroconsult, 2019) for an average rainfall year. This study found that, over a full wet season of average rain (~1,652 mm), the reduction in average flows downstream of OHD due to an annual water extraction volume of 738 ML/year (daily average of 2.02 ML/d) would be 45% during the wet season. This is considered to be the maximum impact on downstream flows due to water extraction for this climatic sequence per Special Condition 4.1(iii) of the WEL. Note that the current pump at OHD has an extraction rate of up to 4.00 ML/d.

The outcomes of the Enviroconsult (2019) assessment would be considered as the baseline limit for downstream impacts due to water extraction from OHD.

4.2 MODELLED DOWNSTREAM IMPACTS FOR VARYING CLIMATIC CONDITIONS

The Enviroconsult (2019) assessment only presented potential downstream impacts for the average wet season. However, it is important to consider the full range of climatic conditions that Grants may experience to determine the limits to potential downstream impacts. For example, water extraction during drier years would likely result in greater downstream impact, compared to the average downstream impact. Whereas, during wetter years, the downstream impact would likely less than average conditions.

The Project GoldSim water balance model was used to estimate the potential downstream impacts of water extraction from OHD for a range of climatic conditions. The model also considered water requirements on site (i.e. water was only taken from OHD as needed). The development of the GoldSim model is documented in WRM (2022).

Note that the OHD extraction volumes would be sensitive to the water balance assumptions including (but not limited to):

- Groundwater inflow rates into the Mining Pit;
- Actual production rates and DMS plant process demands;
- Haul road dust suppression demands; and
- Catchment runoff volumes collected by the site.

Figure 4.1 shows the likely (i.e. taken as needed) and maximum downstream impacts (assessed immediately downstream of the OHD spillway) ranked according to the probability of exceedance. This figure shows the following:

- The black curve represents the potential downstream impacts of water extraction from OHD, taking the requirement for additional site water into consideration (i.e. taken as needed). This curve was generated based on the Goldsim model.
- The dashed grey curve represents the methodology presented in the Enviroconsult (2019) assessment. That is, the average wet season impact was calculated using a constant 2.02 ML/d extraction rate (regardless of the volume in OHD and the Grants water management system).
- The blue dots represent total wet season rainfalls (in mm), plotted corresponding with the associated downstream impact.

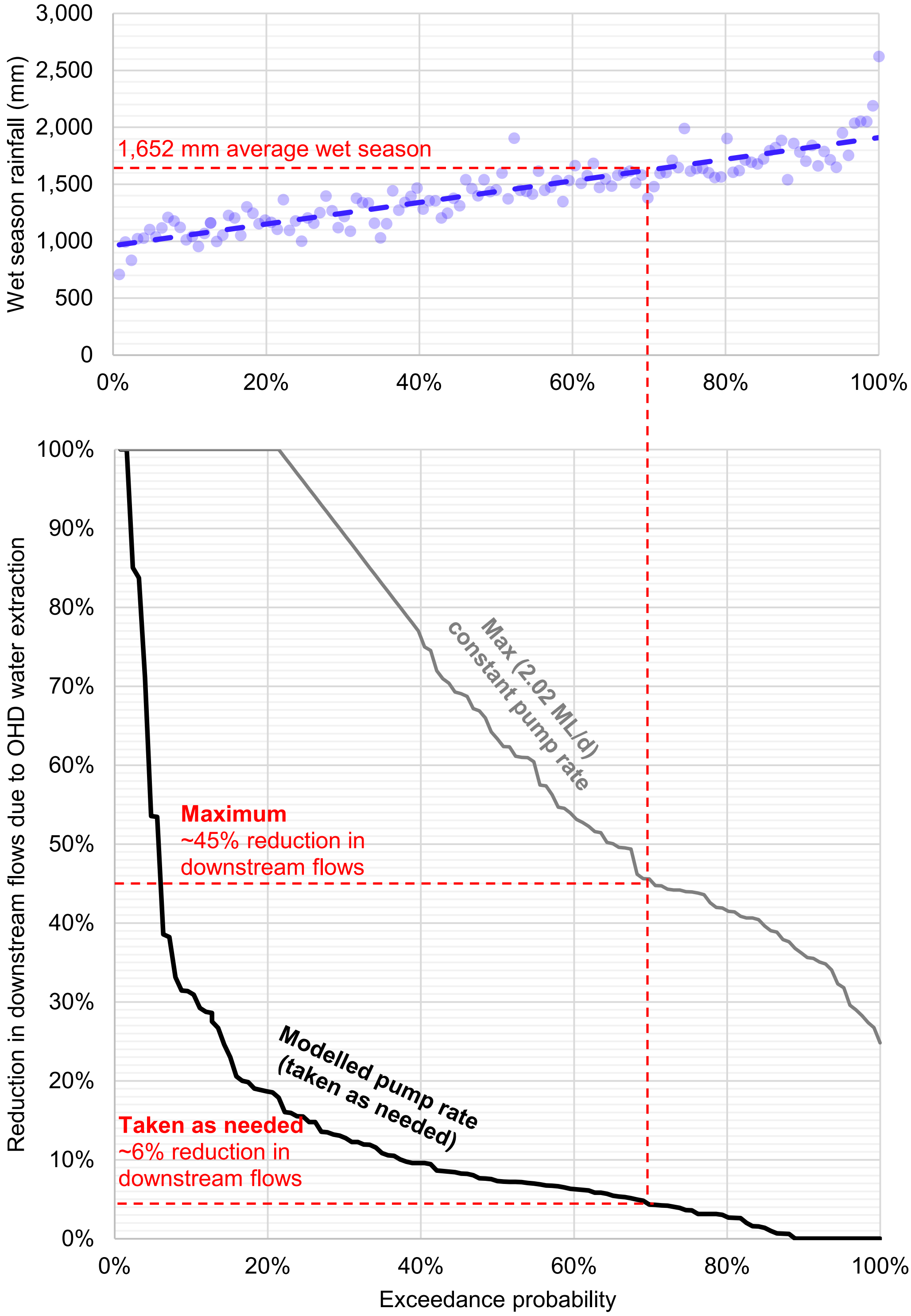


Figure 4.1 – Potential impact of water extraction from OHD on downstream flow volumes

The following is of note regarding this figure:

- For conservativism, it was assumed that OHD would be empty at the beginning of the wet season.
- If water is extracted from OHD as needed (assumed that the site water demand assumptions are correct), is it not likely that the downstream impacts of OHD will exceed the maximum downstream impacts reported by Enviroconsult (2019).
- If OHD is pumped out at a constant rate of 2.02 ML/d, this may result in a downstream flow reduction of 100% (i.e. no overflows occurring during the wet season), for the driest 40% of climatic conditions. Taking water as need from OHD would only result in 100% flow reduction in the driest 2% of climatic conditions.
- If the current maximum pump rate (4.00 ML/d) is maintained for extended periods, there would be a potential for the maximum allowable downstream impact to be exceeded.

Based on the maximum allowable downstream flow reductions presented Figure 4.1, the minimum required annual OHD spill days have been determined. The annual spill days (considering no OHD pumping) were estimated using the Project GoldSim model. The minimum allowable annual spill days are presented in Figure 4.2.

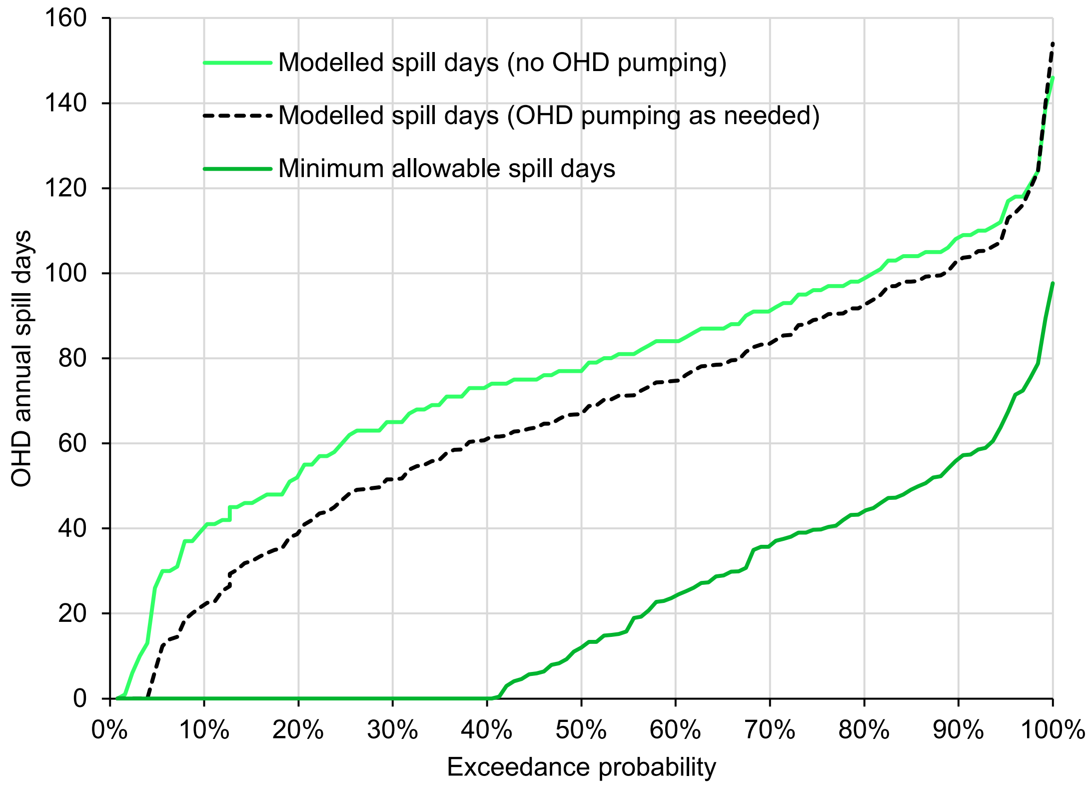


Figure 4.2 - Minimum annual spill days required during OHD water extraction

4.3 APPLICATIONS

The relationship between the maximum downstream impacts and wet season rainfall can be used as an early warning tool, to predict whether the current extraction rate would cause an exceedance of the maximum allowable downstream impacts. The potential downstream impacts from OHD would be managed using two plans: Surface Water Monitoring Plan and Downstream Risk Matrix. The details of these plans are discussed in the following sections.

5 Proposed surface water monitoring plan

5.1 OVERVIEW

Monitoring of surface water levels downstream of OHD will form a key component of the surface water management system. Monitoring of water levels will assist in demonstrating that the site water management system is effective in meeting its objective of minimal impact on downstream flows and will allow for early detection of any impacts and appropriate corrective action.

The surface water monitoring protocols will:

- ensure compliance with the Project Waste Discharge Licence (WDL) and Water Extraction Licence (WEL);
- provide valuable information on the performance of the water management system; and
- facilitate adaptive management of water resources on the site.

5.2 WATER LEVEL MONITORING LOCATIONS

Water levels downstream of OHD should be monitored on a continuous basis to determine the potential impact of water extraction on downstream flow volumes. Water levels would be monitored at the OHD spillway and at the downstream location BPDS SW2. It is recommended that a water level logger is installed in these locations.

Additionally, water levels in OHD should also be monitored. This could be done by collecting a surveyed water level on a weekly basis and as part of routine water quality monitoring.

Locations of the proposed surface water monitoring locations are shown in Figure 5.1 and summarised in Table 5.1.

Table 5.1 - Water level monitoring locations

Name	Location	Easting (m)	Northing (m)	Sampling frequency
OHD DS	OHD spillway	695,185	8,594,842	Continuous
BPDS SW2	Drainage Line BP1 D/S of OHD	694,461	8,593,025	Continuous
OHD	OHD	695,422	8,595,695	Continuous

5.3 RATING CURVE DEVELOPMENT

Rating curves should be developed for the OHD spillway and BPDS SW2 water level monitoring locations, to relate recorded water levels to flows. It is recommended that these rating curves are developed prior to the implementation of this SWMP.

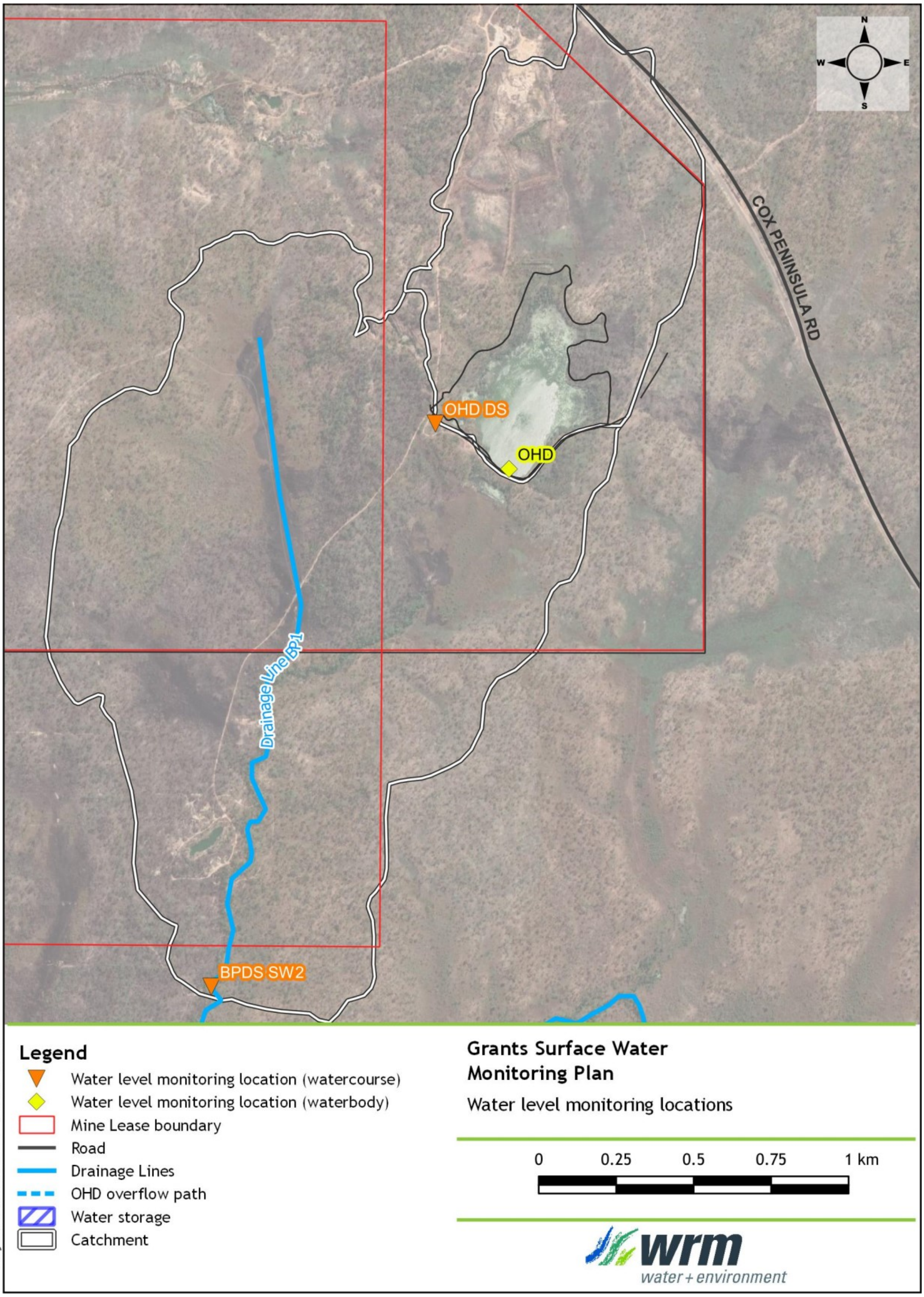


Figure 5.1 – Surface water monitoring locations

6 Downstream Risk Matrix

6.1 GENERAL

This section presents a preliminary Downstream risk matrix (DRM) to manage and minimise the risk of exceeding the allowable downstream streamflow impacts due to the operation of OHD.

6.2 OHD OPERATIONAL RULES

Water would be drawn from OHD during operations to meet site demands, including DMS plant process water makeup and haul road dust suppression. Water would only be drawn from OHD if the following conditions are met:

- The volume in RWD is less than its low alarm volume of 20 ML. This would ensure that excessive volumes are not drawn from OHD, which would then require management in the Grants WMS.
- The volume in OHD is not less than the assumed dead storage (10 ML), to provide a storage buffer to preserve water quality and ecological values.

Water will be transferred to RWD via a 300 mm HDPE pipeline, at a maximum rate of 4.00 ML/d, when required.

6.3 DOWNSTREAM RISK MATRIX

Table 6.1 shows the preliminary DRM table. This table assessed the potential downstream risk based on the cumulative rainfall and spill days from OHD since the onset of the wet season (1 November of each year). As shown in Figure 4.1, the allowable downstream risk would vary based on the severity of the wet season. The range of spill days for each rainfall range were derived from Figure 4.2.

The risks presented in the DRM table range from LEVEL 1 (no or minimum impact on the downstream flows) to LEVEL 4 (potentially significant impact on the downstream flows). The downstream risk during the wet season should be assessed on a regular basis (i.e. weekly) until the end of the wet season (30 April), so that the potential downstream risk can be tracked over the wet season.

Table 6.2 shows the recommended actions for each of the DRM levels. These actions would ensure that the potential downstream impacts are managed throughout the wet season.

It is recommended that the DRM assessment is undertaken on an annual basis as part of the Environmental Monitoring Report, per condition 4.2 of the WEL.

Table 6.1 – Preliminary downstream risk matrix for OHD

		Cumulative rainfall from 1 Nov			
		<1,300 mm	1,300 - 1,500 mm	1,500 - 1,700 mm	>1,700 mm
Number of spill days from 1 Nov	>60	LEVEL 1	LEVEL 1	LEVEL 1	LEVEL 1
	51-60	LEVEL 1	LEVEL 1	LEVEL 1	LEVEL 2
	41-50	LEVEL 1	LEVEL 1	LEVEL 1	LEVEL 3
	31-40	LEVEL 1	LEVEL 1	LEVEL 2	LEVEL 4
	21-30	LEVEL 1	LEVEL 1	LEVEL 3	LEVEL 4
	5-20	LEVEL 1	LEVEL 2	LEVEL 4	LEVEL 4
	<5	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 4

Table 6.2 - Recommended DRM actions

Risk	Action
LEVEL 1	• Continue to monitor the downstream environment.
LEVEL 2	• Continue to monitor the downstream environment. • Review the OHD operational rules.
LEVEL 3	• Continue to monitor the downstream environment. • Investigate and initiate options to source water from alternate locations. • Investigate and initiate options reduce water use and onsite, including options to recycle water.
LEVEL 4	• Undertake an assessment to characterise the nature of impacts to surface water conditions and riparian vegetation. • Initiate investigation into reasons for system failure, including assessment of environmental harm. • Investigate options for potential additional water sources (including C5 Dam, bore water). • Take actions recommended by investigation to prevent recurrence.

7 Trigger Action Response Plan

An operational Trigger Action Response Plan (TARP) has been developed to continually monitor the pumped extraction volumes from OHD to ensure that the WEL entitlements presented in Table 1 of the WEL 8151018 (reproduced in Table 1.1). The TARP recommends actions to minimise the risk of exceeding the entitlement.

Table 7.1 shows the recommended operational TARP for OHD water extraction.

Table 7.1 - Recommended OHD wet season water extraction TARP

Level	Triggers	Action	Response
Level 1 (Normal)	Pumped extraction from OHD is less than 50% of the entitlement.	• No action required.	• No response required.
Level 2 (Early warning)	Pumped extraction from OHD is greater than 50% and less than 80% of the entitlement. *and* ***More*** than half of the entitlement period has passed.	• Ensure monitoring equipment is calibrated and operating correctly. • Review water use and seek approval from the regulator to increase the entitlement if required.	• Post-event review to confirm event was well managed with appropriate resources in place.
Level 3A (Elevated Risk)	Pumped extraction from OHD is greater than 50% and less than 80% of the entitlement. *and* ***Less*** than half of the entitlement period has passed.	• Ensure that the pipeline is operating correctly and efficiently. • Investigate strategies to reduce OHD water use (without impeding on operations). • Seek approval from the regulator to increase the entitlement if required.	• Post-event review to confirm suitability of water transfer infrastructure & operational rules. • Update operational rules if required. • Prepare recommendations for modifications or upgrades to reduce OHD water use.
Level 3B (Imminent Risk)	Pumped extraction from OHD is greater than 80% and less than 100% of the entitlement.	• Investigate strategies to reduce OHD water use (without impeding on operations). • Ensure that the site demands are being drawn from the mine water dams and sediment dams as a priority, rather than OHD where possible. • Seek approval from the regulator to increase the entitlement if possible.	
Level 4 (Exceedance of entitlement)	Pumped extraction from OHD is greater than 100% of the entitlement.	• Cease water extraction from OHD. • Reduce non-essential water consumption as much as possible on site to limit operational impacts. • Ensure that the site demands are being drawn from the mine water dams and sediment dams as a priority. • Seek approval from the regulator to increase the entitlement if possible.	• Initiate investigation into reasons for system failure, including assessment of environmental harm. • Investigate options for potential additional water sources. • Take actions recommended by investigation to prevent recurrence • Notify the regulator per Condition 4.3 of the WEL

8 Review of this document

Special condition 4.1(iv) stipulates that the SWMP should include a review process to ensure the continual improvement of the monitoring program.

The results given in this report have been prepared based on the best available data and information at the time of preparing the report. The data and information used have been obtained from a validated mine Goldsim water balance model, reports prepared and modelling undertaken by other consultants, and verbal and written advice received from Core staff and other consultants.

The key assumptions adopted in this assessment include:

- The capacity of OHD (noting the tentative plans to raise the spillway level in the 2022 dry season);
- The seepage loss from OHD is negligible;
- The maximum extraction rate (pump capacity) from OHD; and
- The catchment area reporting to OHD.

If any of the adopted assumptions are found to be inaccurate or outdated, the potential impacts and required changes to the proposed OHD strategy should be investigated and appropriate changes be made to the monitoring plan.

9 Limitations

The Surface Water Monitoring Report for OHD has been undertaken based on the available information provided to WRM at the time of preparing this report. The data and information used has been obtained from previous reports prepared, survey and design drawings provided by Core and other consultants involved in the project.

While all reasonable care has been taken during the assessment to ensure that modelling undertaken by WRM accurately reflects the behaviour of OHD and the downstream environment, available data such as ground survey, cross section data, rainfall and water level data and design drawings have been sourced from third parties. The accuracy and reliability of model predictions is affected by the accuracy of the available data from third party sources. Although significant effort has been made to confirm the accuracy of available data during the studies undertaken by WRM, WRM takes no responsibility for inaccuracy in any information that has been supplied by a third party.

The following key limitations have been identified:

- The runoff parameters for the OHD catchment have not been validated against recorded data within the catchment. They have been based on recorded water level data from the Carawarra Creek gauge at Cox Peninsula Road. It is recommended that the runoff parameters in the OHD are validated using recorded water level, pumped extraction volumes and downstream water levels at BP SW2.
- The potential seepage rates from OHD are unknown. This assessment assumes that seepage would be negligible. However, if the seepage from OHD is significant in reality, this may affect the outcomes of this assessment.
- Site water demands have been based on the WMS configuration and estimated on site usages presented in WRM (2022). Changes to the adopted WMS may impact on the modelled potential downstream impacts.
- The TARP and risk matrix provided in this assessment have not yet been refined based on actual wet season data. It is recommended that these tools are considered as preliminary until they can be validated to recorded data.

The information used in this assessment is considered to be accurate at the date that supporting documentation was completed. The models, our interpretation of results and recommendations documented in our various reports apply to the site at the time of our investigations and may not necessarily apply to subsequent changes in site conditions or designed or constructed infrastructure in the study area that WRM is not aware of and has not had the opportunity to evaluate. The model should only be regarded as validly representing the conditions within the study area at the time of the investigation. WRM takes no responsibility for any changes that may have occurred after this time.

10 References

ANZECC & ARMCANZ, 2000	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
ANZG, 2018	Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines
ANCOLD, 2012	*'Guidelines on the Consequence Categories for Dams'*, Australian National Committee on Large Dams Incorporated, October 2012.
Core, 2019	'Grants Lithium Project – Environmental Impact Statement - Supplement', Core Lithium, 2019
Core, 2019a	*'Mining Management Plan – Grants Lithium Project Mining Operations'*, Core Lithium, June 2019
Enviroconsult, 2019	*'Supplementary Report: Surface water modelling'*, Enviroconsult, 2019
GHD, 2021	*'Observation Hill Dam Raise: Detailed design'*, GHD, March 2019
WRM, 2021	*Finniss Lithium Project BP33 Underground – Water Balance Modelling Report*, WRM Water & Environment, 2021

Appendix A - Surface Water Monitoring, Supplementary Report (EnviroConsult, 2019)

APPENDIX E SURFACE WATER MODELLING – SUPPLEMENTARY REPORT

The surface water modelling report was originally submitted as Appendix H of the Draft EIS.

This document provides supplementary information that should be read in conjunction with the original report.

Core Exploration Ltd, Cox Peninsula

Supplementary Report
Surface water modelling

Core Exploration Ltd, Cox Peninsula

Supplementary Report
Surface water modelling

February 2019

RELIANCE, USES and LIMITATIONS

This study, report and analyses have been based on the information available to EnviroConsult Australia Pty Ltd at the time of preparation. EnviroConsult Australia PTY Ltd accepts responsibility for the report and its conclusions to the extent that the information was sufficient and accurate at the time of preparation. EnviroConsult Australia Pty Ltd does not take responsibility for errors and omissions due to incorrect information or information not available to at the time of preparation of the study, report or analyses. No chemical analysis, groundwater hydrology, water quality or contaminant export studies of any kind were conducted. Any comment made in the report with respect to the above are speculative based on the surface hydrology analysis and should not be relied upon as fact.

Executive Summary

EcOz Environmental Consultants (EcOz) were engaged by Core Lithium Ltd (Core) to prepare the Draft EIS for Grants Lithium Project on Cox Peninsula. As part of the preparation of the Draft EIS, EnviroConsult Australia Pty Ltd (EnviroConsult) were engaged to conduct a hydrological assessment and water balance for the project. An independent review recommended that the hydrological and hydrogeological modelling (separate report) use consistent climate data and pit geometry. Additionally, since the submittal of the Draft EIS, project planning has resulted in a change to the mining site layout and pit dimensions.

This supplementary report addresses these recommendations and project changes by re-running the hydrological model using:

- Climate data consistent with the hydrogeological model
- Updated project layout and pit geometry.

Pre- and post-mining water balance

The surface water modelling was rerun simulating a low, average and high rainfall year based on 24-hour SILO rainfall data and updated mine layout and dimensions.

The HEC-HMS model was recalibrated and validated using the 24-hour(h) time steps using the methods in the initial EIS studies. Annual catchment outflows from the Darwin Harbour catchments 2 and 5 for the low, average (50th percentile) and high rainfall years were 6775ML, 16890ML, and 33631ML respectively. Annual catchment outflows from the Bynoe Harbour catchments for the low, average and high years were 9400ML, 23679ML, and 47294ML respectively.

For the Post-mining Darwin Harbour catchment with updated mine infrastructure only, the percentage reduction in stream flow at the catchment outlet for an average rainfall year is 18% of the pre-mine catchment outflow. This is based on a conservative simulation scenario where all water is retained in the sub-catchment containing the infrastructure.

During mining, when there are water releases from the mine infrastructure, the reduction in stream flow at the outlet of catchments 2 and 5 is 14% for an average rainfall year. When the mine site dam (MSD) is included in the Darwin Harbour catchment, reduction to catchments 2 and 5 outflow due to the dam and the infrastructure is about 19% of the pre-mine outflow. So, for an average year, MSD is responsible for a reduction of about 5%.

Observation Hill dam yield analysis

Updated results for 24-h timesteps for constant pump rates of 2.02 MLd^{-1} and 1.2 MLd^{-1}, for a 5-year scenario, indicate that there will be a water deficit for the low rainfall year for each of the lift scenarios. Overall, simulations indicate variable deficits of water for mine applications ranging from of 9 ML to 225 ML. Economies of water usage, such as no dust suppression in the Wet Season and de-watering of the pit allowing the dam to re-fill to capacity may address the deficit.

With respect to accumulated reduction in flows downstream of the dam, the maximum reduction in monthly flow volume is 100% at the spillway under the worst case scenario (2.02 ML pumping). For the

larger sub-catchment that contains the OHD, the maximum monthly reduction in stream flow discharge to Charlotte River was 58.3% when 2.02 MLd^{-1} pumping is applied. The maximum monthly reduction in stream flow discharge to Bynoe Harbour receiving waters was 12.6%.

Alternative water storage facilities

Apart from a wall lift or reduction in water usage, an alternative to achieve enough water storage may be the construction of a second smaller dam.

The preferred MSD in catchment 5 is assessed. The site has similar catchment sizes as the OHD. The simulations show the site is suitable for ancillary water storage for the worst-case scenario of an annual average deficit of 225 ML.

The cumulated impact of the MSD, with a spillway level of 16.93mAHD in catchment 5, on downstream flows were assessed at 4 locations. The impact of the dam on downstream flows during mining reduces progressively downstream from the catchment 5 outlet to the outlet of the watershed draining to the Darwin Harbour. When the impact of the mine infrastructure without the MSD is simulated, the maximum reduction in monthly total flows is 28.8% at the outlet of catchment 5 and 7.6% at the watershed outlet. When MSD is considered during mining, the maximum monthly reductions are 55.8% and 14.7%.

Flood Hydrological Modelling

The rainfall and hydrograph for the 1%AEP model simulations was determined probabilistically using the Monte Carlo simulation feature of the RORBwin hydrology model. The simulations gave a critical rainfall duration of 6h for the event and the probable maximum peak discharge for the pre-mining condition as 118.9m^3s^{-1} and 121m^3s^{-1} for the post-mining condition, a change of 2.5%. For total discharge there was a drop of 11% between the pre- and post-mining conditions. The change in peak discharge caused by the mine infrastructure is due to the ponds and the pit which are water retaining structures and, although the final depths of the ponds have not been designed, do not contribute to the total discharge under post-mining conditions.

Flood inundation

The HEC-RAS 2D modelling was updated for the 1%AEP flood inundation affected by mine infrastructures and MSD with the updated rainfall and runoff hydrographs for node inputs derived using RORBwin. The surge inundation is not considered as analysis in the initial report showed that storm surge did not affect the site.

There are some differences in inundation areas between pre- and post-mining caused by the mine infrastructure and the MSD. The mine site is protected from flood risk by the inundation bund and the flood water around the mine site can be drained away through natural stream lines and the haul road culvert.

Culvert 1 is inundated for a short period (3.5 hrs) compared to the pre-mine condition (7 hrs). Culvert 2, originally inundated under the pre-mine condition is prevented from inundation due to the presence of MSD.

In summary the mine infrastructure does not cause a flood risk off site. The presence of the mine infrastructure and MSD reduces the time of inundation on Cox Peninsula Road during floods.

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1 Introduction

EcOz Environmental Consultants (EcOz) were engaged by Core Lithium Ltd (Core) to prepare the Draft EIS for Grants Lithium Project on Cox Peninsula. As part of the preparation of the Draft EIS, EnviroConsult Australia Pty Ltd (EnviroConsult) were engaged to conduct a hydrological assessment and water balance for the project. The information in the hydrological assessment was used to inform the Water Management Plan which was submitted as part of the EIS.

The Draft EIS was submitted in October 2018, and the public comment period has been completed and the Water Management Plan has been independently peer reviewed. The independent review recommended that the hydrological and hydrogeological modelling (separate report) use consistent climate data and pit geometry. Additionally, since the submission of the Draft EIS, project planning has resulted in a change to the mining site layout and pit dimensions.

This supplementary report addresses these recommendations and project changes by re-running the hydrological model using:

- Climate data consistent with the hydrogeological model
- Updated project layout and pit geometry.

This supplementary report should be read in conjunction with the previously completed surface water reports:

1. Project 1[1]: Description of hydrological conditions of site and calibration of hydrological model,
2. Project 2[2]: Application of hydrological model to complete a hydrological assessment and water balance, and
3. Project 3[3]: Inundation modelling of the site.

The reports can be downloaded at:
https://ntepa.nt.gov.au/__data/assets/pdf_file/0006/590721/draft_eis_grants_lithium_appendixH_surface_water_modelling_reports.PDF

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[1] EnviroConsult (2018a). Project 1: Existing hydrological condition and hydrology model calibration, Report prepared for Core Exploration Limited by EnviroConsult Pty Ltd, August 2018, Darwin.

[2] EnviroConsult (2018b). Project 2: Mining Lease 31726 and Observation Hill Dam Water Balance, Report prepared for Core Exploration Limited by EnviroConsult Pty Ltd, August 2018, Darwin.

[3] EnviroConsult (2018c). Project 3: Mining Lease 31726 Flood Inundation Study, Report prepared for Core Exploration Limited by EnviroConsult Pty Ltd, August 2018, Darwin

2 Climate data inconsistencies

Groundwater modelling[4] used SILO data from a national scale data base of climate records for Australia (https://www.longpaddock.qld.gov.au/). SILO products provide national coverage with interpolated infills for missing data. Averaged monthly data for a calendar-year from the SILO record from 1971 to 2018 at 12°39'S 130°48'E (Figure 1) were used.

For surface water modelling, 15-min rainfall data from the NTG water portal Winnellie site were used based on analysis of regional Bureau of Meteorology (BOM) and Northern Territory Government Water Portal (NTGWP) rainfall gauges. For modelling, the data for a full Wet Season were used – July one year to June the next year.

To address the inconsistency and relative uncertainties associated with the different data sets, surface water modelling was conducted for this supplementary report using the same rainfall period and SILO data source as the groundwater modelling, 1971 to 2018. For surface water modelling, the highest resolution, local data available should be used, however, only 24-hour rainfall from SILO were available. SILO products provide national coverage, mostly based on BOM data, with interpolated infills for missing data and the rainfall data. At the location coordinates,12°39'S 130°48'E, used in this study, data are interpolated.

[4] CLOUDGMS 2018. Groundwater Model for the Grants Lithium Project Final Version 1.0

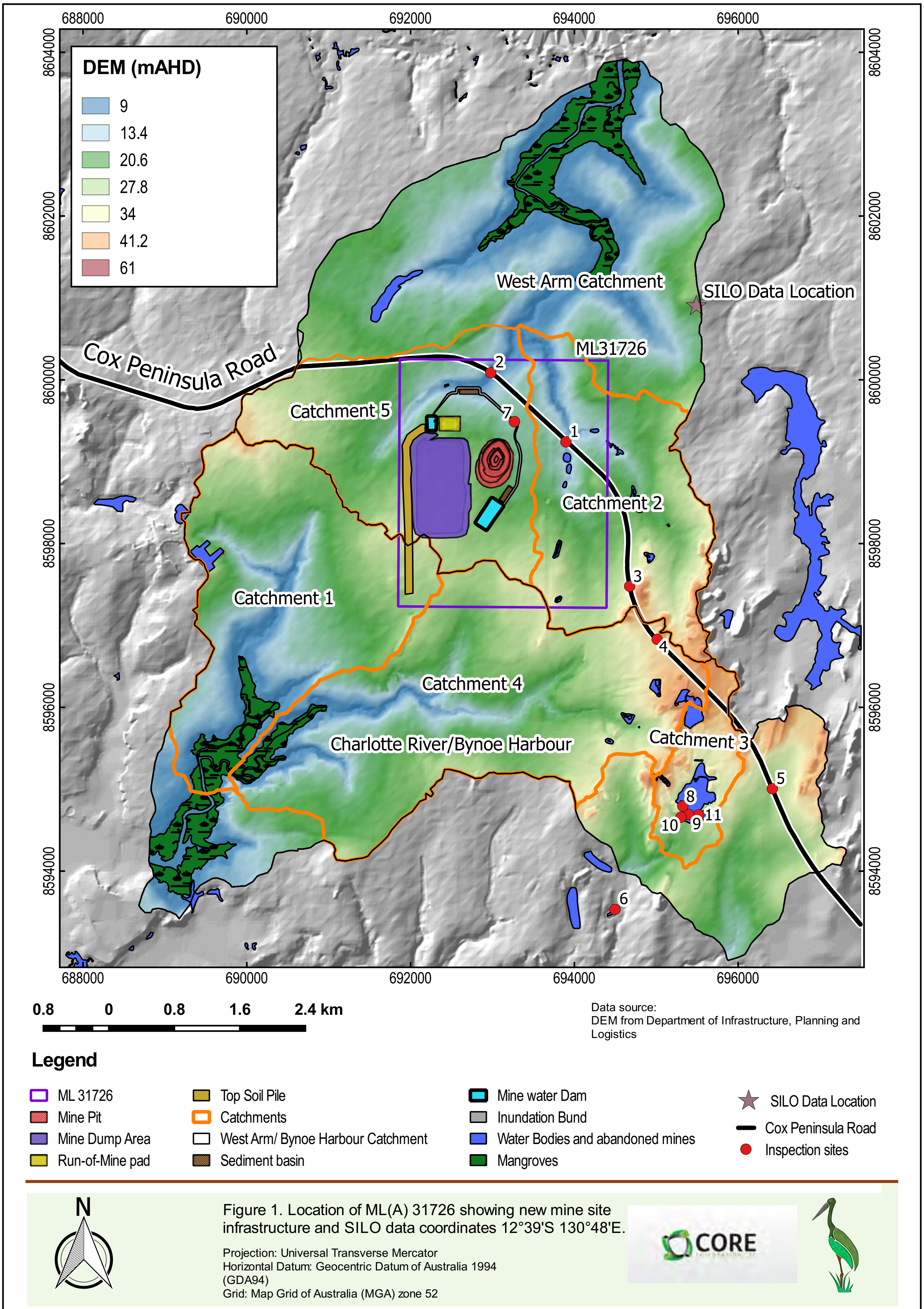


Figure 1. Location of ML(A) 31726 showing new mine site infrastructure and SILO data coordinates 12°39'S 130°48'E.

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

The average monthly rainfalls and evaporation based on SILO data at the Core site are shown in *Figure 2*.

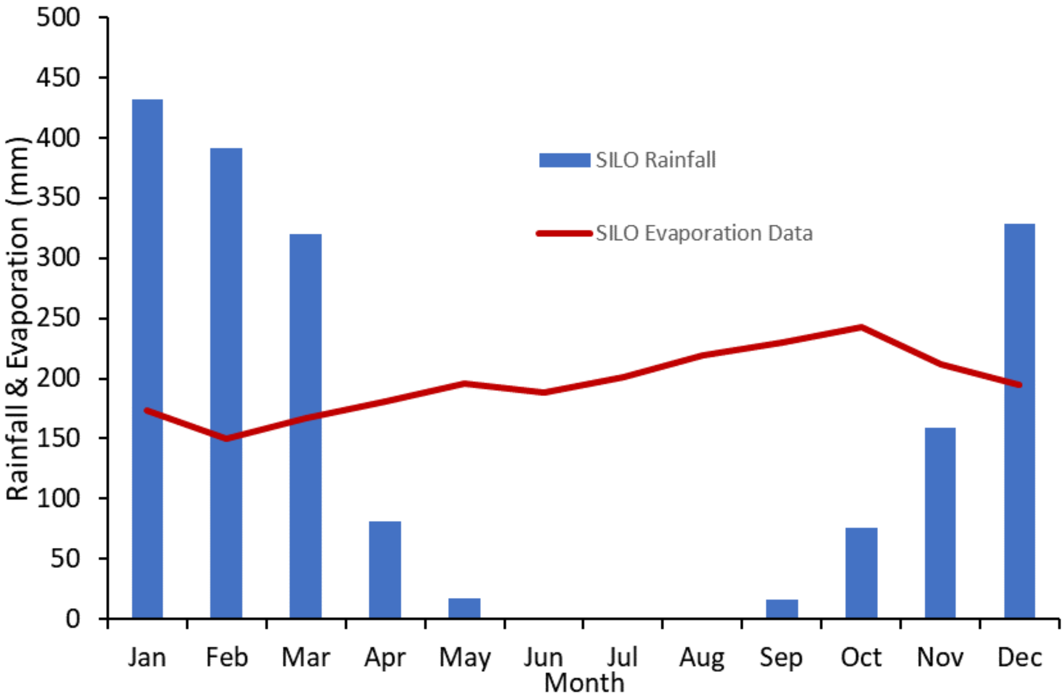


Figure 2 Average monthly rainfall and evaporation for SILO data from 1971 to 2018 for the Core site.

2.1 Gulungul Creek recalibration with 24-h inputs

Since input time steps for surface water modelling change from 15 minutes to 24 hours the HEC-HMS model was recalibrated using the Gulungul Creek monitoring data (Appendix B.4, Project 1[1]). The calibration and validation methods used in Project 1[1] were repeated here for Gulungul Creek using (24-hour rainfall and discharge data courtesy of the Environmental Research Institute of the Supervising Scientist – *eriss*).

HEC-HMS was calibrated to Gulungul Creek 24-h data from 29 December 2009 to 11 June 2010 and validated to 24-hour data from 12 December 2005 to 30 April 2006 (Section 4.2.5, page 27, Project 1[1])

The fitted parameters based on the 24-hour time step are shown in *Table 1*. The only change in parameter values from the recalibration was Continuing Loss which changed from 4.4mmh^{-1} to 0.3mmh^{-1}. This is due to the changed timestep.

Calibration results are presented in *Figure 3*. Validation results are presented in *Figure 4*.

Good fits were obtained for the calibration process (*Figure 3*). There was some underprediction for the larger peaks but for catchment water balance studies correct flow volumes are more important. The peak discharges are more important for flood inundation, erosion, drainage and road design.

Applying the fitted parameter values to the Gulungul 2005-2006 Wet Season, HEC-HMS simulated flows were similar to observed flows with some minor overprediction which is conservative. SILO rainfall data for Gulungul Creek for 2005-2006 gave validation results very similar to those using monitored rainfall data (*Figure 4*).

Table 1 Updated Table 2, page 23, Project 1[1]. Calibrated parameter values.

Parameter	Loss method parameter			Base flow method parameter		
	Initial (mm)	Constant (mmhr^{-1})	Impervious (%)	Initial discharge (m^{3}s^{-1})	Recession constant	Ratio to peak
Value	400.0	0.3	5%	0.00	0.90	0.05

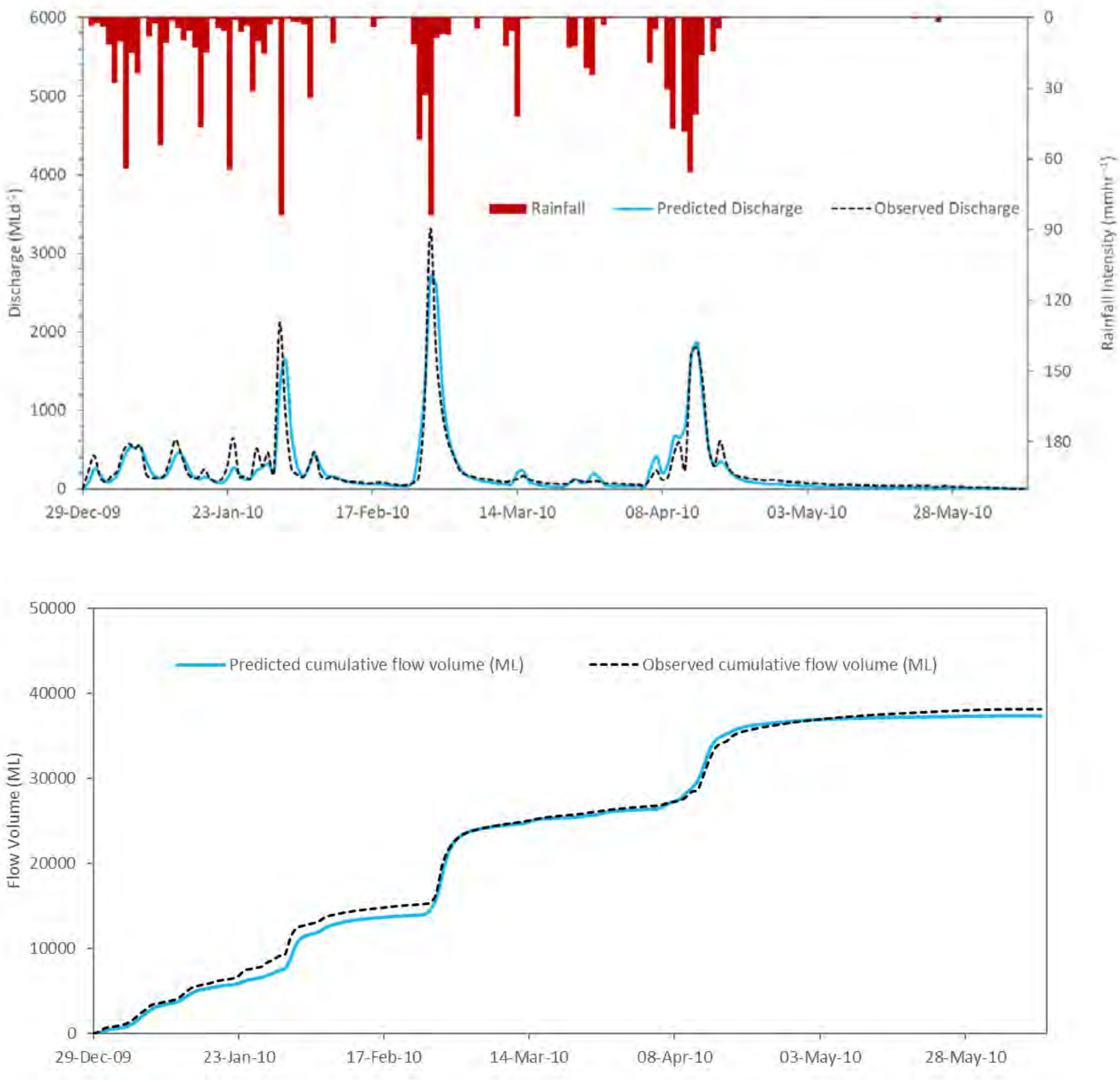


Figure 3. Graphs of fitted and observed hydrographs and cumulative flow (24-h intervals).

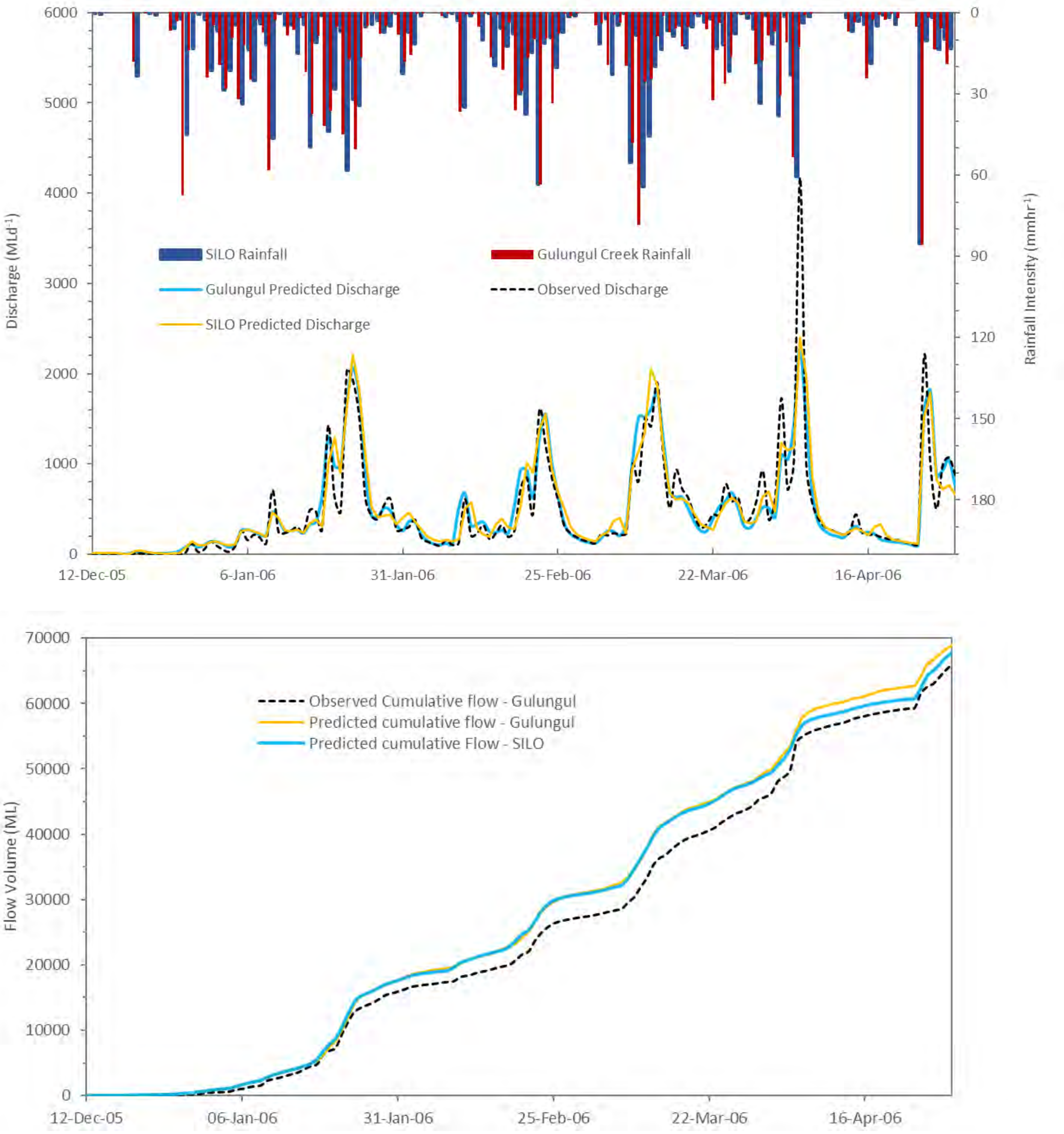


Figure 4 Comparison between fitted and observed 24-h discharge and cumulative discharge for the 2005-2006 Wet Season at Gulungul Creek.

2.2 Updated low, average and high rainfall year scenarios for HEC-HMS modelling

The Darwin Harbour HEC-HMS basin models for post-mining with the mine infrastructure only and the mine infrastructure plus MSD were updated to reflect the updated infrastructure (Appendix A1 & A2). Low, average (50th percentile event) and high rainfall-year scenarios for HEC-HMS modelling in this supplementary report were based on calendar-year SILO rainfall from 1st January to 31st December. Due to the distinct Wet and Dry seasons at the site the rainfall year is from July to June the following year (*Figure 2*). Therefore, antecedent rainfall and simulated antecedent discharge from 1st July the previous year was used to condition the catchment i.e. simulate initial losses, and continuing losses and generate runoff that can be applied to the simulations starting from 1 January of the year of interest. Since the HEC-HMS initial loss was fitted as 400mm (*Table 1*) it was important that the initial loss was applied to the antecedent simulations otherwise it would be applied at 1 January of the year of interest when the catchment is saturated or near saturation resulting in an underprediction of catchment discharge. An example of antecedent rainfall and discharge is shown in *Figure 5*. All simulations in this study have similar hydrograph form with the magnitude of volumes and magnitude and timing of peak discharges depending on catchment area and rainfall depth. The 24-hour SILO rainfall record was used for simulations (*Table 2*).

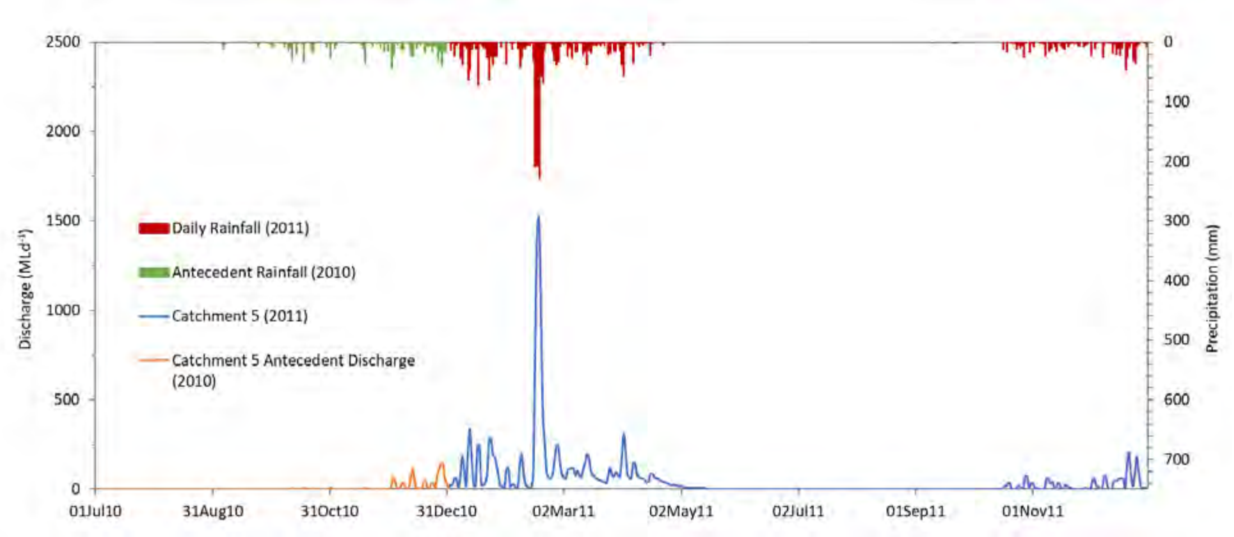


Figure 5 An example of the variation of instantaneous discharge with 24-hour rainfall for a simulation of a high rainfall year for Darwin Harbour catchment 5. The antecedent rainfall occurs prior to 1 January 2011. In this case the year of interest is 2011.

Table 2 Selected low, average and high rainfall years Update of Table 2,.page 14, Project 2[2].

Rainfall scenario	Year	Wet season annual rainfall depth (mm)	Annual Exceedance Probability	Probability of an equal or lower annual rainfall depth occurs in a 5-year period
Low	1979	919	0.99	0.05
50%ile	1991	1652	0.50	0.97
High	2011	2766	0.01	1.00

3 Updated catchment water balance

The HEC-HMS model calibrated to 24-h data was used to simulate rainfall discharge for Darwin Harbour catchments and the Bynoe Harbour catchments intersected by ML(A) 31726. The updated mine infrastructure (*Figure 1)* only affects Darwin Harbour catchment 5 and thus post-mining and during-mining condition were only run for this catchment.

Darwin Harbour simulation results, pre-, post- and during-mining are in *Table 3* and the Bynoe Harbour simulation results are in *Table 4*.

The mine infrastructure and MSD reduce total flows (ML) and peak flows (MLd^{-1}). For post-mining condition, the modelling assumes the worst-case scenario where all rainfall entering the mine infrastructure catchment is retained i.e. there is no release to the environment. For during-mining condition, mine infrastructure with and without the MSD scenarios were assessed. In addition, 2.02 $MLday^{-1}$ pumping and controlled release to the environment were applied for the during-mining scenarios.

For post-mining, the percentage reduction in combined stream flow at the outlet of catchments 2 and 5 outlet for low, average and high years was about 18%, 18% and 17% of the pre-mine catchment low respectively.

For during-mining, when MSD is not included, the percentage reduction in combined stream flow at the outlet of catchments 2 and 5 outlet for average rainfall years was about 14% of the pre-mine flow. When MSD is included, the percentage reduction increased to 19%. So, for an average year, MSD is responsible for a 5% reduction in flow.

Table 3 Results of surface water flow modelling for Darwin Harbour catchments 5 and catchment 2.

Catchment	Undisturbed Catchment Area (km^2)	Low rainfall year			Average rainfall year			High rainfall year		
		Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})	Discharge (ML)	Losses (ML)	Peak Q (MLd^{-1})	Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})
5 (pre-mining)	7.2	3630	2986	333	9050	2845	545	17980	1935	1520
5 (post-mining)	4.8	2447	1964	210	6087	1843	370	12156	1121	1025
5 (during-mining)	4.8	n/a	n/a	n/a	6576	1843	n/a	n/a	n/a	n/a
5 (during-mining + MSD)	4.8	n/a	n/a	n/a	5851	2396	n/a	n/a	n/a	n/a
2 (pre-mining)	6.4	3146	2735	276	7840	2732	464	15651	2051	1313
Common outlet (pre-mining)	**13.6**	**6775**	**5721**	**n/a**	**16890**	**5577**	**n/a**	**33631**	**3986**	**n/a**
Common outlet (post-mining)	**11.2**	**5593**	**4699**	**n/a**	**13927**	**4575**	**n/a**	**27807**	**3172**	**n/a**
Common outlet (during-mining)	**11.2**	**n/a**	**n/a**	**n/a**	**14462**	**4575**	**n/a**	**n/a**	**n/a**	**n/a**
Common outlet (during-mining+MSD)	**11.2**	**n/a**	**n/a**	**n/a**	**13687**	**5128**	**n/a**	**n/a**	**n/a**	**n/a**

Table 4 Results of surface water flow modelling for Bynoe Harbour catchments 1 and 4.

Catchment	Area (km^2)	Low rainfall year			Average rainfall year			High rainfall year		
		Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})	Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})	Discharge (ML)	Losses (ML)	Peak Discharge (MLd^{-1})
1	8.2	4035	3454	354	10221	3252	582	20421	2122	1697
4	10.7	5365	4485	467	13458	4252	748	26873	2779	2226
Total	**18.9**	**9400**	**7939**	**n/a**	**23679**	**7504**	**n/a**	**47294**	4,901	**n/a**

4 Observation Hill dam yield assessment

Observation Hill dam (OHD) is the main water storage facility near the mining lease and the stored water will be used for mining operations.

4.1 Catchment hydrology

Using the recalibrated HEC-HMS model, 3 24-h SILO annual rainfall scenarios (low, average and high rainfall years) were simulated and the total volume of direct rainfall and catchment run-off input to OHD and the peak rate of the run-off inflow determined (*Table 5*).

Table 5 Results of the HEC-HMS model of the sub-catchments draining to OHD.

Rainfall scenario	Total Rainfall (mm)	Total Inflow (ML)	Peak Inflow Rate (MLd^{-1})
Low rainfall year	919	403	35
Average rainfall year	1652	1117	86
High rainfall year	2766	2318	242

4.2 Yield analysis

The recalibrated HEC-HMS model, using 24-h timesteps, was used for a yield analysis for the various dam wall heights and rainfall scenarios as per those completed in Section 5.3 of Project 2[2].

4.2.1 OHD HEC-HMS model setup and simulation scenarios

The OHD HEC-HMS model was setup and simulation scenarios used the same specifications as those used in Project 2[2]. The main changes in the setup were the application of the SILO 24-h rainfall (*Table 2*) and SILO evaporation (*Table 6*).

Table 6. SILO monthly evaporation (mm) for the Core site.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaporation	173	150	167	181	195	187.99	201	219	229	243	212	195

4.2.2 Updated OHD water balance simulation results for 24-h timesteps

The modelling result for each water use scenario under the 30, 31.5 and 33.6 mAHD spillway elevation scenarios are shown in *Figure 6*, *Figure 7* and *Figure 8*[5]. The deficit of water for different scenarios are shown in *Table 7, Table 8* and *Table 9*. These tables are updates of Tables 9, 10 & 11 respectively, pages 24, 25, & 26, Project 2[2].

[5] Where the figures show the pump is off, this is due to a lack of water rather than the project not requiring water to be pumped during this period.

Table 7. Simulated deficits for 30.0 mAHD spillway level scenario

Water use scenario	2.02 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	56	222	102	72	105
Water deficit (ML)	113	448	206	145	212
Average annual deficit (ML)	225				
Water use scenario	1.2 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	120	48	0	0
Water deficit (ML)	0	144	57	0	0
Average annual deficit (ML)	40				
Water use scenario	1.07 MLd^{-1} in wet, 2.02 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	43	-	-	-	-
Water deficit (ML)	87	-	-	-	-
Water use scenario	0.64 MLd^{-1} in wet, 1.2 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-

Table 8. Simulated deficits for 31.5 mAHD spillway level scenario

Water use scenario	2.02 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	206	48	29	3
Water deficit (ML)	0	416	97	59	6
Average annual deficit (ML)	116				
Water use scenario	1.2 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	36	48	0	0
Water deficit (ML)	0	43	58	0	0
Average annual deficit (ML)	20				
Water use scenario	1.07 MLd^{-1} in wet, 2.02 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-
Water use scenario	0.64 MLd^{-1} in wet, 1.2 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-

Table 9. Simulated deficits for 33.6 mAHD spillway level scenario

Water use scenario	2.02 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	194	48	29	0
Water deficit (ML)	0	392	97	59	0
Average annual deficit (ML)	110				
Water use scenario	1.2 MLd^{-1} for a 5-year simulation				
Year (1st April to 1st Oct)	Average	Low	Average	High	Average
No. of days in deficit	0	0	48	0	0
Water deficit (ML)	0	0	58	0	0
Average annual deficit (ML)	12				
Water use scenario	1.07 MLd^{-1} in wet, 2.02 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-
Water use scenario	0.64 MLd^{-1} in wet, 1.2 MLd-1 in dry 1-year average rainfall simulation				
Year (1st April to 1st Oct)	Average	-	-	-	-
No. of days in deficit	0	-	-	-	-
Water deficit (ML)	0	-	-	-	-

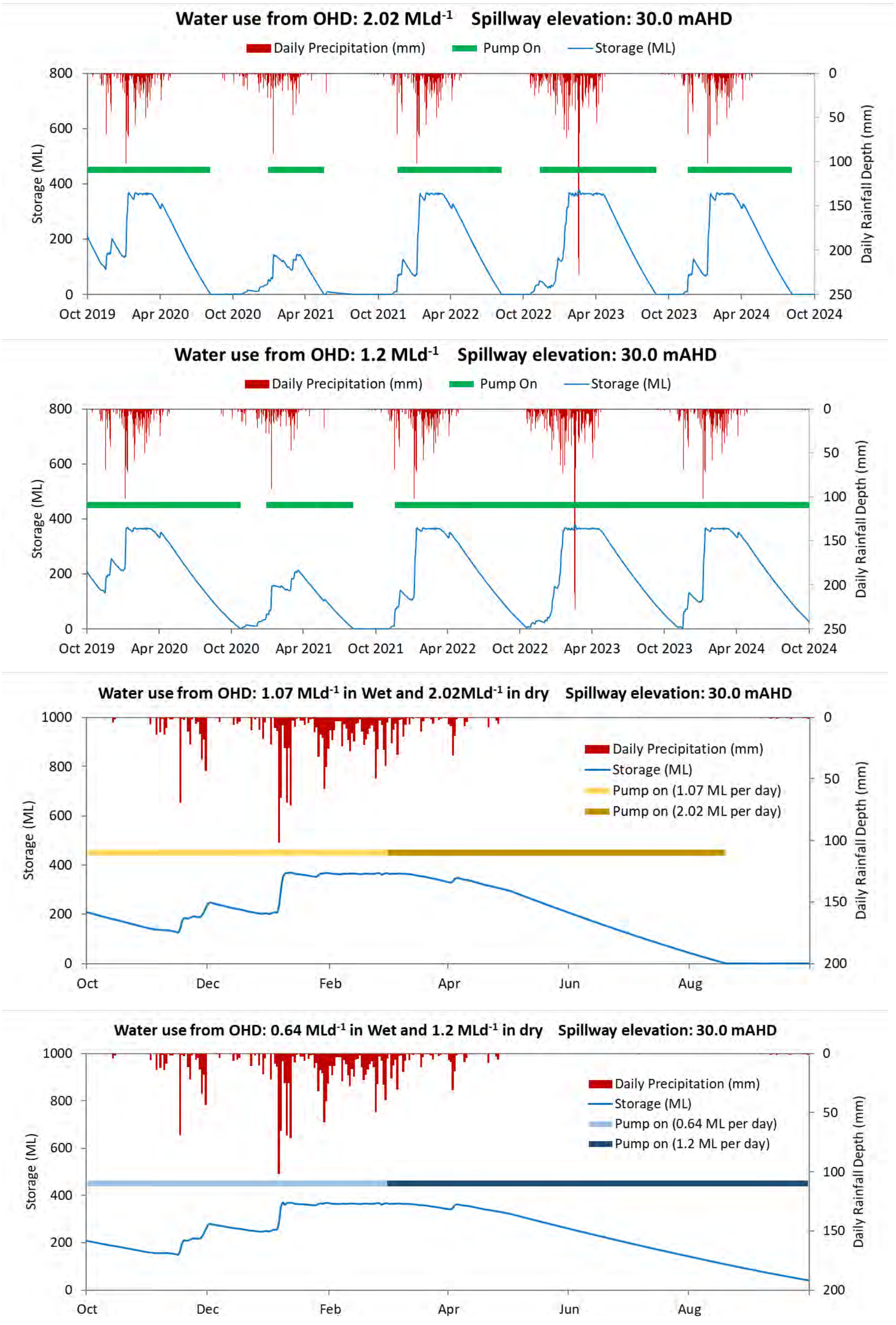


Figure 6 HEC-HMS modelling result for 30 mAHD spillway elevation scenario.

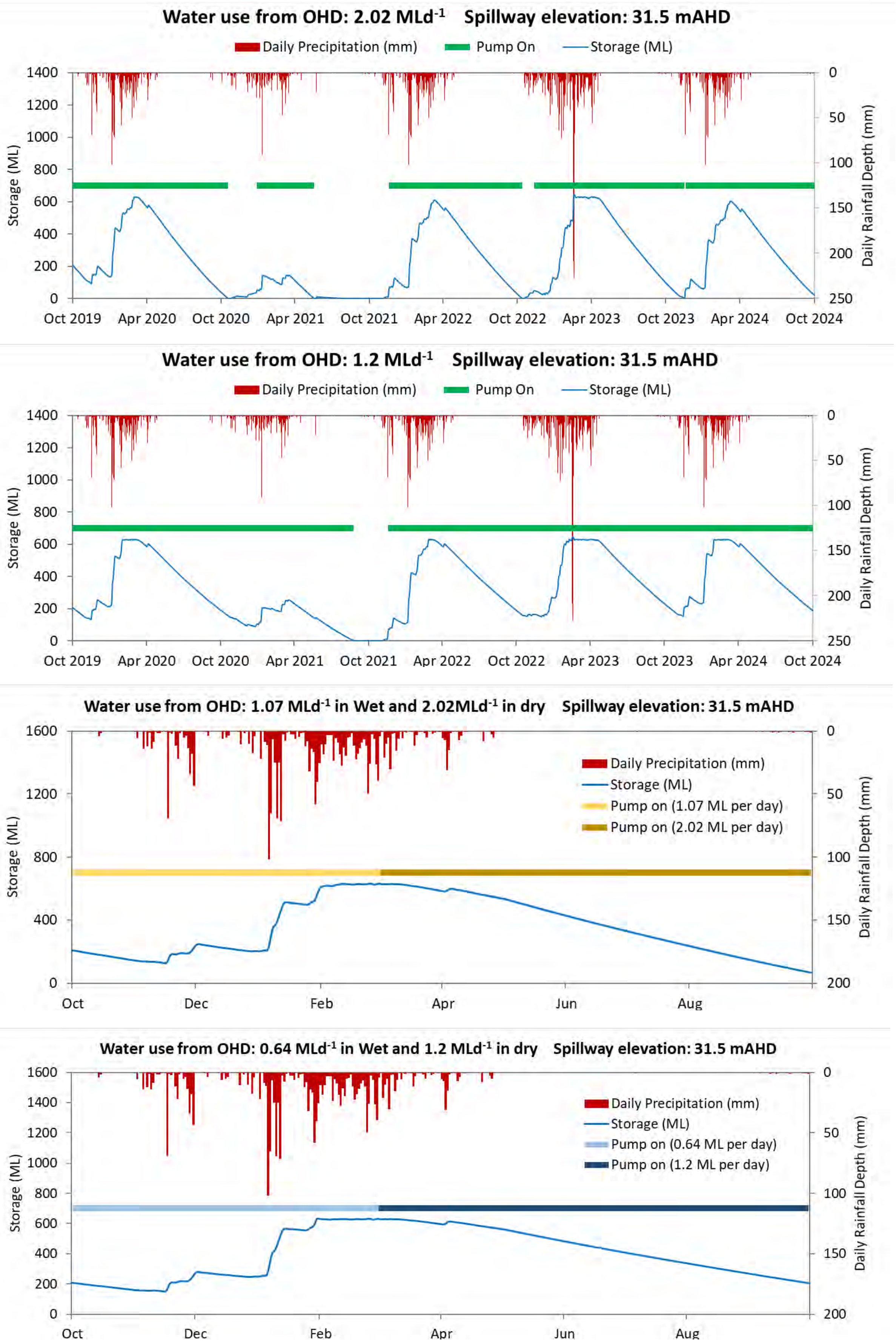


Figure 7. HEC-HMS modelling result for 31.5 mAHD spillway elevation scenario.

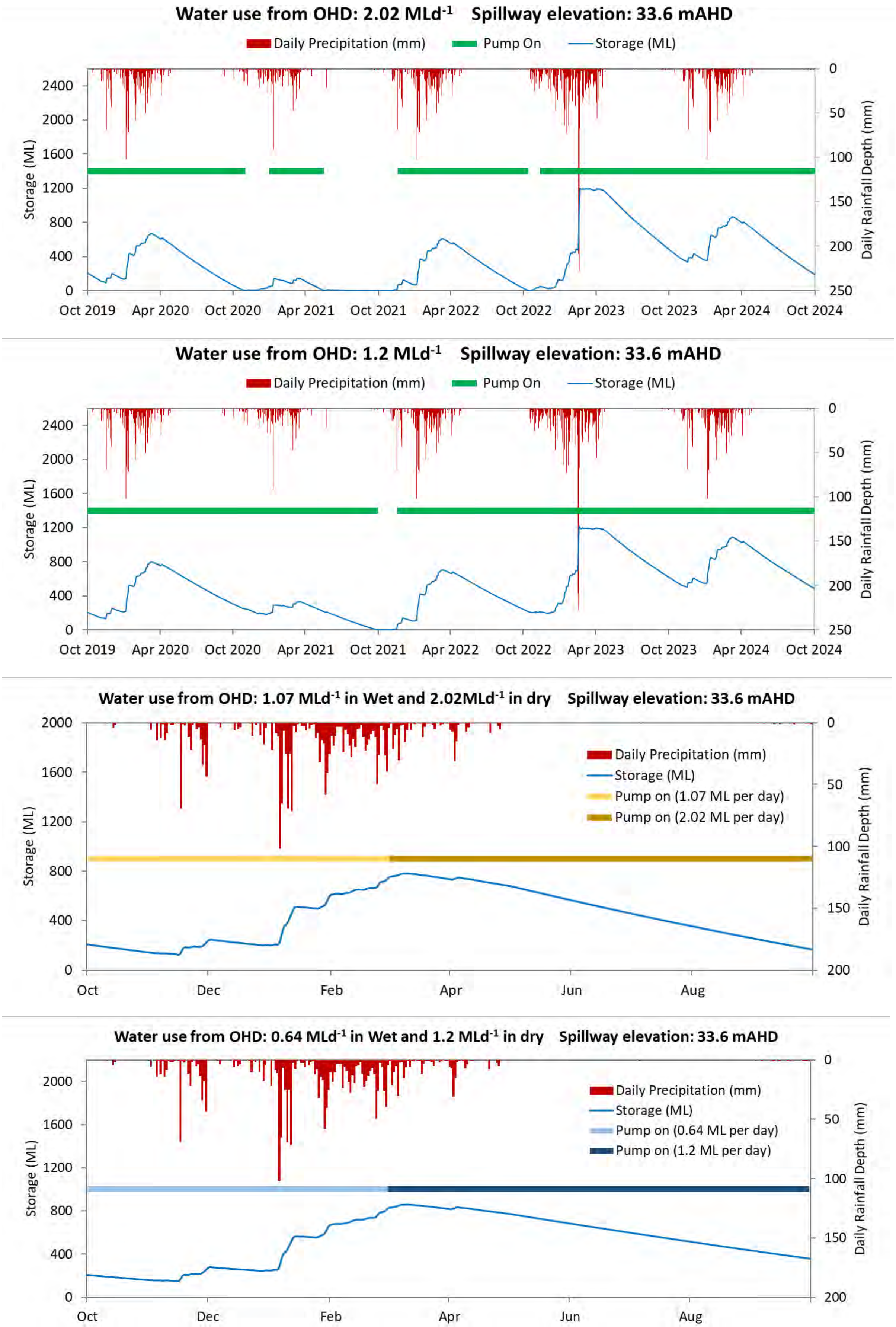


Figure 8. HEC-HMS modelling result for 33.6 mAHD spillway elevation scenario.

4.3 Influence of pumping and wall lift on downstream flows

The HEC-HMS simulations conducted in Section 5.4, page 30, Project 2[2] showed the impact of OHD on downstream flows is inversely proportional to downstream catchment size. That is, the further downstream the smaller the effect of OHD. The effect of the size (spillway height) of OHD and pumping on downstream flows was updated using the 24-h SILO rainfall data for an average year. The updated downstream flow volumes at different locations are shown in *Table 10*, *Table 11, Table 12*, and *Table 13* updating Table 12 & 13, page 32, Project 2[2]. These downstream locations and the catchments draining to them are shown in *Figure 9*.

Table 10. The flow volumes (ML) at OHD spillway outlet.

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr
Natural catchment condition (no OHD, no pumping)	58	14	554	289	145	51
Current OHD without pumping	0	0	323	253	108	28
Current OHD and 2.02 MLd^{-1} pumping applied	0	0	117	195	80	0
OHD spillway raised to 31.5 mAHD without pumping	0	0	78	240	98	26
OHD spillway raised to 31.5 mAHD and 2.02 MLd^{-1} pumping applied	0	0	0	42	79	0

Table 11. The flow volumes (ML) at the catchment outlet to Charlotte River

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr
Natural catchment condition (no OHD, no pumping)	100	28	2035	1097	612	177
Current OHD without pumping	42	13	1803	1062	574	155
Current OHD and 2.02 MLd^{-1} pumping applied	42	13	1598	1005	547	126
OHD spillway raised to 31.5 mAHD without pumping	42	13	1558	1049	565	152
OHD spillway raised to 31.5 mAHD and 2.02 MLd^{-1} pumping applied	42	13	1483	849	545	126

Table 12. The flow volumes (ML) at the watershed outlet to Bynoe Harbour

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr
Natural catchment condition (no OHD, no pumping).	453	164	14920	8482	4896	1308
Current OHD without pumping.	396	148	14687	8448	4858	1286
Current OHD and 2.02 MLd^{-1} pumping applied.	396	148	14482	8390	4830	1258
OHD spillway raised to 31.5 mAHD without pumping.	396	148	14442	8434	4849	1284
OHD spillway raised to 31.5 mAHD and 2.02 MLd^{-1} pumping applied.	396	148	14369	8233	4829	1258

Table 13. The accumulated % reduction (compared with natural catchment condition/no OHD) in down streams flows.

Scenarios	Nov	Dec	Jan	Feb	Mar	Apr
Spillway **under current conditions. No pumping.**	100	100	41.8	12.2	25.6	43.9
Spillway **when raised to 31.5mAHD. No pumping.**	100	100	86.0	17.0	32.0	48.0
Approximately 3km downstream. Represents stream flow discharge to Charlotte River **under current conditions. No pumping.**	58.3	52.8	11.4	3.1	6.1	12.6
Approximately 3km downstream. Represents stream flow discharge to Charlotte River **when raised to 31.5mAHD. No pumping.**	58.3	52.8	23.5	4.4	7.7	14.0
Approximately 4.5 km downstream. Represents stream flow discharge at Charlotte River outlet to Bynoe Harbour receiving waters **under current conditions. No pumping.**	12.6	9.4	1.6	0.4	0.8	1.7
Approximately 4.5 km downstream. Represents stream flow discharge at Charlotte River outlet to Bynoe Harbour receiving waters **when raised to 31.5mAHD. No pumping.**	12.6	9.4	3.2	0.6	1.0	1.9
Spillway **under current conditions. 2.02 MLd-1 pumping applied.**	100	100	78.8	32.4	44.6	100
Spillway **when raised to 31.5mAHD. 2.02 MLd-1 pumping applied.**	100	100	100	85.6	46.7	100
Approximately 3km downstream. Represents stream flow discharge to Charlotte River **under current conditions. 2.02 MLd-1 pumping applied.**	58.3	52.8	21.5	8.4	10.6	28.7
Approximately 3km downstream. Represents stream flow discharge to Charlotte River **when raised to 31.5mAHD. 2.02 MLd-1 pumping applied.**	58.3	52.8	27.1	22.6	11.0	28.7
Approximately 4.5 km downstream. Represents stream flow discharge at Charlotte River outlet to Bynoe Harbour receiving waters **under current conditions. 2.02 MLd-1 pumping applied.**	12.6	9.4	2.9	1.1	1.3	3.9
Approximately 4.5 km downstream. Represents stream flow discharge at Charlotte River outlet to Bynoe Harbour receiving waters **when raised to 31.5mAHD. 2.02 MLd-1 pumping applied.**	12.6	9.4	3.7	2.9	1.4	3.9

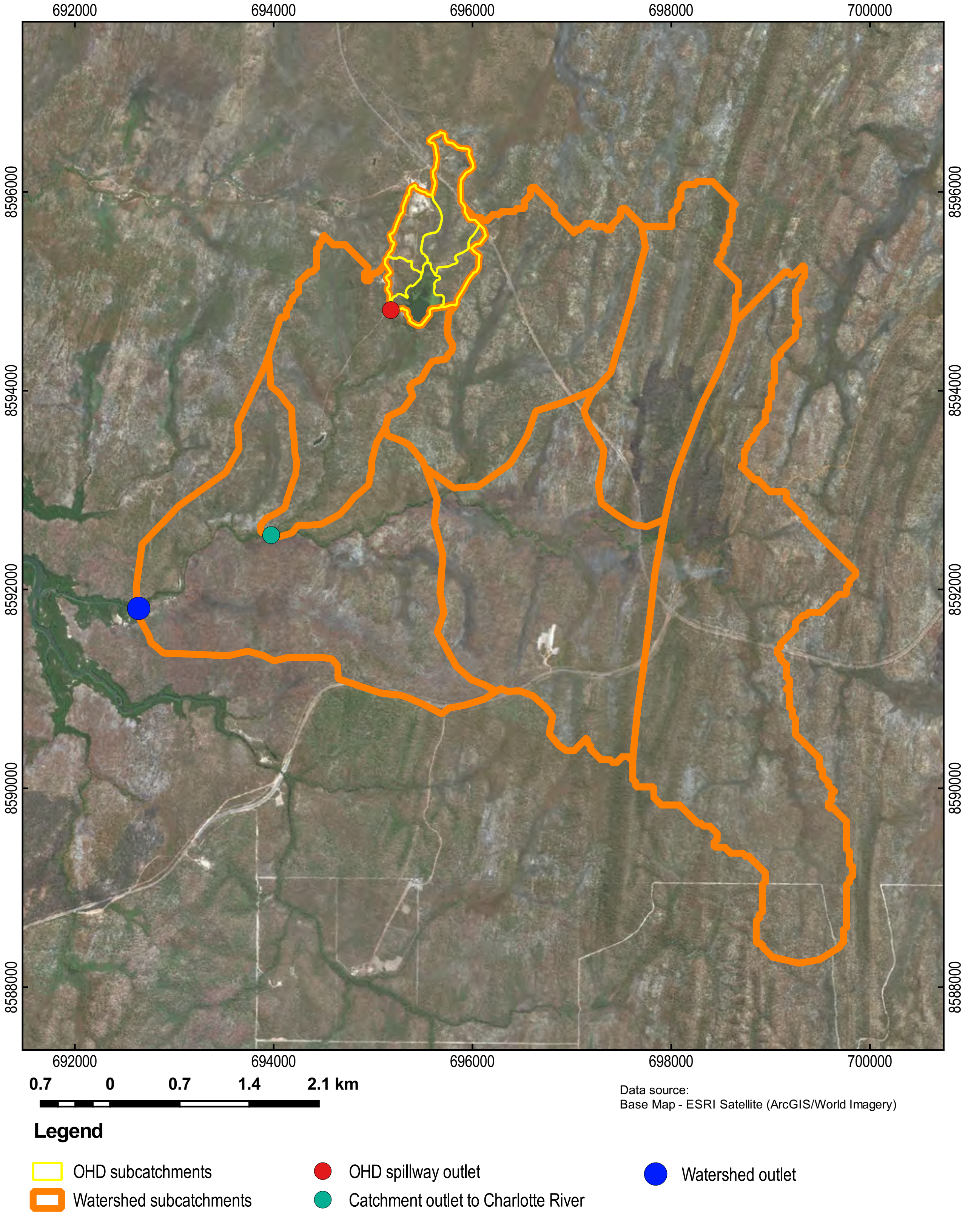


Figure 9. The watershed drains to the Bynoe Harbour tributary

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

4.4 Summary

The updated 5-year simulations, with constant pump rates, indicate that for all spillway levels, should a low rainfall year occur during mining, there will be a deficit of water for mine applications. The 1-year simulation, for an average rainfall year, for the existing OHD indicates that for a pump rate of $0.64MLd^{-1}$ in the wet, and $1.2MLd^{-1}$ in the dry, water storage will be enough for mining operations, however, this does not take into consideration the effect of lower than average rainfall years. Apart from a wall lift or reduction in water usage, or in addition to these strategies, an alternative to secure mine application water requirements may be the construction of a second dam (MSD).

With respect to accumulated reduction in flows downstream of the dam, the maximum reduction in monthly flow volume is 100% at the location right after the spillway under the worst scenario (2.02 ML pumping). For the larger sub-catchment that contains the OHD, the maximum monthly reduction in stream flow discharge to Charlotte River was reduced to 58.3% when 2.02 MLd^{-1} pumping is applied. The maximum monthly reduction in stream flow discharge to Bynoe Harbour receiving waters was only 12.6%.

5 Alternate water storage

The potential storage capacity of the preferred MSD was updated using the SILO rainfall data. Updated pump extraction volumes, and evaporation and seepage losses are shown in *Table 14, Table 15,* & *Table 16*.

Table 14. Pump extraction volumes and evaporation and seepage losses during dry season for the existing OHD

Pumping rate in dry season	Evaporation and seepage losses L (ML)	Pump extraction volume P (ML)	Total storage P+L	The ratio of total storage to pumped volume
2.02 MLd^{-1}	100	264	364	1.38

During the dry season, a part of storage is lost due to evaporation. The total storage in a dam can be 1.38 times the actual storage available for pumping based on the simulation results for OHD (*Table 14*). Therefore, the required storage capacity of MSD to provide required water is estimated as 1.5 times the worst-case scenario average annual deficit of 225 ML (*Table 7*). In this way, the required storage capacity in an alternate dam is 338 ML which is smaller than 387 ML identified in previous analysis (Project 2[2]). However, the more conservative storage requirement of 387 ML is recommended to be used for the planning of MSD. The minimum spillway level for MSD to meet the storage requirement is in *Table 15*.

Table 15. Minimum spillway levels for MSD to meet the deficit of water under the worst-case scenario.

Dam	Minimum spillway level to meet the required storage capacity of 387 ML (mAHD)
MSD	16.93

Updated HEC-HMS modelling determined the amount of runoff draining to the MSD in low, average and high rainfall years (*Table 16*).

Table 16. The total volume of inflow to MSD for low, average and high rainfall year scenarios.

Scenario	Total Inflow (ML)
Low rainfall year	1140
Average rainfall year	2735
High rainfall year	5380

The simulations show that the site received enough annual inflow to fill the proposed MSD to the spillway level (16.93 mAHD) in a single wet season.

5.1 Influence of MSD on downstream flows

If the MSD is constructed in catchment 5, the retention of surface flow and pumping could cause changes in downstream flows; these flows can be important to environmental values in downstream areas, especially where catchment outlets meet mangroves.

The investigations conducted in Project 2[2] (Section 6) were updated using the SILO 24-h rainfall inputs to HEC-HMS. The updated results of monthly flow volumes at 4 locations shown in *Figure 10* are shown in *Table 17.* The cumulated percentage reduction in downstream flows against the pre-mining condition is in *Table 18*.

The maximum percentage reduction in downstream monthly flows due to mine site infrastructure range from 28.8% at the catchment 5 outlet to 7.6% at the watershed outlet (DS4). When MSD is included in the modelling, the reductions in flow are greater (55.8% at the catchment outlet to 14.7% at the watershed outlet). The effect of MSD on downstream flows was greatest in early and late wet season months. *Figure 11* shows the changes in downstream hydrographs due to the presence of mine infrastructure and MSD.

Table 17. Monthly flow volumes at 4 locations downstream from proposed MSD during the wet season months.

Scenarios	Outflow location	Jan	Feb	Mar	Apr	Nov	Dec
Pre-mining	Catch-5 DS	3715	2015	1287	363	1313	326
	Catch-2&5 DS	6923	3769	2409	678	2439	621
	DS 5	8704	4808	3074	860	3035	838
	DS 4	13279	7500	4780	1331	4570	1391
During mining when MSD is not constructed. Controlled release form mine infrastructure area applied.	Catch-5 DS	2647	1470	985	259	982	299
	Catch-2&5 DS	5873	3222	2105	574	2113	590
	DS 5	7667	4278	2770	765	2729	808
	DS 4	12268	6953	4468	1234	4284	1342
During mining when MSD is constructed, 2.02 ML pumping applied. Controlled release form mine infrastructure area applied.	Catch-5 DS	2488	1441	922	218	594	204
	Catch-2&5 DS	5714	3193	2042	533	1725	495
	DS 5	7479	4235	2705	715	2335	696
	DS 4	12077	6914	4401	1183	3910	1211
Post-mining. No MSD. No release from mine infrastructure area.	Catch-5 DS	2508	1353	863	243	969	299
	Catch-2&5 DS	5734	3105	1983	558	2020	507
	DS 5	7528	4161	2648	749	2636	725
	DS 4	12129	6836	4346	1218	4191	1259

Table 18. The accumulated % reduction in downstream flow volumes (compared to pre-mining catchment condition).

Scenarios	Outflow location	Jan	Feb	Mar	Apr	Nov	Dec
During mining when MSD is not constructed. Controlled release form mine site applied.	Catch-5 DS	28.8	27.1	23.5	28.7	26.2	8.3
	Catch-2&5 DS	15.2	14.5	12.6	15.4	13.9	5.0
	DS 5	11.9	11.0	9.9	11.1	10.5	3.6
	DS 4	7.6	7.3	6.5	7.3	6.5	3.5
During mining when MSD is constructed, 2.02 ML pumping applied. Controlled release form mine site applied.	Catch-5 DS	33.0	28.5	28.4	40.0	55.8	37.4
	Catch-2&5 DS	17.5	15.3	15.3	21.4	29.8	20.3
	DS 5	14.1	11.9	12.0	16.9	23.5	16.9
	DS 4	9.1	7.8	7.9	11.1	14.7	12.9
Post-mining. No MSD. No release from mine site.	Catch-5 DS	32.7	32.4	32.3	32.5	33.3	29.1
	Catch-2&5 DS	17.2	17.6	17.7	17.7	17.2	18.4
	DS 5	13.5	13.5	13.9	12.9	13.1	13.5
	DS 4	8.7	8.9	9.1	8.5	8.3	9.5

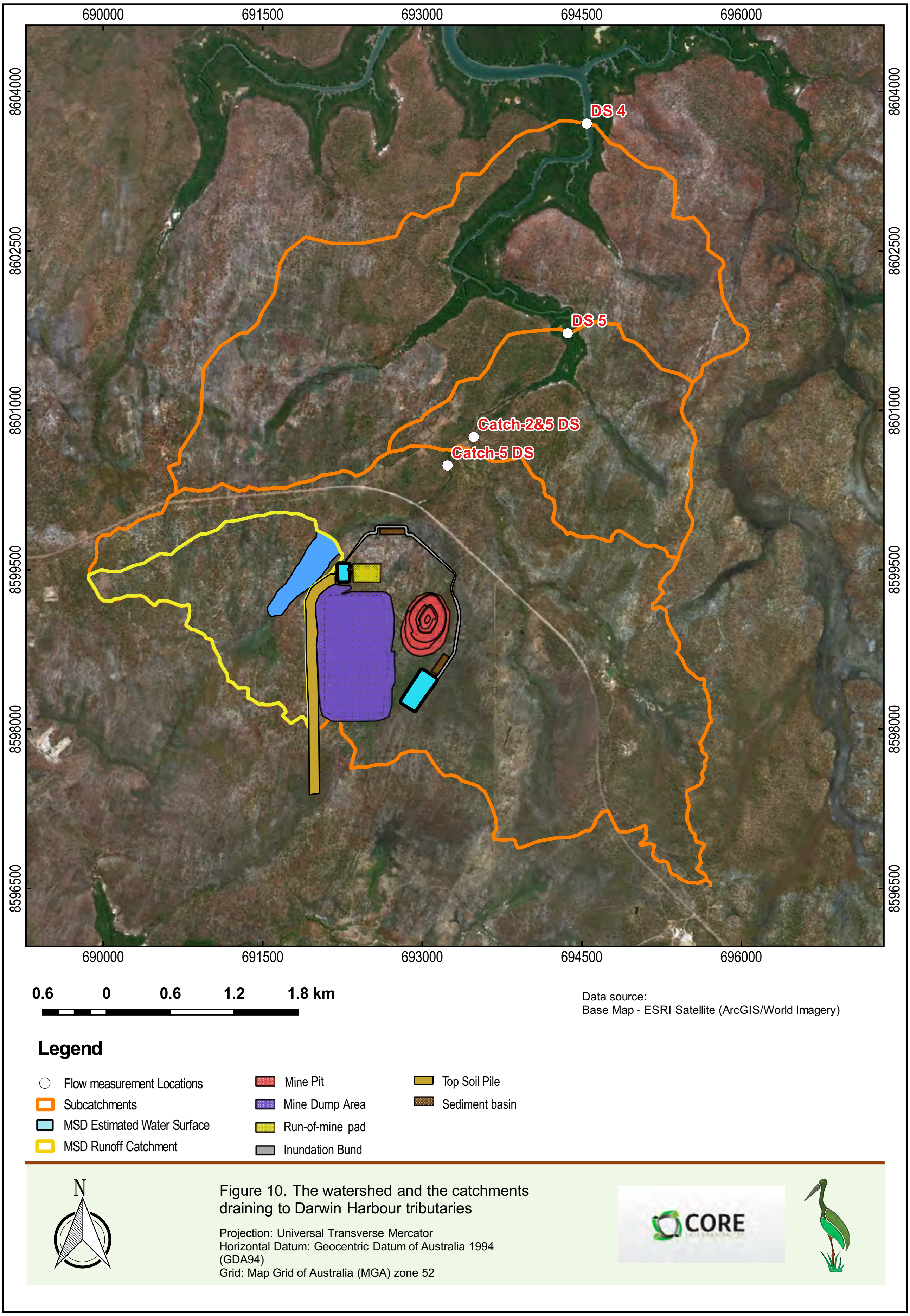


Figure 10. The watershed and the catchments draining to Darwin Harbour tributaries

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

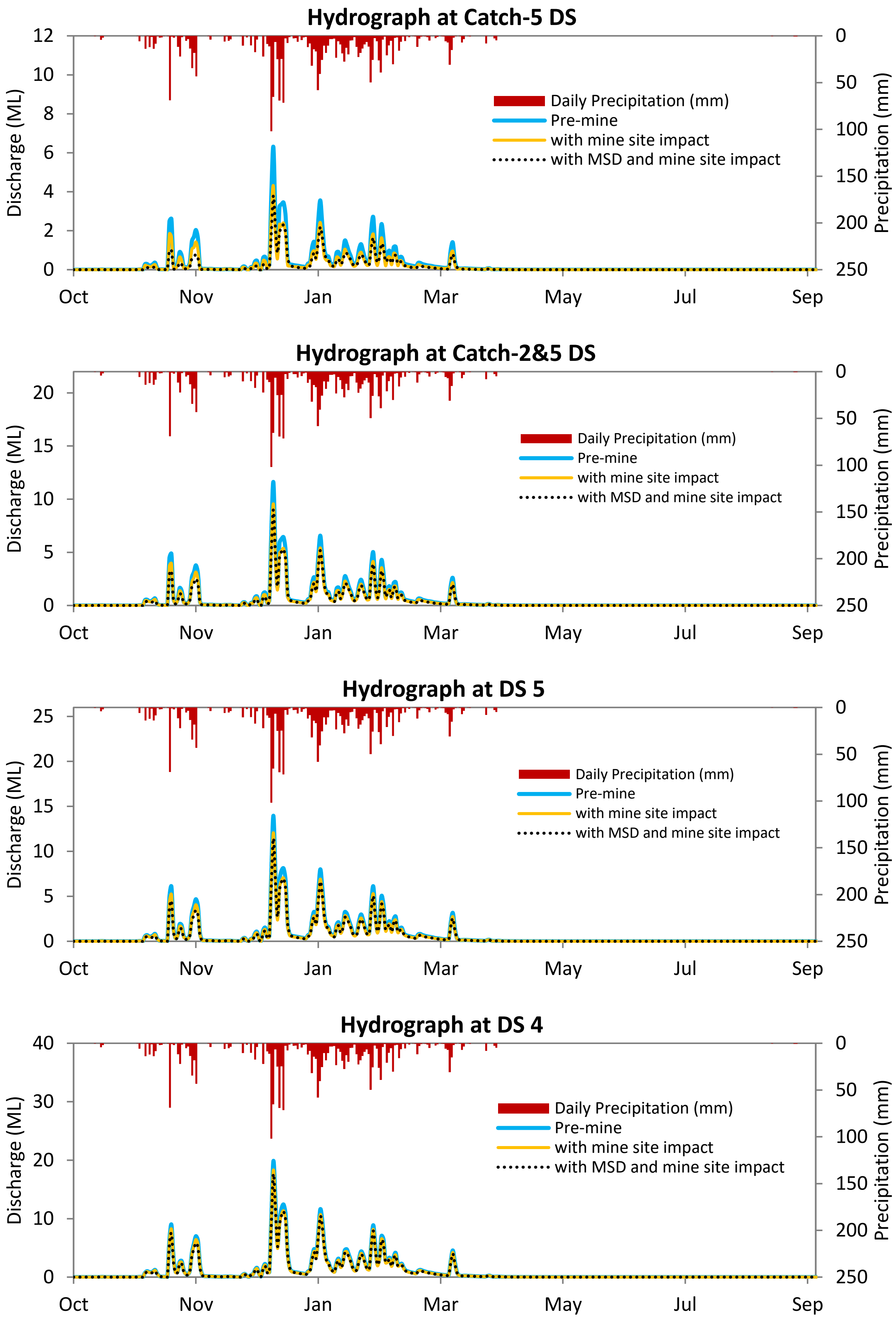


Figure 11. Hydrographs at Catch-2 DS, Catch-2&5 DS, DS 5 and DS 4.

6 Updated Flood Inundation Modelling

The section describes the changes in flood inundation due to the updated mine infrastructure (*Figure 1*) and the consideration of MSD. Project 3[3]**Error! Bookmark not defined.** assessed flood inundation of the site pre-mining and post-mining and focused on Darwin Harbour catchments 2 and 5. The methods in Sections 1 & 2 of Project Report 3[3] were used here with the updated DEM based on the revised mine infrastructure.

Using the updated DEM, a 1%AEP (Annual Exceedance Probability) rainfall event was used for the inundation studies. RORBwin hydrology model (Section 2.2, page 3, Project Report 3[3]) and the HEC-RAS 2D hydrodynamic model (Section 2.3, page 4, Project Report 3[3]), which uses the RORBwin output hydrographs, where used to simulate flood inundation modelling. The 24-h SILO data are not used in this analysis.

RORBwin was used to determine the hydrograph for a 1%AEP rainfall event at the various locations in catchment 5 (catchment 2 is no longer impacted by the updated mine infrastructure) (*Figure 13*). These hydrographs were used as an input for the HEC-RAS 2D model to determine the inundation scenarios caused by the rainfall event (Section 2.3, Project Report 3[3]).The input hydrographs for each node in *Figure 13* are shown in *Figure 14*.

6.1 The effect of primary storm surge in Darwin Harbour

The simulation of when a 1%AEP rainfall event coincides with storm surge was not updated as previous analysis (Section 3.2.3, page 23, Project 3[3]) showed that storm surge did not affect the site.

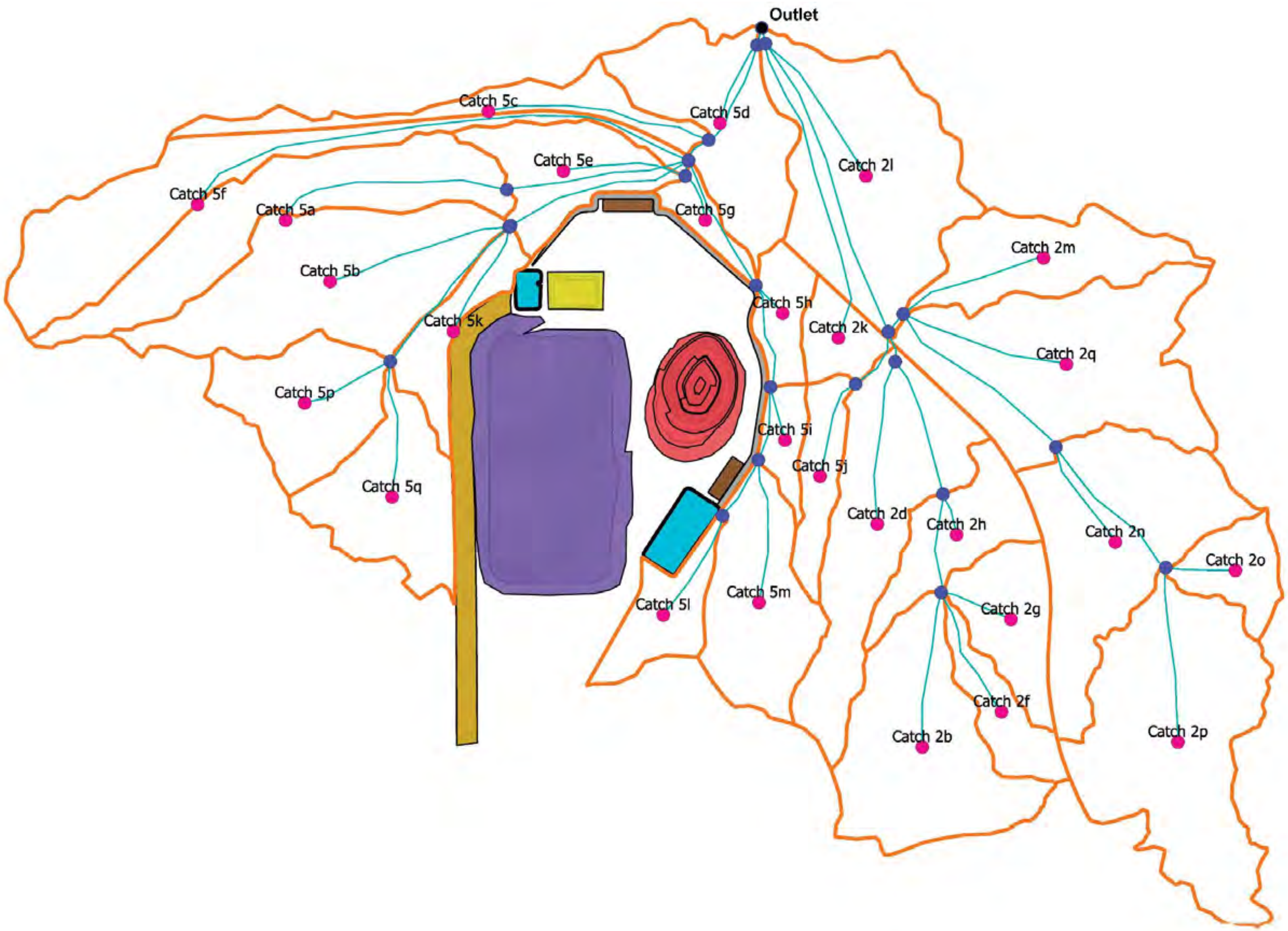


Figure 12. RORB catchment model

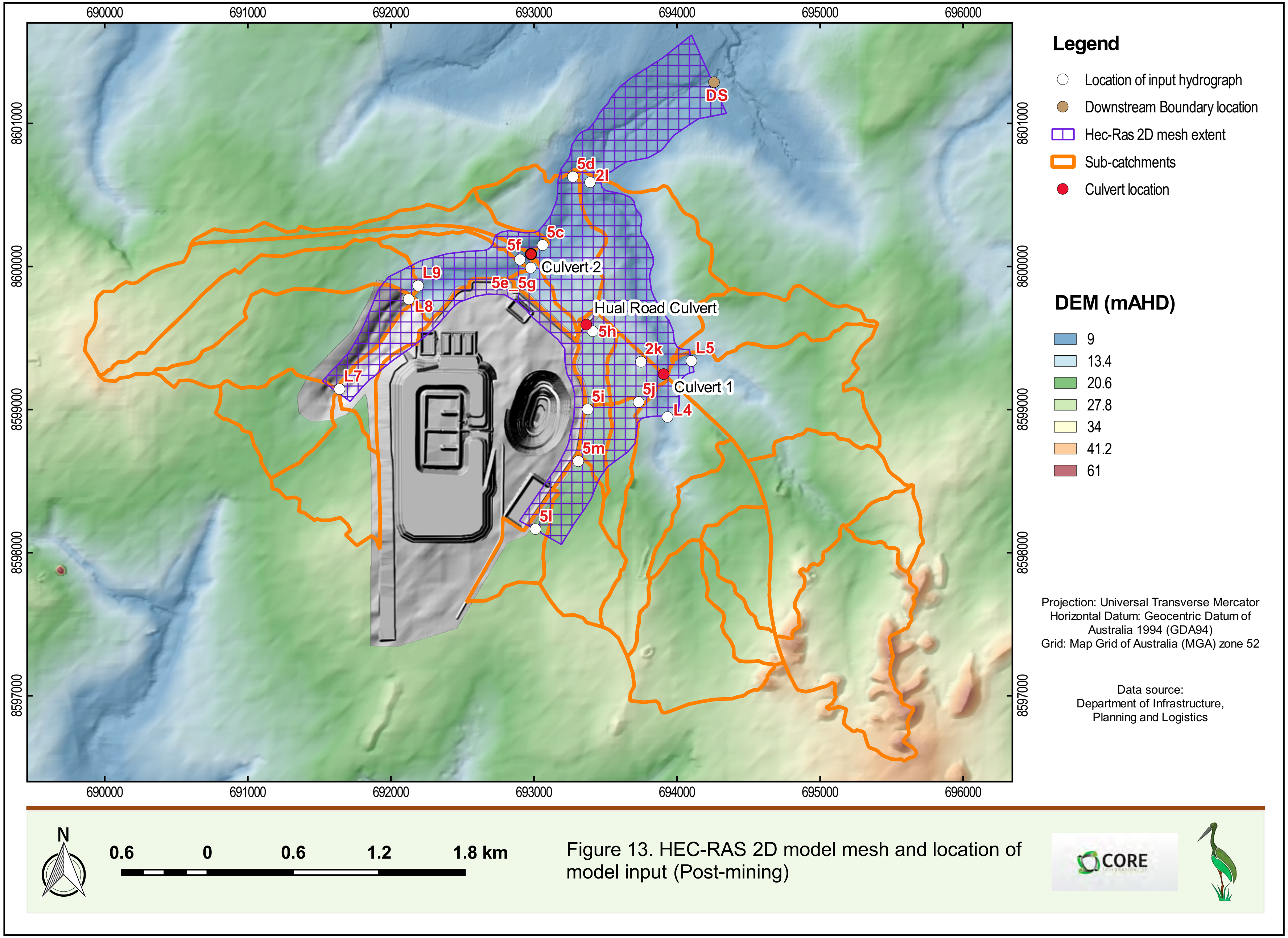


Figure 13. HEC-RAS 2D model mesh and location of model input (Post-mining)

6.2 RORBwin modelling

The calibrated RORBwin parameter values were IL = 15mm, CL = 3.1mmh^{-1}, k_c = 4.22, and m = 0.8. The empirically derived Se value was 8.15mkm^{-1}.

The RORBwin simulated 1%AEP event peak discharge and total discharge for the HEC-RAS 2D nodes for post-mining conditions are given in *Table 19*. The differences in pre- and post-mine peak discharges for the same nodes are because the mine infrastructure affects drainage routes and the area of sub-catchments draining through those nodes. Pre-mine total discharges and peak discharge are provided in Table 1, page 13, Project 3[3].

The RORBwin Monte Carlo simulations gave the critical rainfall duration of 6h for the 1%AEP event. RORBwin simulated peak discharge at the Outlet node (*Figure 12*) as 118.90m^{3}s^{-1} for pre-mine scenario, and 121.0m^{3}s^{-1} for post-mine scenario, an increase of 2.5%, and a time to peak discharge as approximately 2h. Total discharge at the outlet of catchments 2 and 5 for the 1%AEP event is 2090ML for pre-mine scenario and 1850ML for the post-mine scenario, a drop of 11% between the pre- and post-mining condition. It should be noted that the MSD is not considered in RORB model due to the limitation of the model. The peak discharge and flow volume at model outlet were calculated under the condition when the impact of MSD is not considered. The impact of MSD was assessed in the HEC-RAS model using the sub catchment hydrograph (*Figure 14*) generated by RORB.

The RORBwin simulated rainfall hyetographs and their resulting hydrographs for sub-catchments as they combine downstream for the 1%AEP event are shown in *Figure 14* (update of Figure 9, page 15, Project 3[3]). The upper hyetograph is the rainfall depth per 15-min interval and the continuous hydrograph are those simulated by RORBwin Monte Carlo simulations for the probable peak discharge of the event.

These hydrographs are used as input to the HEC-RAS 2D inundation model to assess local inundation as a result of 1%AEP rainfall event and the 1%AEP rainfall event occurring at the same time as primary storm surge.

Table 19. RORBwin simulated total discharge and peak discharge for the updated post-mining HEC-RAS 2D input nodes for the 1%AEP event.

HEC-RAS 2D Node	Post-mining		
	Area (km^2)	Peak Q (m^3s^{-1})	Total Q (ML)
L7	0.782	15.04	124.00
L8	0.941	16.33	149.00
L9	0.604	9.043	95.90
5e_5g	0.381	7.332	60.40
5f	0.842	8.67	134.00
5c	0.606	7.35	96.30
5d	0.486	9.88	71.40
5l	0.192	3.510	30.50
5m	0.434	7.95	68.80
5i	0.093	1.959	14.80
5h	0.137	3.132	21.70
5j	0.163	3.077	25.90
L4	1.999	27.48	317.00
L5	3.029	40.31	418.00
2k	0.126	15.01	134.00
2l	0.844	1.421	20.00
Outlet	11.66	121.1	1850.00

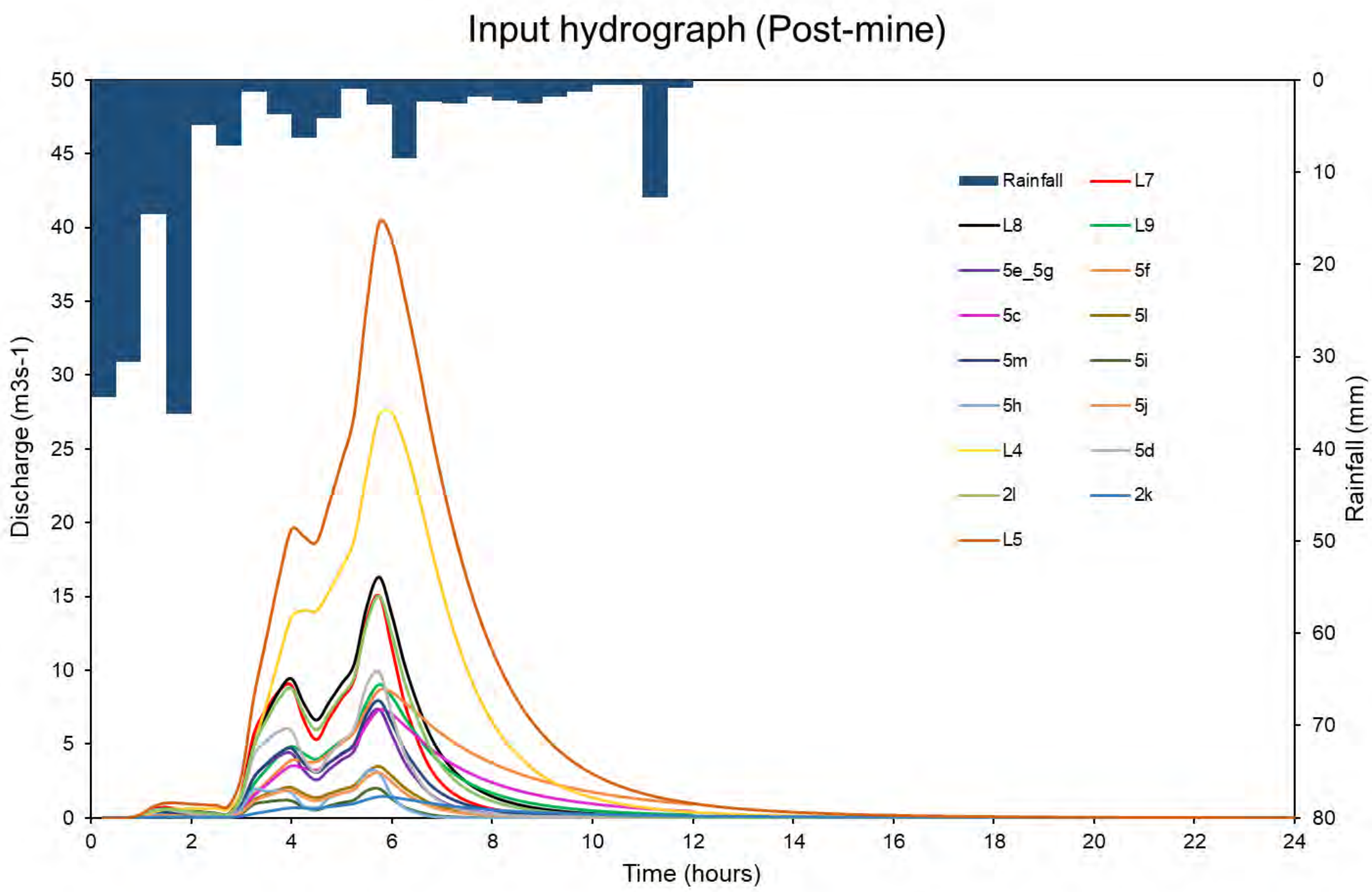


Figure 14. Input hydrographs from RORBwin for post-mining scenario for the 1%AEP design rainfall event. Update of Figure 9, page 15, Project 3[3].

6.3 Flood Inundation Modelling

The results of inundation modelling for a 1%AEP rainfall event for the new mine infrastructure allowed the re-assessment of the following:

1. What impact will inundation have on mine infrastructure, and
2. How would the mine infrastructure affect flooding of the Cox Peninsula Road at the culverts 1 and 2 (*Figure 17*) where the road intersects catchments 2 & 5.

6.3.1 Update of catchment inundation

Figure 16 shows the post-mine flood inundation for the 1%AEP rainfall event for catchments 2 and 5. The pre-mine inundation does not change. The post-mine inundation area is less than the pre-mine area because some pre-mine flow paths are no longer existed due to the presence of mine infrastructure (Green arrows in *Figure 17*). The inundation of Cox Peninsula Road around culvert 2 will be considerably reduced if MSD is constructed (*Figure 17*). The slightly increases in the inundation area to the east of the mine (Red circles in *Figure 17*) is due to water originally drained to culvert 2 (Yellow flow path in *Figure 17*) flow towards northeast due the mine infrastructure. The mine site is protected from an overland flood to the east of the mine site by the inundation bund (*Figure 16*). After the flood peak, the flood water is gradually drained away through natural stream lines and the culverts under the haul road and Cox Peninsula Road (*Figure 18*). The hydrograph of the flow through the haul road culvert is shown in *Figure 15*.

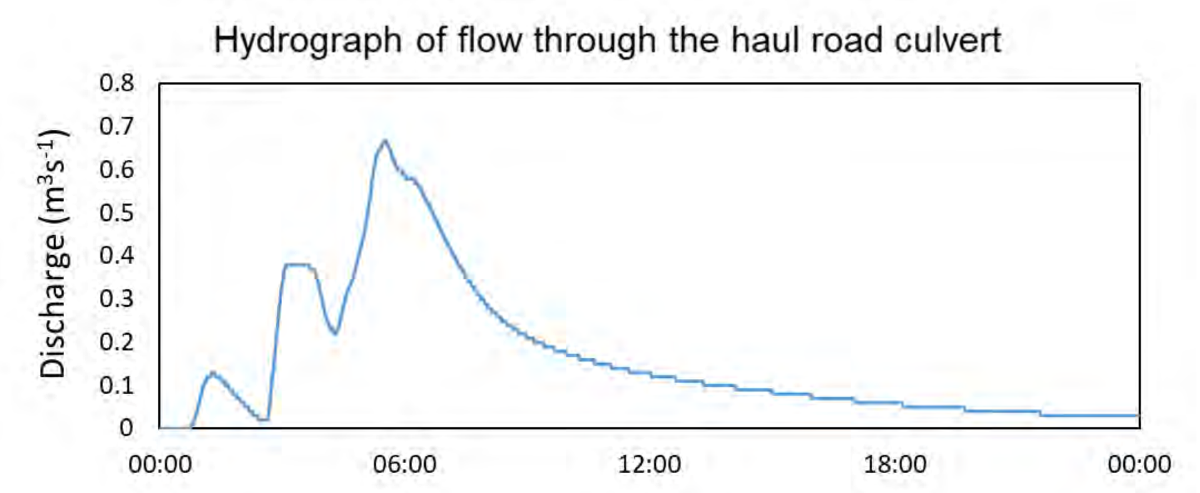


Figure 15. Simulated hydrograph of flow through the haul road culvert.

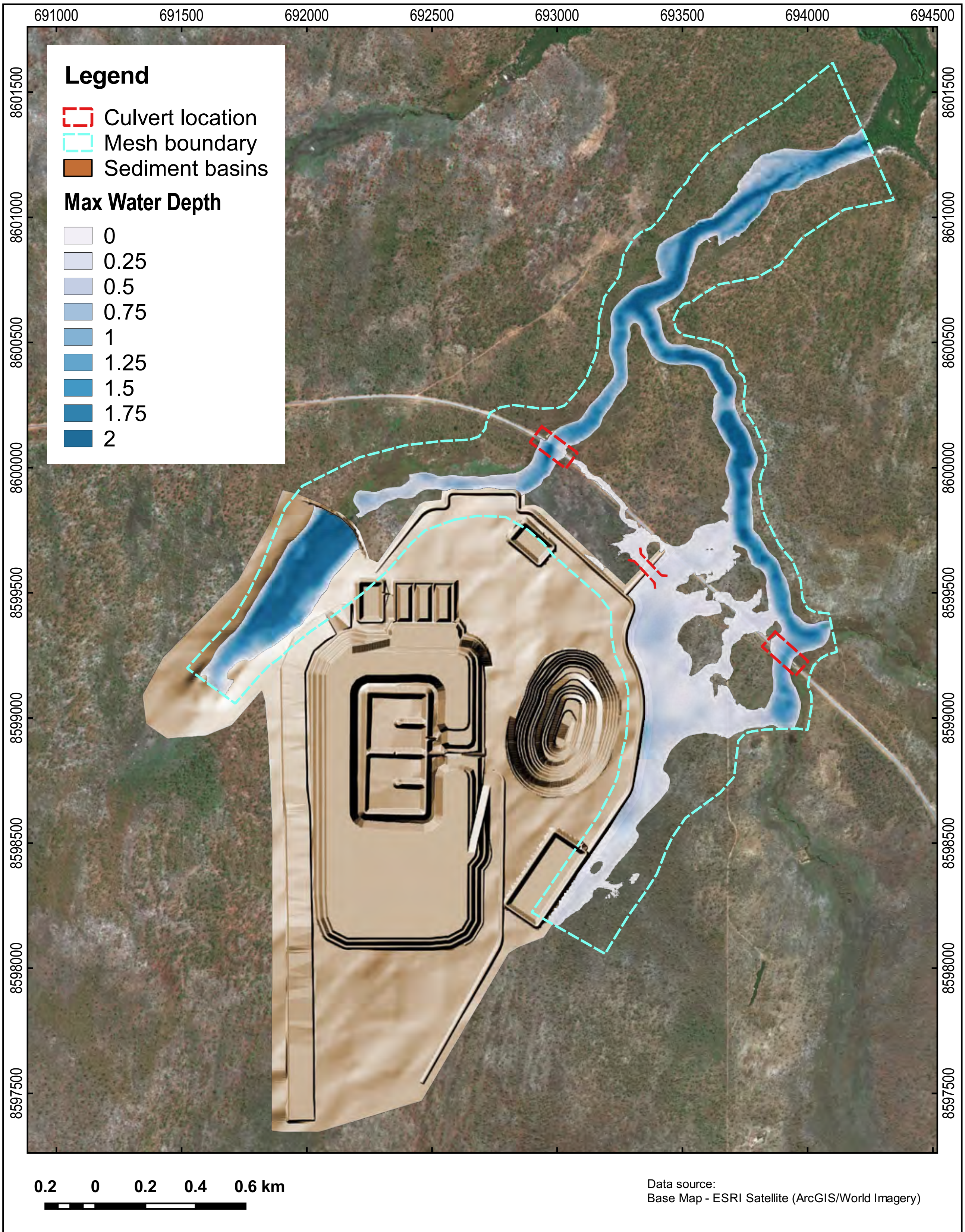


Figure 16. Post-mine 1%AEP rainfall inundation extent

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94) Grid: Map Grid of Australia (MGA) zone 52

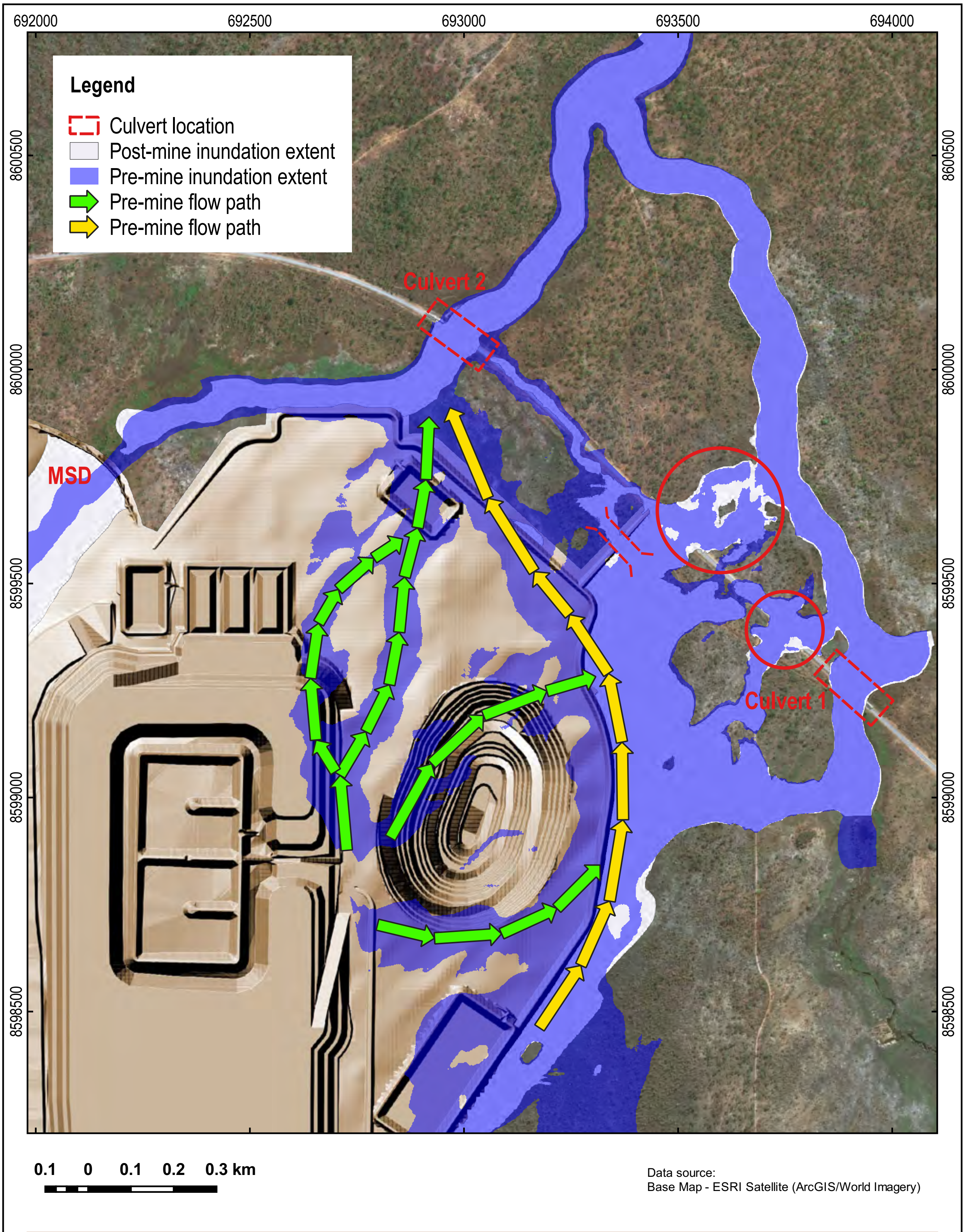


Figure 17. Pre- and post-mine 1%AEP rainfall inundation extents

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

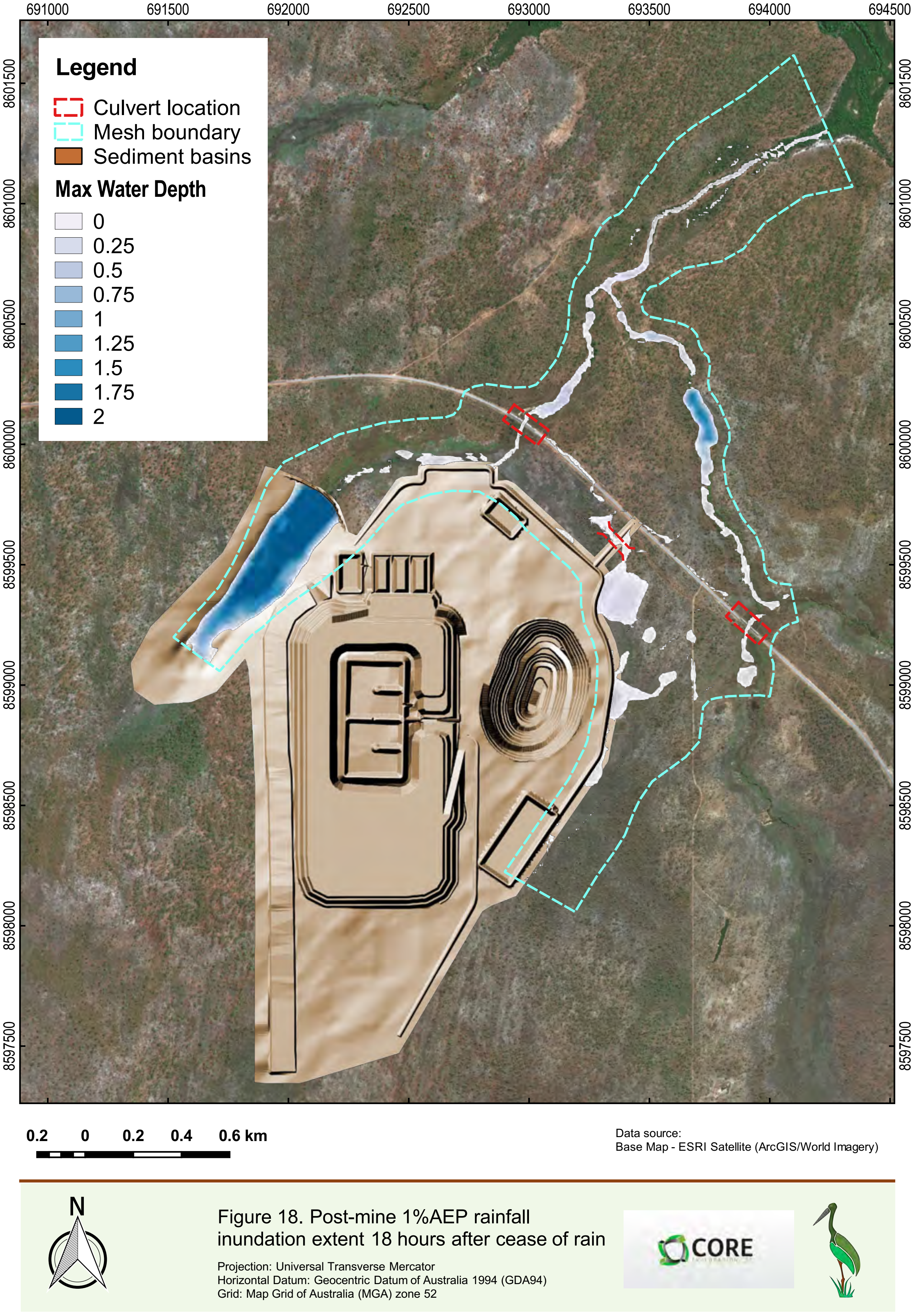


Figure 18. Post-mine 1%AEP rainfall inundation extent 18 hours after cease of rain

Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Grid: Map Grid of Australia (MGA) zone 52

6.3.2 Update of Cox Peninsula Road inundation

The simulation results for the 1%AEP flood for the post-mine conditions for Culvert 1 are shown in *Figure 19.* Cox Peninsula Road is inundated for a shorter period for post-mine conditions (4.5 hrs) than for the pre-mine conditions (7.0 hrs). The maximum water depth above the road surface at the location of this culvert is 0.38m for pre-mine and 0.28m for post-mine scenarios.

The updated simulation results for the 1%AEP flood for pre- and post-mine conditions for Culvert 2 are shown in *Figure 20*. As the flood water is retained by the MSD, the Cox Peninsula Road is not inundated under post-mine conditions while it was inundated for 3.5 hrs under the pre-mine condition. The maximum water depth above the road surface at the location of this culvert is 0.29m for pre-mine scenarios.

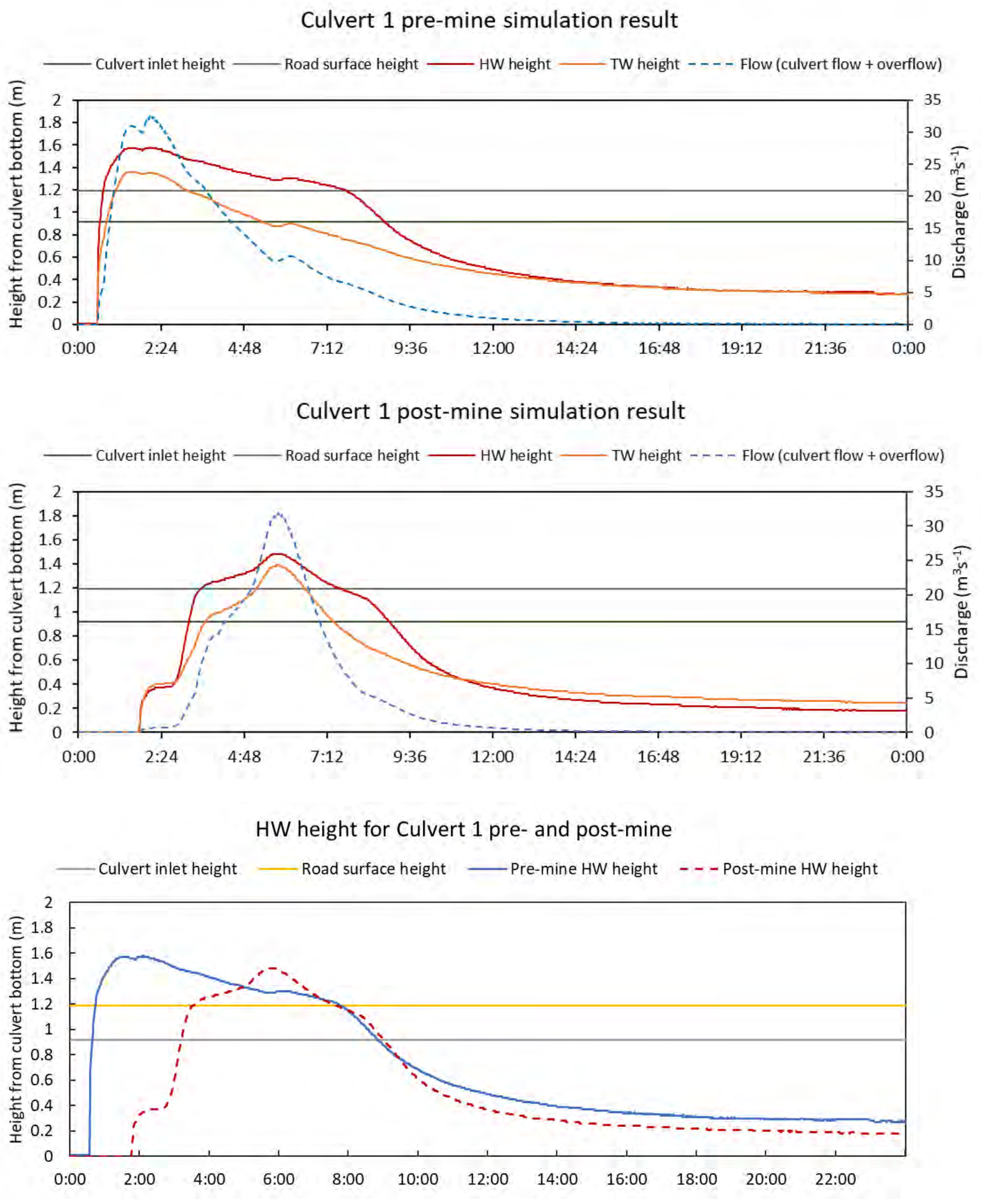


Figure 19. Culvert 1 pre- and post-mine simulation results. (Updated Figure 15, page 22, Project 3[3])

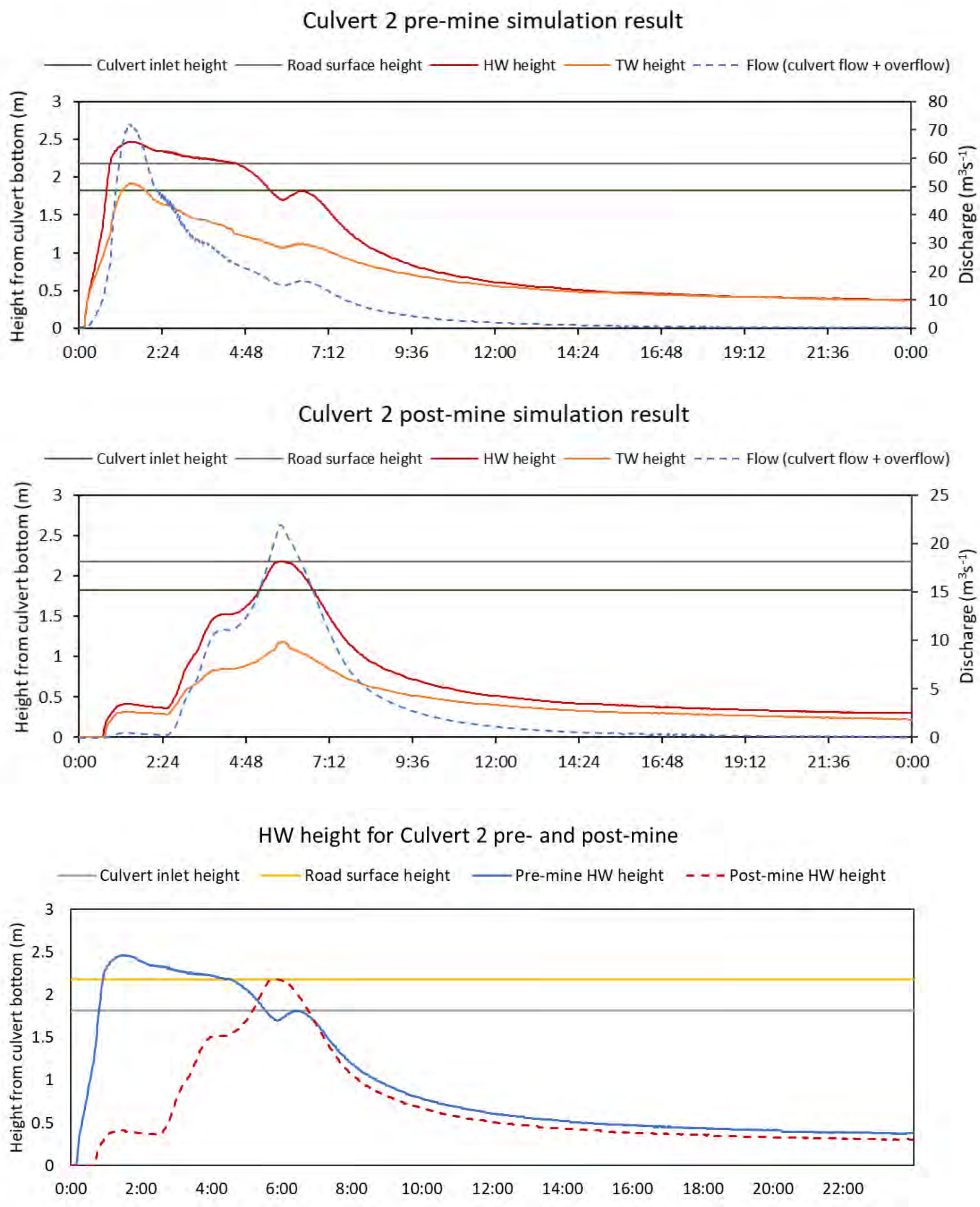


Figure 20. Culvert 2 pre- and post-mine simulation results. (Updated Figure 16, page 23, Project 3[3])

7 Summary

The HEC-HMS model was recalibration using 24-h rainfall inputs to address inconsistencies in climate data used for groundwater and surface water studies. The only change to parameter values was CL which was due to the change in time step from 15 minutes.

Applying 24-h rainfall and the new CL value to HEC-HMS for the pre-mine condition gave similar results to the simulations using 15-min input data.

The updated HEC-HMS simulations show that for the post-mining Darwin Harbour catchment with updated mine infrastructure only, the percentage reduction in stream flow at the catchment outlet for an average rainfall year is 18% of the pre-mine catchment outflow. This is based on a conservative simulation scenario where all water is retained in the sub-catchment containing the infrastructure.

During mining, when there are water releases from the mine infrastructure, the reduction in stream flow at the outlet of catchments 2 and 5 is 14% for an average rainfall year. During mining when the mine site dam (MSD) is included in the Darwin Harbour catchment, reduction to catchments 2 and 5 outflow due the dam and the infrastructure is about 19% of the pre-mine outflow. So, for an average year, MSD is responsible for a reduction of about 5%.

Observation Hill dam yield analysis indicated a water deficit for low rainfall year scenarios for the 2 wall lifts tested. The monthly reduction in flows to Bynoe Harbour receiving waters ranged from 1.4% to 12.6% for the same scenarios.

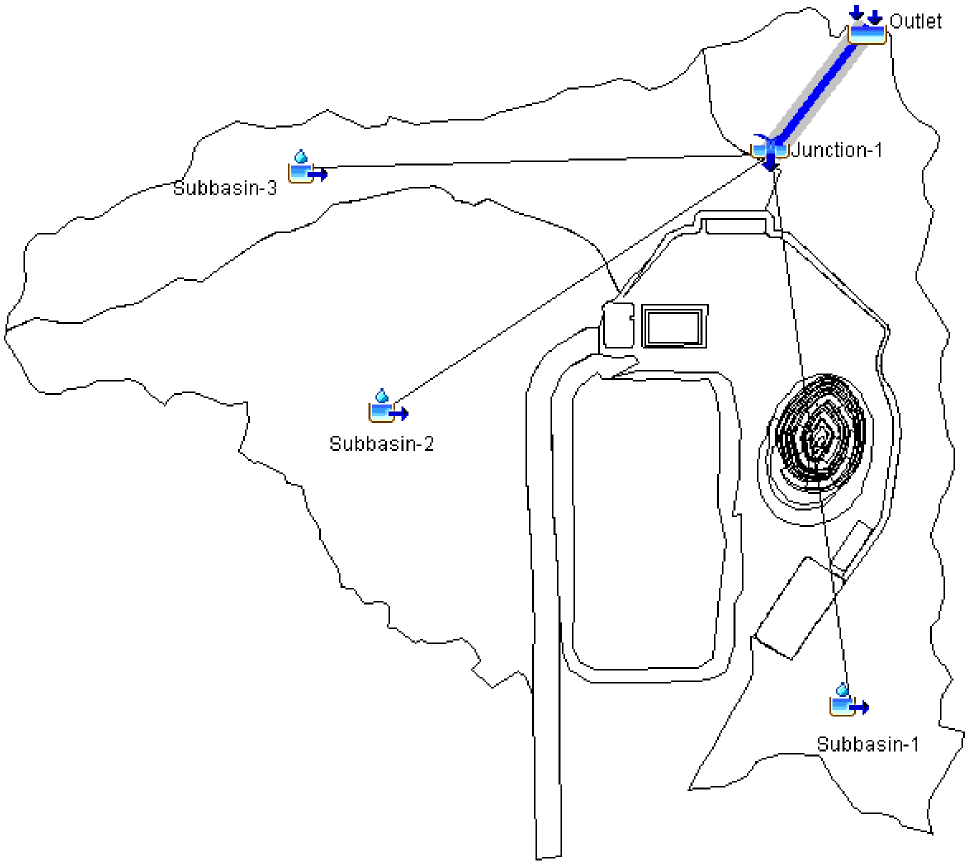
The assessment of the effects of the mine infrastructure on downstream flows at the outlet (DS 4) to Darwin Harbour indicated a monthly reduction ranging from 9.5% to 8.3%; and 16.5% to 9.4% when the MSD was included.

There was little change in the peak discharge (+2.5%) and total discharge (-11%) at the outlet of catchments 2 and 5 for for pre-mining and post-mining conditions for the probabilistic 1%AEP rainfall runoff event.

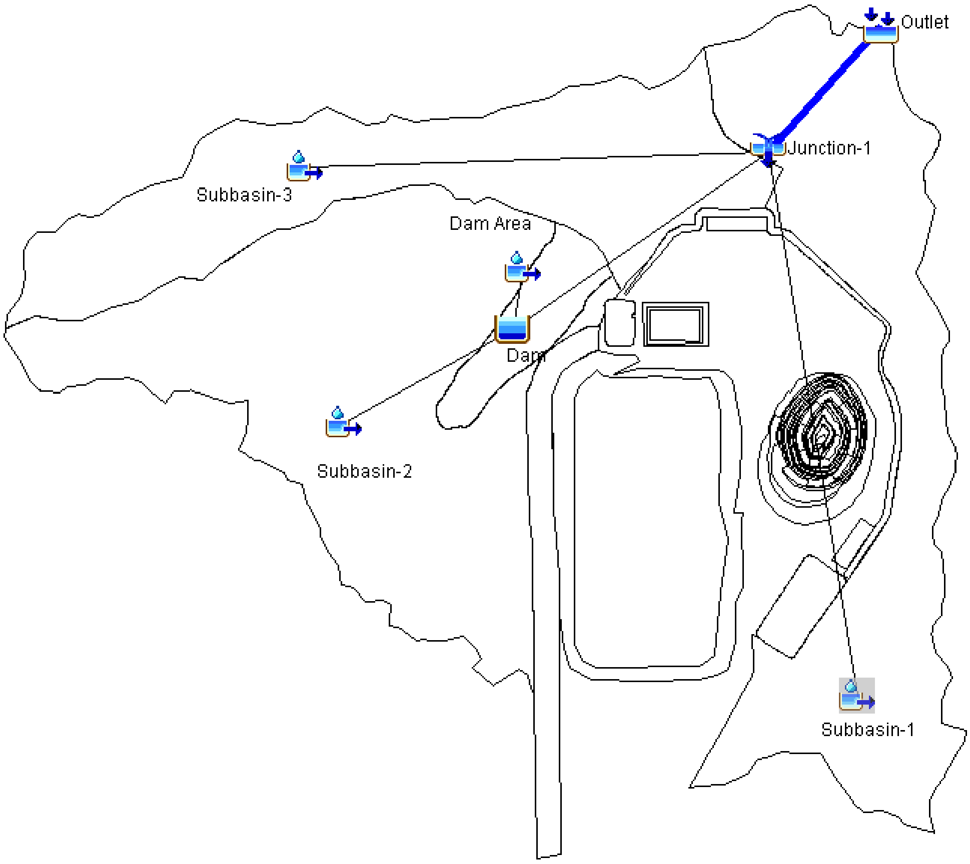
There is a reduction in the catchment inundation area between pre- and post-mining caused by the mine infrastructure and MSD retaining water. The mine site is protected from flood risk by the inundation bund. Flood water around the mine site drains away through natural stream lines and the haul road and Cox Peninsula Road culverts. Inundation of Cox Peninsula Road is reduced in time, extent and depth in the post-mining condition compared to the pre-mining condition.

Appendix A

A1. Darwin Harbour catchment post-mining HEC-HMS model (without mine site dam)



A2. Darwin Harbour catchment post-mining HEC-HMS model (with mine site dam)



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Description	Author	Reviewer	Approved for Issue		
			Name	Signature	Date
Version 0	Ken Evans Mike Liu	Mike Liu	Ken Evans	KG Evans	04/03/2018

Surface Water Extraction Licence 8151018: Monitoring Report 2023 Grants Lithium Project

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ACRONYMS

AWBM	Australian Water Balance Model
BACI	Before After/Control Impact
BOM	Bureau of Meteorology
DEPWS	Department of Environment, Parks and Water Security (Northern Territory)
DRM	Downstream risk matrix
GDE	Groundwater dependant ecosystem
LDGNT	Lithium Developments (Grants NT)
ML	Mineral Lease (granted)
NVIS	National Vegetation Information System
OHD	Observation Hill Dam
RVMP	Riparian Vegetation Monitoring Plan
RWD	Raw Water Dam
SWEL	Surface water extraction licence
SWMP	Surface Water Monitoring Program
TARP	Trigger action response plan

1 INTRODUCTION

1.1 Background

Core Lithium Limited (Core Lithium) was granted a licence in November 2021, to take or use surface water, pursuant to section 45 of the *Water Act*, 1992. The surface water extraction licence, or SWEL (Licence number: 8151018), permits the use of surface water from the existing Observation Hill Dam (OHD) located on mineral lease (ML32074) for the beneficial use of mining on ML31726 and ML32074. The SWEL period is from 1 December 2021 until 30 April 2025 (3.5 years).

Condition 2.2 of the SWEL provisions that Core Lithium may seek approval from the Controller to change the Period, by completing an application to amend the licence, however, the total extraction from the listed waterway (i.e., OHD) must not exceed the maximum water entitlement of 620 ML/year. An amendment to SWEL 8151018 was granted on 13 October 2022, which increased the entitlement of the 1/11/2022 to 30/04/2023 period to 310 ML. A copy of the SWEL (and Notice of Amendment) is provided as Appendix A, and the entitlements per period are shown in Table 1-1.

Table 1-1. Licenced extraction volumes under SWEL 8151018

Entitlement	Period
310 ML	Commencement date (1/12/2021) to 30/04/2022
310 ML	1/05/2022 to 31/10/2022
310 ML	1/11/2022 to 30/04/2023
121 ML	1/05/2023 to 30/04/2024
121 ML	1/05/2024 to 30/04/2025

Lithium Developments (Grants NT) Pty Ltd (LDGNT) commenced construction during Q4 2021. Water sourced from OHD for the Grants mine is pumped via a 6 km long buried pipeline (constructed and commissioned in Q4 2021) which traverses across both ML32074 and ML31726 from OHD to the Raw Water Dam (RWD) located at the Grants mine.

1.2 Scope and purpose

The purpose of this SWEL Monitoring Report is to fulfil the reporting requirements of SWEL 8151018 Condition 4.2, which stipulates that Core must provide a monitoring report to the Controller within 2 weeks of 30 June each year of the licence.

The monitoring report must:

> *(vi) include data collected in accordance with the monitoring program under 4.1 for the previous reporting year (1 May – 30 April);*
>
> *(vii) outline any management actions taken in response to the quantitative triggers or limits established under 4.1(iii);*
>
> *(viii) include a summary of the outputs from updated surface water modelling using the most recent monitoring data;*
>
> *(ix) discuss the measured and modelled impacts of water taken under this licence on the downstream riparian vegetation and surface water flows; and*
>
> *(x) publish a copy of the monitoring report on a website on the internet that is publicly accessible.*

1.3 Reporting period

The monitoring report period is 1 May 2022 to 30 April 2023 (the water accounting year).

2 RAINFALL

There was a total of 1453.2 mm of rain over the reporting period. Rainfall was measured at the Grants mine site and not the Bureau of Meteorology (BoM) station 014264, located at the Territory Wildlife Park some 20 km away (most direct route). WRM Water & Environment (WRM) compared the site and BoM data, and noted a significant difference between the total rainfall (1453.2 mm compared to 1720 mm at the Territory Wildlife Park). Given this difference, WRM has used the site data to validate the surface water model, and for consistency this data is reported here. The rainfall record is provided as Appendix B and summarised in Table 2-1 and Figure 2-1.

Table 2-1. Rainfall at OHD

Month	Rainfall (mm)	Cumulative Total (mm)
November 2022	215. 2	215.2
December 2022	445.5	660.6
January 2023	198.1	858.7
February 2023	307.7	1166.4
March 2023	169.7	1336.1
April 2023	117.1	1453.2

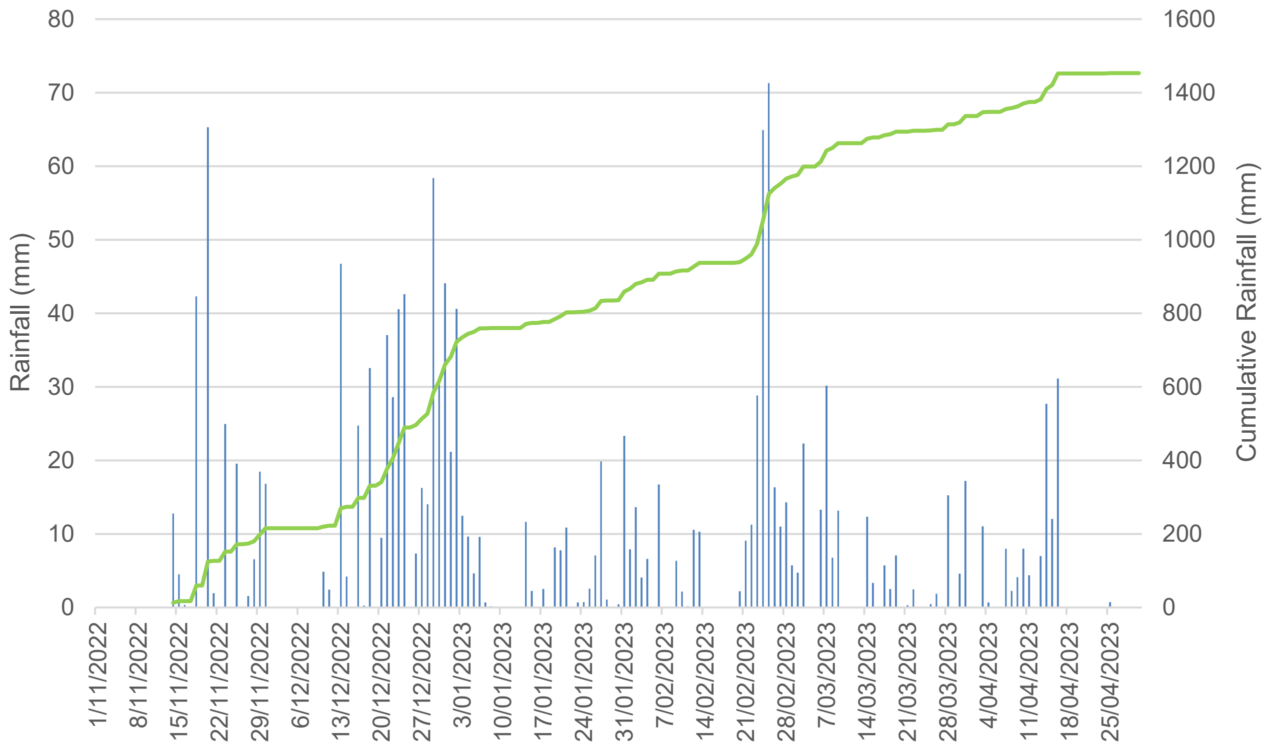

Figure 2-1. Rainfall at OHD (mm)

Rainfall commenced at Grants on 14 November 2022.

3 SURFACE WATER EXTRACTION

3.1 Observation Hill Dam

OHD was originally constructed to supply water for tin and tantalite mining and ore processing that occurred in the 1980's and 1990's (Frater, 2005).

3.1.1 Catchment and drainage

The existing OHD lies within the Charlotte River catchment and drains into Bynoe Harbour. The OHD receives runoff from a 93.9 ha catchment generally south of the Cox Peninsula Road (WRM, 2022).

OHD is situated in the upper reaches of a north-south trending stream order 1 drainage line. The unnamed drainage line flows south for approximately 3 km to the confluence of a stream order 3 waterway and flows west for around 3 km to meet the tidal, mangrove-lined upper reaches of the Charlotte River.

Immediately downstream of OHD, there is a broad, open wet area with poorly defined drainage that supports wetland sedges and herbs during the wet season and early dry season, but mostly dries out later in the dry season. Approximately 1 km downstream of the dam wall the watercourse has a well-defined channel. Around 2 km downstream of the OHD wall the watercourse has well-developed riparian vegetation. A site inspection conducted by EcOz in late-dry season (October 2017), observed pools persisting around 2 km downstream of the OHD but no visible flows.

3.1.2 Capacity

The capacity of OHD was estimated in 2018 to be approximately 364 ML (EnviroConsult, 2018). This figure has since been revised to 345,316 m^3 or 345.3 ML, following a post 2022/23 wet season survey (23 May 2023). The spillway currently sits at an elevation of RL29.315.

To ensure water security for the project in the event of lower-than-average rainfall, LDGNT is considering raising the dam wall embankment by 1.4 m and spillway by 1.5 m, to increase the storage capacity to approximately 620 ML. The OHD upgraded spillway and embankment design is provided in the Observation Hill Dam Surface Water Monitoring Program (WRM, 2022).

3.2 Volume extracted from OHD

During the reporting period, water extraction from OHD was within the entitlement limit for the period. The OHD Surface Water Extraction Record is provided as Appendix C and summarised in Table 3-1.

Table 3-1. Surface water extraction volume from Observation Hill Dam during the reporting period

Beneficial Use of Water Entitlement	Period	Maximum Water Entitlement (ML)	Water Usage (ML)
Mining Activity	1 May 2022 - 31 Oct 2022	310	128.65
Mining Activity	1 Nov 2022 - 30 April 2023	310	308.1
Mining Activity	1 May 2022 - 30 April 2023	620	436.75

The volumes presented in Table 3-1. Surface water extraction volume from Observation Hill Dam during the reporting period do not take into account the volume of water returned to the dam, via a return line. Due to the pump configuration, the pump was required to run 24 hr/7 days per week. Water, surplus to demand, was returned to OHD. The return line was decommissioned in June 2023 when new telemetry was installed on the pump to allow remote operation, removing the need for continuous pumping.

The volumes extracted and cumulative volume over the reporting period are shown in Figure 3-1.

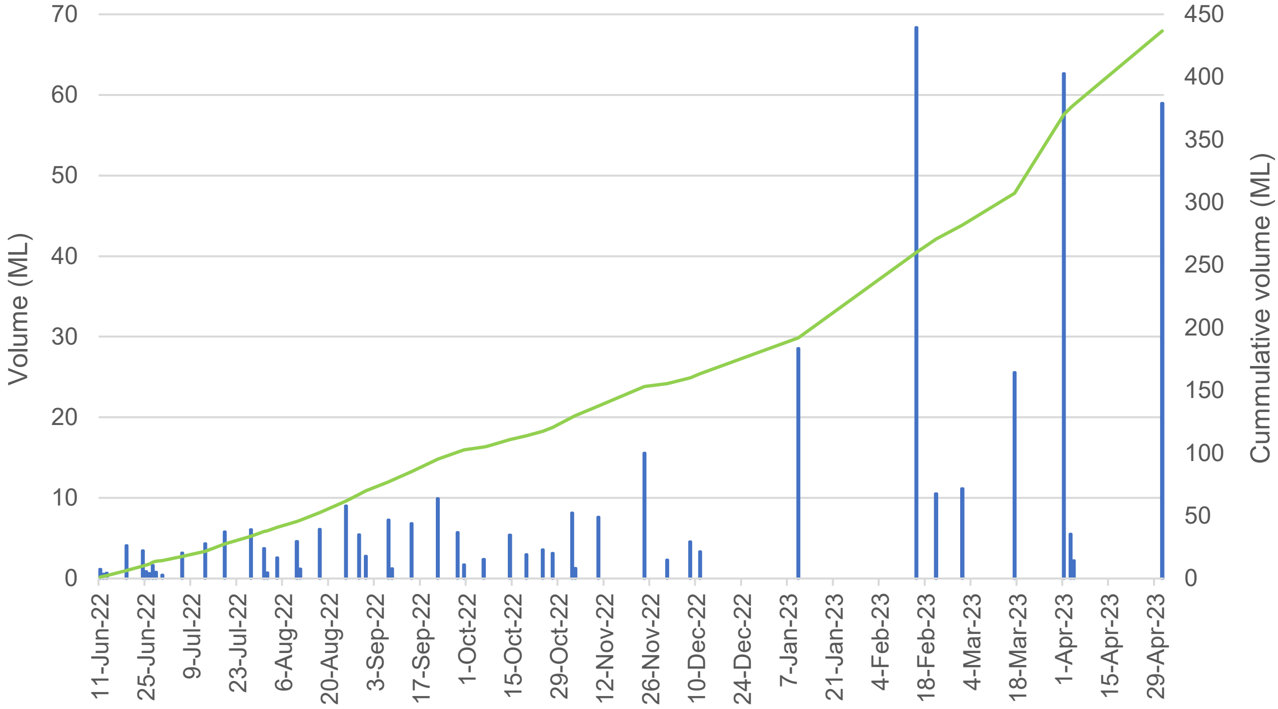

Figure 3-1. Volume extracted from OHD this reporting period.

4 MONITORING PROGRAMS

The SWEL Monitoring Plan (EcOz, 2022) was submitted to the Department of Environment, Parks and Water Security (DEPWS) for approval on 29 September 2022. The SWEL Monitoring Plan is provided as Appendix D. The plan was informed by the modelled downstream flow impacts and recommendations made by WRM (WRM, 2022).

4.1 Riparian vegetation

4.1.1 Background

EcOz undertook an assessment of the riparian vegetation along the waterway downstream of OHD (EcOz, 2019). Riparian vegetation boundaries were mapped using drone imagery captured in March 2019, and an on-ground survey was undertaken in June 2019 describing the riparian vegetation community present and its condition. The survey identified the riparian community as *Xanthostemon eucalyptoides*, *Syzygium armstrongii* and *Erythrophleum chlorostachys* mid woodland over *Pandanus spiralis*, *Helicia australasica* and *Carallia brachiata* mid shrubland over *Eriachne triseta* mid tussock grassland. The community was found to be in good condition with no major weed populations or fire impacts.

The presence of this riparian vegetation indicates this waterway receives a proportion of groundwater inputs to sustain this freshwater-dependant community during the dry season. This is also supported by the observation of pools (but not flowing water) persisting along this waterway during site visits by EcOz during the mid to late dry season. The area is also mapped as a ‘moderate’ potential groundwater dependant ecosystem (GDE) in the national GDE Atlas (BoM, 2021). Riparian vegetation communities are not rare, but they are considered significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DEPWS, 2021).

4.1.2 Methodology

The riparian vegetation monitoring plan (RVMP) was developed in accordance with Special Condition 4.1 of SWEL 8151018, and stipulates riparian vegetation monitoring methodologies, locations and frequency (refer to Section 4.3 of Appendix C). Riparian monitoring has been undertaken using drone survey and site assessments, as described below.

Drone survey has been undertaken to capture imagery of riparian vegetation and allow for comparison over years to identify any retraction or change in coverage of riparian vegetation. Vegetation health was analysed using Visible Atmospherically Resistant Index (VARI), where ‘green’ imagery representing healthy vegetation and red imagery representing bare ground (and class intervals established to categorise how green an image is).

For the reporting period, the drone surveys were undertaken biannually to establish a baseline, once at the end of the wet season and once at the end of the dry season, to account for seasonal variability. Once a baseline is established, the surveys will be undertaken annually, in the late dry season only.

Riparian vegetation site assessments were also undertaken at five sites located along the watercourse east and south of the mine site (tributaries of the Charlotte River), and one control (reference) site located upstream of Cox Peninsula Road, on a tributary of the Charlotte River. Site locations are presented in Figure 4-2 of the SWEL Monitoring Plan (Appendix D). Dominant layers, ground cover and species richness were recorded, including the presence of invasive species. Vegetation is described and recorded to a standard that is equivalent to National Vegetation Information System (NVIS) Level 5, and in accordance with Brocklehurst et al. (2007). Riparian vegetation continuity was measured along a transect, and canopy cover used to represent continuity. Data was analysed using the Before After/Control Impact (BACI) method to assess changes over time.

Consistent with the drone surveys, riparian vegetation site assessments were undertaken biannually during this reporting period, to establish a baseline (once at the end of the wet season and once at the end of the dry season). Surveys will now be undertaken annually at the end of the dry season.

A Trigger Action Response Plan (TARP) has been developed and included in the monitoring plan (see Section 4.4 of Appendix D). The TARP provides triggers for action and responses to be implemented, based on monitoring performance indicators.

4.1.3 Results

Riparian vegetation surveys were undertaken in May (post wet season) and October (post dry season) 2022. The results of the monitoring undertaken are reported in the Baseline Riparian Vegetation Monitoring Report (EcOz, 2023) provided as Appendix E. The report consolidates, and presents interpretation of previous surveys undertaken in 2019 (EcOz, 2019).

No impacts to riparian vegetation were identified. The assessment indicated that vegetation communities within the study sites are in good condition, with limited pre-development disturbance. This is with the exception of the swamp community, which occurs downstream of the mine site in the West Arm catchment. Weeds and impacts from off-road racing tracks were observed within this vegetation community. Detailed interpretation and recommendations are provided in Appendix E.

The next round of riparian vegetation monitoring is due to be undertaken post dry season 2023 (nominally October 2023), and results will be reported in the next SWEL Monitoring Report. Riparian vegetation monitoring data will be entered into databases and compared to assessment criteria stipulated in the SWEL Monitoring Plan.

4.2 Surface water flows

4.2.1 Background

The SWEL Monitoring Plan details the surface water level monitoring to be undertaken in accordance with Special Condition 4.1 of SWEL 8151018. Water levels are to be monitored at the OHD spillway (OHD DS) and at the downstream location BPDS SW2 on a continuous basis to:

- Inform the assessment of potential impacts on downstream flows, based on spillway data;
- Monitor flows downstream to assess impact of extraction on flows in Drainage Line BP1; and
- Provide flow data to assist in interpretation of riparian vegetation monitoring data.

4.2.2 Methodology

Details of the surface water level monitoring are summarised in Table 4-1. The continuous loggers at the OHD spillway and BPDS SW2 were installed and operational by 30 September 2022 and 10 November 2022, respectively.

Table 4-1. Surface water level monitoring sites

Name	Location	Coordinates (GDA 94 Zone 52)		Monitoring Measure	Sample Frequency	Sample Methodology	Site Type
		Easting	Northing				
OHD DS	OHD Spillway	695 185	8 594 842	Water level / flow	Continuous	Logger	Compliance
BPDS SW2	Drainage Line BP1 D/S of OHD	694 461	8 593 025	Water level / flow	Continuous	Logger	Information
OHD	OHD	695 422	8 595 695	Water level / storage	Weekly	Manual survey pickup	Information

The instruments have capability to continuously measure water velocity and water level / depth. Data remotely collected by the loggers is transmitted to the Grants site server. This will allow for continuous real time data collection and monitoring.

The locations of water level/flow monitoring sites are shown Figure 4-1 of the SWEL Monitoring Plan (Appendix D). A downstream risk matrix (DRM) has been developed which identifies the risk to the downstream environment based on spill days and cumulative rainfall scenarios (see Table 6-1 of Appendix D).

4.2.3 OHD spillway continuous logger data

Flow data is available for the OHD spillway from 30 September 2022. Flow at the spillway is illustrated in Figure 4-1. The figure shows sustained flow at the spillway from early to mid-February 2023. A significant increase in flow was observed between February 24 and 27, corresponding to a period of increased rainfall at OHD. The greatest flow at the OHD spillway, of 3.85 kL/s, was observed on 26 February 2023.

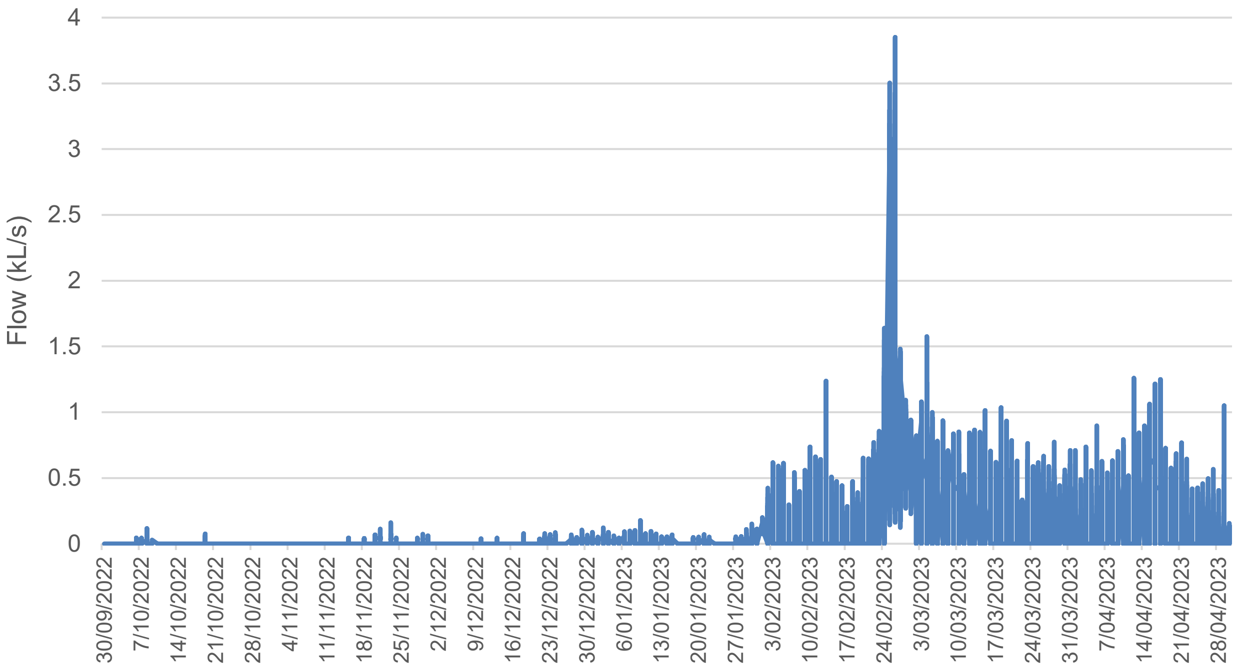

Figure 4-1. Flow at OHD spillway

4.2.4 BPDS SW2 continuous logger data

Flow data is available for monitoring site BPDS SW2 from 10 November 2022. Flow is illustrated in Figure 4-2. Figure 4-3 provides a comparison of flows at the OHD spillway and BPDS SW2.

Flows at BPDS SW2, located approximately 2 km downstream of the OHD, commenced earlier and were comparatively much higher than those at the OHD spillway. The greatest flow observed at BPDS SW2 was 9.315 kL/s on 25 February 2023, reflecting both the significantly greater catchment area and period of increased rainfall. The BPDS SW2 catchment area is estimated to be 298 ha, in comparison to OHD which has an estimated catchment area of 93.9 ha (WRM, 2022).

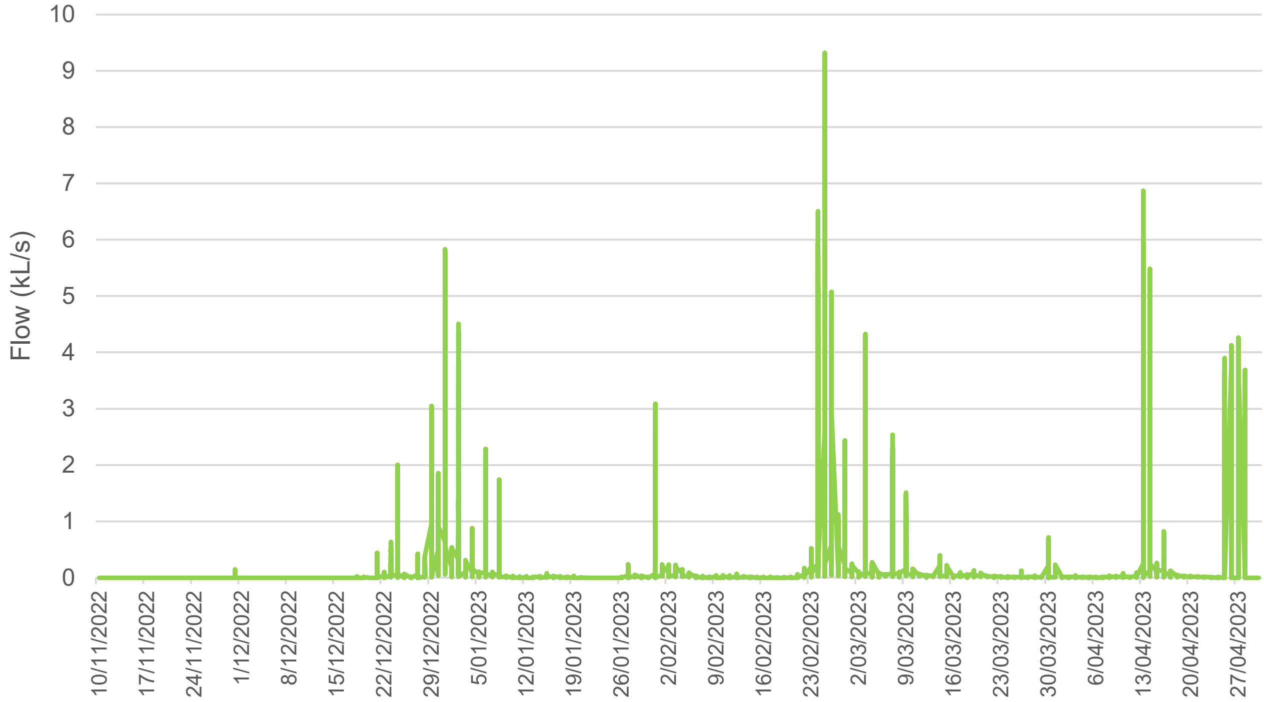

Figure 4-2. Flow at BPDS SW2

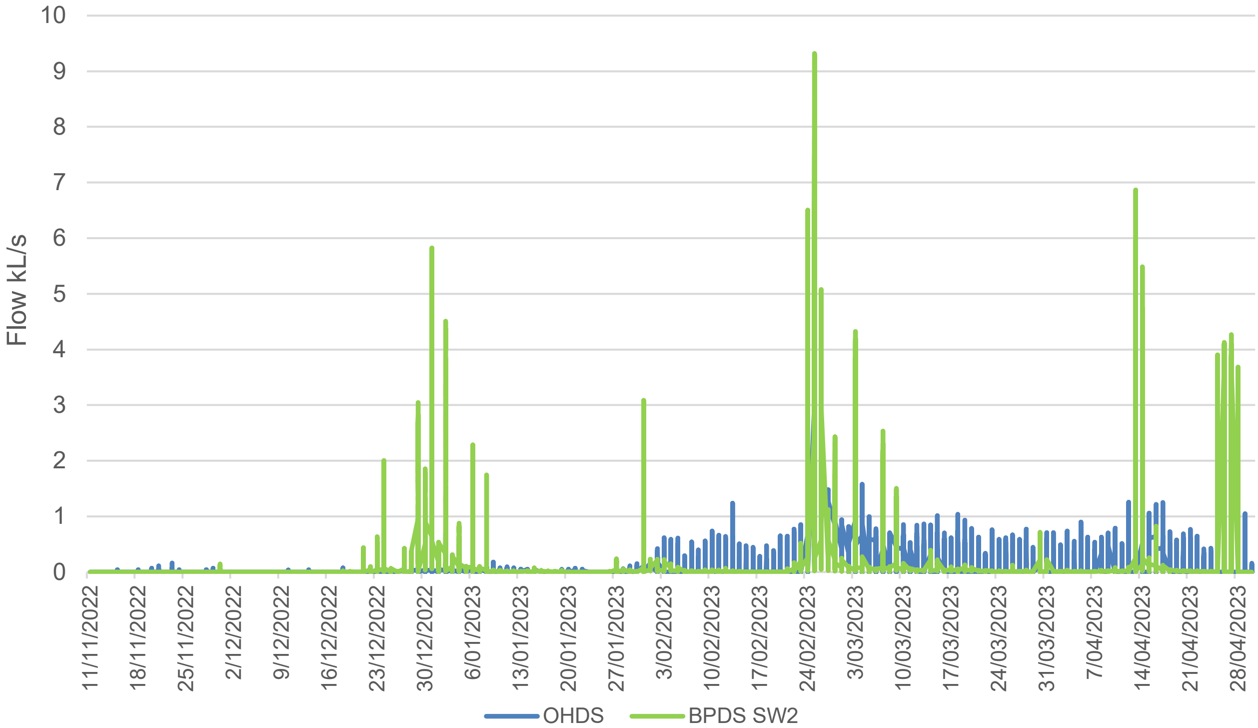

Figure 4-3. Comparison of continuous flow data

4.2.5 Weekly surveyed OHD water levels

In addition to continuous monitoring using water loggers, the water level at OHD was recorded weekly as part of the routine monitoring program. The water levels are presented in Figure 4-4 and tabulated data provided as Appendix F.

The weekly manual survey data indicate that the OHD is likely to have spilled between mid-February 2023 and mid-April 2023. This is consistent with the OHD spillway continuous data and suggests overtopping of the dam between approximately 12 February and at least 21 April 2023. This assumes a spillway elevation of RL29.315.

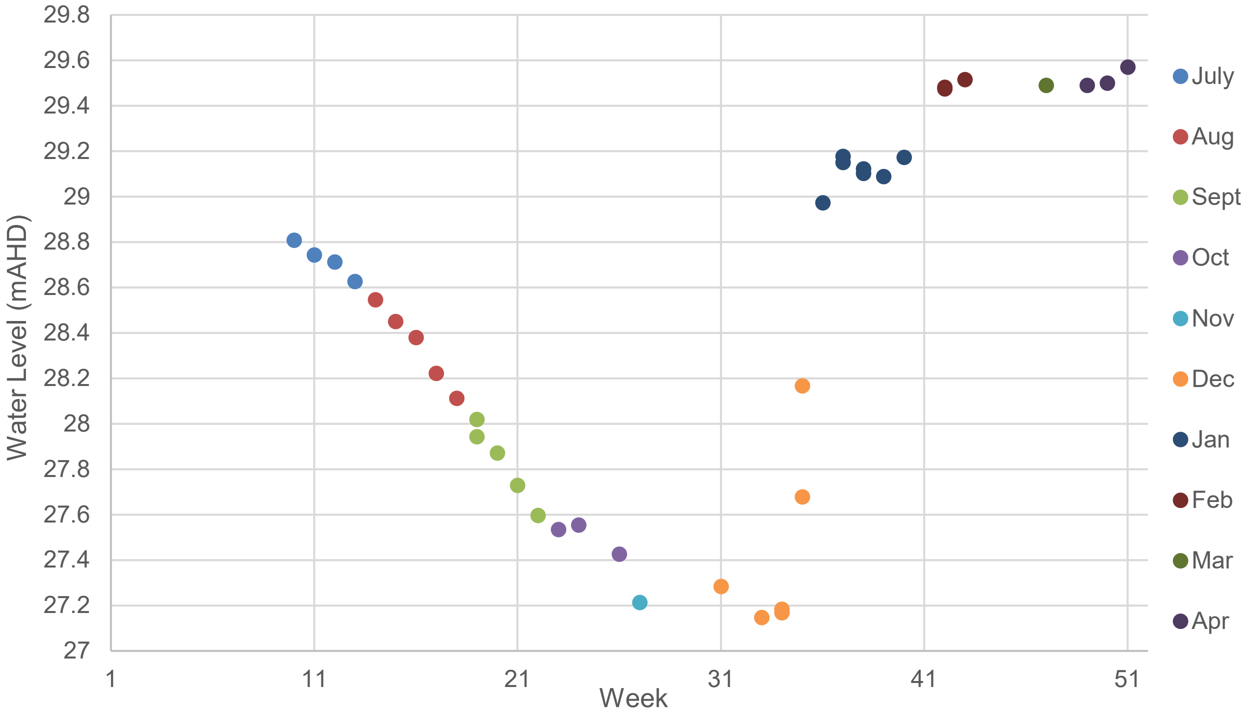

Figure 4-4. Weekly surveyed OHD water levels

5 MANAGEMENT ACTIONS

No management actions were taken during the reporting period in response to the quantitative triggers or limits established in the SWEL Monitoring Plan.

In 2023, weekly water levels were generally collected by the survey team at OHD. Given the sampling increment, the precise number of days that the dam spilled cannot be determined. The data in Appendix H shows that on 30 January, the measured water level sat below the spillway (RL29.173). On 12 February the measured water level was RL29.475. The final measurement, collected on 21 April was RL29.57 and an increasing trend in water level can be observed (see Appendix H). This indicates at least 68 spill days from 1 November 2022.

With consideration of the performance criteria provided in Section 4.2 of the SWEL Monitoring Plan, provided here as Table 5-1, no action was required to be undertaken by LDGNT during the reporting period.

Table 5-1. Surface water level monitoring performance criteria

		Cumulative rainfall from 1 November*			
		<1,300mm	1,300-1,500mm	1,500 – 1,700mm	>1,700mm
Number of spill days from OHD from 1 November	>60	Level 1	Level 1	Level 1	Level 1
	51-60	Level 1	Level 1	Level 1	Level 2
	41-50	Level 1	Level 1	Level 1	Level 3
	31-40	Level 1	Level 1	Level 2	Level 4
	21-30	Level 1	Level 1	Level 3	Level 4
	5-20	Level 1	Level 2	Level 4	Level 4
	<5	Level 2	Level 3	Level 4	Level 4

6 SURFACE WATER MODELLING

The Finniss Lithium Project Goldsim model (combined Grants open cut and BP33 underground system) was used by WRM to calibrate the OHD runoff parameters to the recorded OHD dam water level, OHD spillway flow and flow through surface monitoring location BPDS SW2 during the reporting period (WRM, 2023a attached as Appendix G). The development and configuration of the Finniss Lithium Project Goldsim model is presented in the Grants Lithium Water Balance Model Assessment (WRM, 2023b) and BP33 Underground Mine Water Balance Water Balance Model Assessment (WRM, 2023c).

Catchment runoff for OHD and BP SW2 was modelled using the Australian Water Balance Model (AWBM). The AWBM parameters for OHD and BP SW2 were reviewed as part of this assessment. The following was of note:

- The original AWBM parameters used for BPDS SW2 were found to be appropriate.
- The original AWBM parameters used for OHD did not match recorded water levels and overflows in OHD. It was found that recorded runoff into OHD was significantly attenuated when compared to the original AWBM parameters. The reasons for this unknown, however it may be due to the historical tin mining operations in the OHD catchment and/or flood attenuation within the OHD. Hence, the OHD AWBM parameters were updated for this assessment.
- The volumetric runoff coefficient for the original and updated parameter sets is the same. Hence, there is no material change in the catchment yield when compared with previous studies.

Figure 6-1 shows the modelled and recorded water level in OHD during the reporting period.

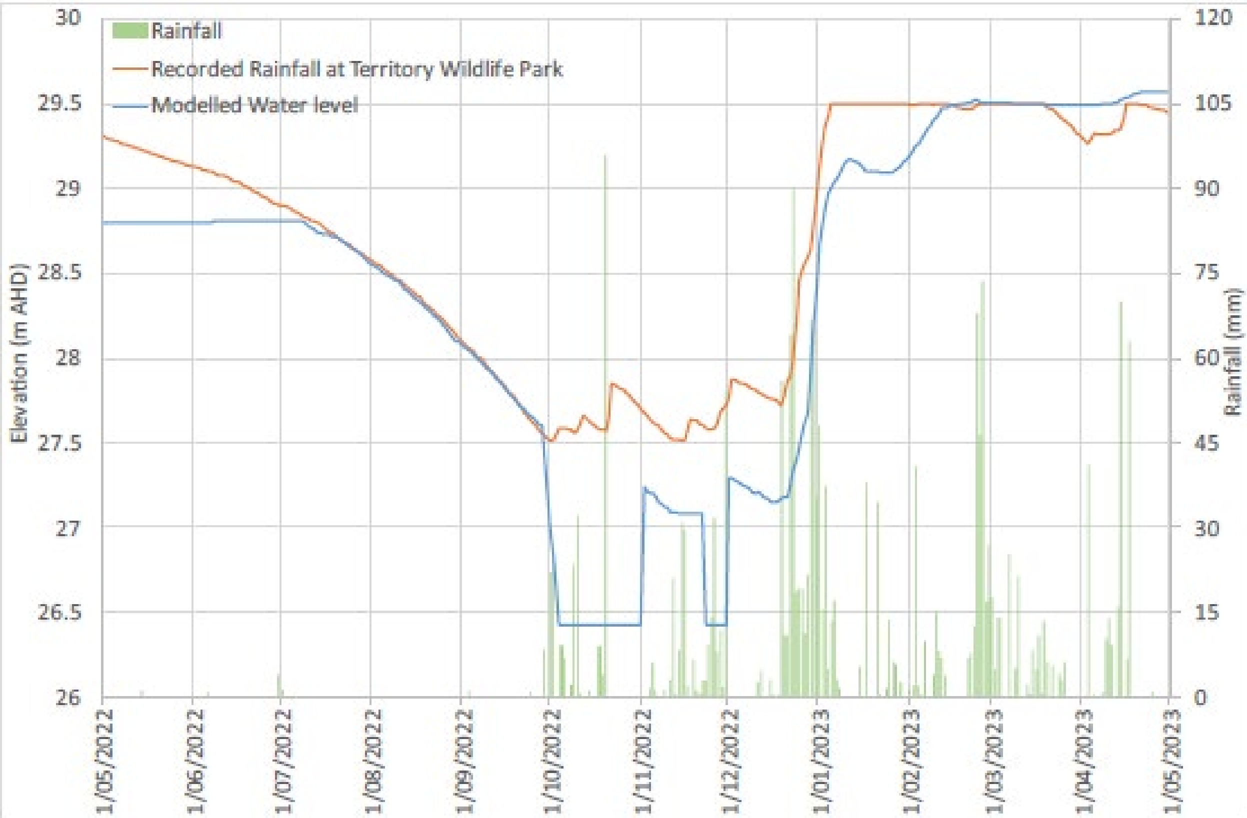

Figure 6-1. Calibrated model water level vs recorded level at OHD

Figure 6-2 shows the modelled and recorded OHD spillway flow during the reporting period.

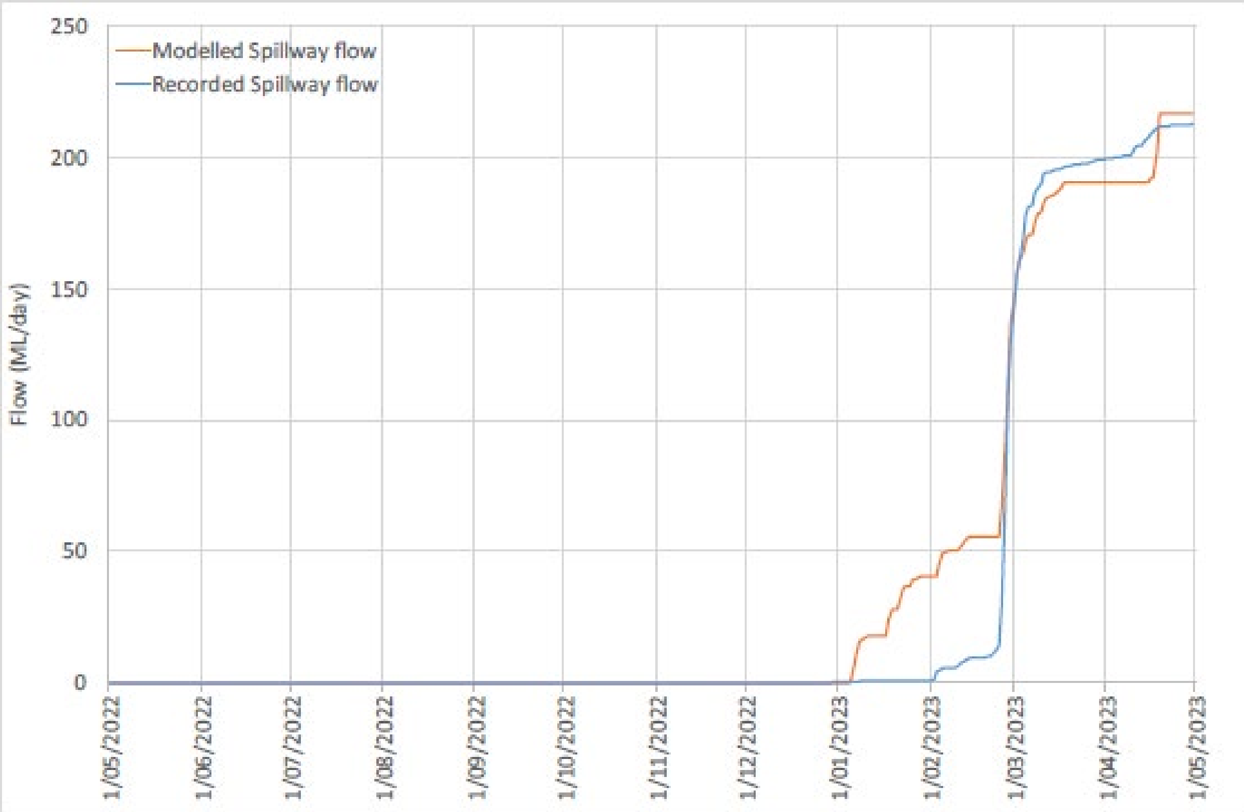

Figure 6-2. Calibrated model water level vs recorded spillway flow at OHD

Figure 6-3 shows the modelled and recorded flows at BPDS SW2 during the reporting period.

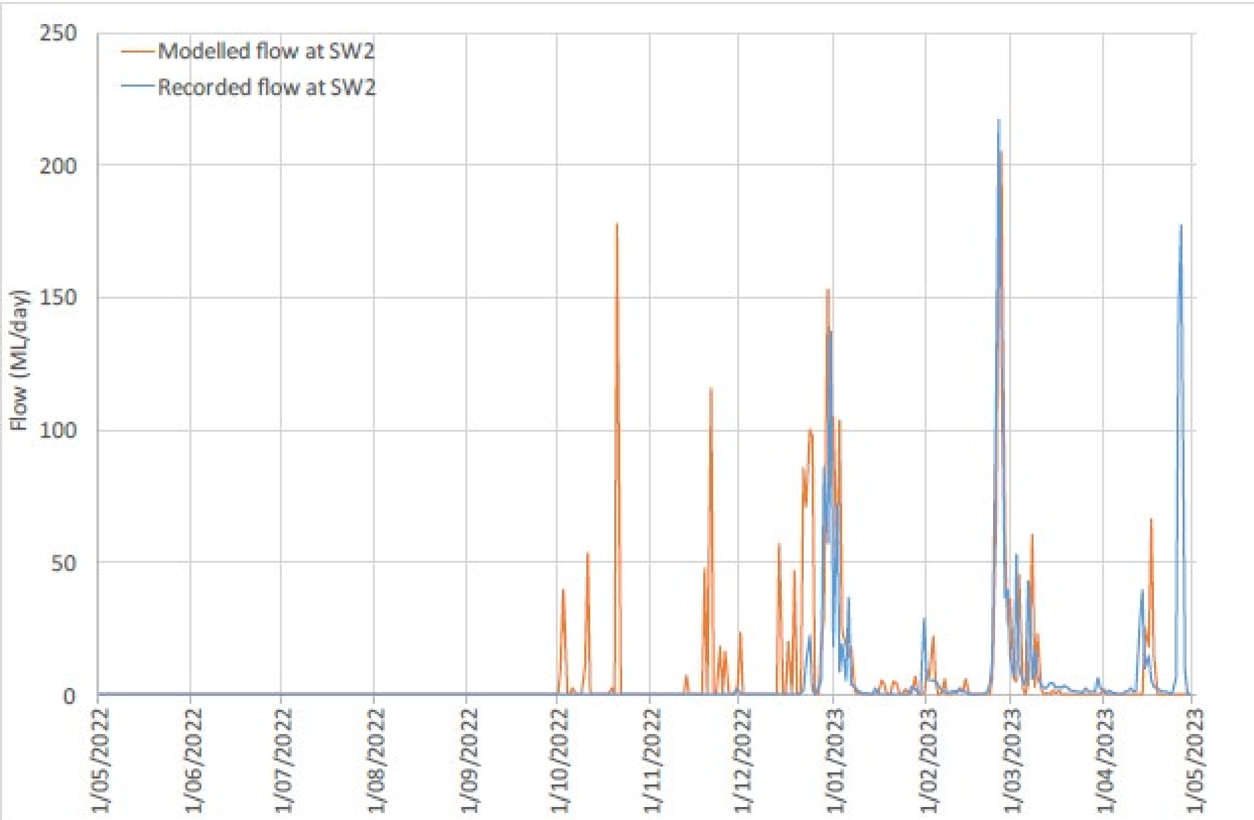

Figure 6-3. Calibrated model water level vs recorded flow at SW2

WRM concluded, that in general, the calibration results indicate that the adopted AWBM parameters for the OHD and BPDS SW2 catchments provide a reasonable fit to recorded data, when taking into account the rainfall and land-use uncertainty in the OHD catchment (WRM, 2023c attached as Appendix G).

7 COMPLIANCE

Table 7-1 provides status and compliance of the SWEL 8151018 terms and conditions. There are no non-compliance issues to report.

Table 7-1. Compliance to SWEL 8151018 conditions

Condition	Status / comments	Compliant (Y/N)
1. General Conditions		
1.1 The licence holder must comply with the provisions of the Act and all other laws in force in the Territory, including all regulations made under the Act.	Noted.	Y
1.2 The licence holder can surrender or apply for modification of this licence at any time.	Noted.	Y
1.4 Subject to Conditions 1.2 and 1.3, this licence is in force until the expiry date.	Noted.	Y
1.5 If the licence holder wishes to apply for a renewal of this licence, the licence holder must make an application to the Controller in the prescribed form at least 6 months before the Expiry Date via email to water.regulation@nt.gov.au	Noted.	Y
2. Water Extraction conditions		
2.1 Subject to Conditions 2.3 and 2.4, the licence holder must ensure that total extraction from the listed Waterway over the Periods specified below does not exceed the Entitlements.	The total extraction limit of 620 ML was not exceeded as shown in Table 3-1.	Y
2.2 The licence holder may seek approval from the Controller to change the Period, by completing an Application to amend the licence and submitting that application to water.regulation@nt.gov.au at least 20 business days prior to the start date of the relevant Period.	An amendment to SWEL 8151018 was granted 13/10/2022, which increased the entitlement for the 1/11/2022 to 30/04/2023 period.	Y
2.3 The licence holder must have the amendment approved by the Controller in writing before the amendment takes effect.	The amendment for the 1/11/2022 to 30/04/2023 period was granted 13/10/2023.	Y
2.4 In each Period the licence holder must ensure that total extraction from the listed Waterway does not exceed the Entitlement.	The period entitlement limits were not exceeded as shown in Table 3-1.	Y
2.5 The Maximum Water Entitlement must be used for no purpose other than the specified beneficial use without the prior written approval of the Controller.	All water extracted from OHD was used in mining activities.	Y
2.6 The licence holder may only extract water under this licence for use on a property listed on this licence.	All water extracted from OHD was used within Mineral Leases 31726 and 32074 (4200 Cox Peninsula Rd, Cox Peninsula, Section 1 Hundred of Parsons).	Y
3. Water Metering and Reporting Conditions		
3.1 Extraction from the listed Waterway must be recorded by a meter or meters supplied, installed and maintained by the licence holder in accordance with the Northern Territory Non-Urban Water Metering Code of Practice for Water Extraction Licences, as amended from time to time.	Water extraction from OHD is recorded by a meter or meters supplied, installed and maintained by LDGNT in accordance with the Northern Territory Non-Urban Water Metering Code of Practice for Water Extraction Licences.	Y
3.2 Within two (2) weeks following the end of each Quarter of each year, the licence holder must supply the Controller with a record of total extraction from each of the listed extraction point(s) during that month.	LDGNT has provided the Controller, within two (2) weeks of the end of each Quarter, a record of total volume of water extracted from OHD.	Y

CORE LITHIUM

4. Special Conditions		
4.1 The licence holder must develop and submit for approval by the Controller a monitoring program to assess the impact of water taken under this licence on the riparian vegetation and surface water flows downstream of the Waterway. The monitoring program must: (i) be prepared by a suitably qualified professional; (ii) include the monitoring parameters, methodology and frequency for monitoring downstream impacts attributable to water taken under this licence on: (a) riparian vegetation; and (b) surface water flows; (iii) include quantitative triggers and limits which can be used to initiate adaptive management actions when surface water flows deviate significantly from the predictions outlined in Core Exploration Ltd, Cox Peninsula Supplementary Report, Appendix H Surface Water Modelling, February 2019; (iv) include a review process to ensure continuous improvement of the monitoring program; and (v) be implemented immediately following the Controller's approval.	A revised SWEL Monitoring Plan was submitted to DEPWS on 29/09/2022. See Appendix D.	Y
4.2 The licence holder must provide a monitoring report to the Controller within 2 weeks of 30 June each year of the licence. The monitoring report must: (vi) include data collected in accordance with the monitoring program under 5.1 for the previous water accounting year (1 May - 30 April); (vii) outline any management actions taken in response to the quantitative triggers or limits established under 5.1(iii); (viii) include a summary of the outputs from updated surface water modelling using the most recent monitoring data; (ix) discuss the measured and modelled impacts of water taken under this licence on the downstream riparian vegetation and surface water flows; and (x) publish a copy of the monitoring report on a website on the internet that is publicly accessible.	This report.	Y
4.3 The licence holder must immediately notify the department on becoming aware of non-compliance (or suspected non-compliance) with any condition of this licence. A notification under this condition must: 4.3.1 contain particulars of the non-compliance, including the identified or potential impacts associated with the non-compliance; 4.3.2 identify the steps that have or will be taken to minimise the impacts of the non- compliance; and 4.3.3 identify the steps that have or will be taken to prevent a reoccurrence or minimise the risk of further non-compliance.	Noted.	Y
4.4 The licence holder must maintain a website on the internet that is publicly accessible. The licence holder must publish on the website, as soon as practicable: 4.4.1 this licence, any amendments to its conditions and information about this licence including any: 4.4.1.1 approved monitoring program (5.1); 4.4.1.2 monitoring report (5.2); 4.4.1.3 non-compliance with its conditions as reported (5.3); or	Noted. This report will be published on the Core Lithium website.	Y

4.4.1.4 other documents related to this licence, or the activities conducted under it, as directed by the Controller.		
4.5 The licence holder must have in place a Mining Management Plan to conduct Approved Mining Activities, approved by the Minister in accordance with the Mining Management Act 2001 throughout the Term of this licence. If the Mining Management Plan is revoked, the licence holder must notify the Controller within 7 days. The notification must be via email to water.regulation@nt.gov.au.	The Grants mine operates under mining Authorisation 1021-02 and an accepted Mining Management Plan (dated 2/9/2022). The MMP is publicly available on the Core Lithium website.	Y

8 REFERENCES

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WRM (2023a). *Calibration of the Observation Hill dam (OHD) Water balance model*, Memo prepared by WRM Water and Environment. July 2023.

WRM (2023b). *Grants Lithium - Water Balance Modelling* Report. May 2023.

WRM (2023c). *BP33 Underground Mine – Water Balance Modelling Report*. June 2023.

APPENDIX A SWEL 8151018

NORTHERN TERRITORY OF AUSTRALIA
LICENCE TO TAKE OR USE SURFACE WATER
Pursuant to section 45 of the *Water Act*

Licence No: 8151018

Licence Holder:	Core Lithium Limited (ACN 146 287 809)		
Address:	PO Box 6028 Halifax St ADELAIDE SA 5000		
Commencement Date:	1 December 2021		
Expiry Date:	30 April 2025		
Water Control District:	Darwin Rural Water Control District		
Management Zone:	N/A		
Water Allocation Plan:	N/A		
River Basin:	Finniss River Basin, Charlotte River Sub-Catchment		
Waterway:	Observation Hill Dam		
Location of extraction point(s):	Mineral Lease 32074 E:695400 N:8594848 Z52 GDA94		
Property(s) on which water is used:	Mineral Leases 31726 and 32074 4200 Cox Peninsula Rd, Cox Peninsula Section 1 Hundred of Parsons		
Beneficial Use(s) of Water Entitlement	**Maximum Water Entitlement ML/year**	**Security Level**	**Licence Trading Allowed?**
Mining Activity	620	Not Specified	N/A
Total Maximum Water Entitlement:	**620 ML/year**		

Terms and Conditions:

1. General Conditions

1.1 The licence holder must comply with the provisions of the Act and all other laws in force in the Territory, including all regulations made under the Act.

1.2 The licence holder can surrender or apply for modification of this licence at any time.

1.4 Subject to Conditions 1.2 and 1.3, this licence is in force until the expiry date.

1.5 If the licence holder wishes to apply for a renewal of this licence, the licence holder must make an application to the Controller in the prescribed form at least 6 months before the Expiry Date via email to water.regulation@nt.gov.au

2. Water Extraction Conditions

2.1 Subject to Conditions 2.3 and 2.4, the licence holder must ensure that total extraction from the listed Waterway over the Periods specified below does not exceed the following Entitlements:

Table 1:

Entitlement	Period
310	Commencement Date to 30 April 2022
310	1 May 2022 to 31 October 2022
61	1 November 2022 to 30 April 2023
121	1 May 2023 to 30 April 2024
121	1 May 2024 to 30 April 2025

2.2 The licence holder may seek approval from the Controller to change the Period, by completing an Application to amend the licence and submitting that application to water.regulation@nt.gov.au at least 20 business days prior to the start date of the relevant Period.

2.3 The licence holder must have the amendment approved by the Controller in writing before the amendment takes effect.

2.4 In each Period the licence holder must ensure that total extraction from the listed Waterway does not exceed the Entitlement.

2.5 The Maximum Water Entitlement must be used for no purpose other than the specified beneficial use without the prior written approval of the Controller.

2.6 The licence holder may only extract water under this licence for use on a property listed on this licence.

3. Water Metering and Reporting Conditions

3.1 Extraction from the listed Waterway must be recorded by a meter or meters supplied, installed and maintained by the licence holder in accordance with the Northern Territory Non-Urban Water Metering Code of Practice for Water Extraction Licences, as amended from time to time.

3.2 Within two (2) weeks following the end of each Quarter of each year, the licence holder must supply the Controller with a record of total extraction from each of the listed extraction point(s) during that month.

4. Special Conditions

4.1 The licence holder must develop and submit for approval by the Controller a monitoring program to assess the impact of water taken under this licence on the riparian vegetation and surface water flows downstream of the Waterway.

The monitoring program must:

(i) be prepared by a suitably qualified professional;

(ii) include the monitoring parameters, methodology and frequency for monitoring downstream impacts attributable to water taken under this licence on:

(a) riparian vegetation; and

(b) surface water flows;

(iii) include quantitative triggers and limits which can be used to initiate adaptive management actions when surface water flows deviate significantly from the predictions outlined in Core Exploration Ltd, Cox Peninsula Supplementary Report, Appendix H Surface Water Modelling, February 2019;

(iv) include a review process to ensure continuous improvement of the monitoring program; and

(v) be implemented immediately following the Controller's approval.

4.2 The licence holder must provide a monitoring report to the Controller within 2 weeks of 30 June each year of the licence.

The monitoring report must:

(vi) include data collected in accordance with the monitoring program under 5.1 for the previous water accounting year (1 May – 30 April);

(vii) outline any management actions taken in response to the quantitative triggers or limits established under 5.1(iii);

(viii) include a summary of the outputs from updated surface water modelling using the most recent monitoring data;

(ix) discuss the measured and modelled impacts of water taken under this licence on the downstream riparian vegetation and surface water flows; and

(x) publish a copy of the monitoring report on a website on the internet that is publicly accessible.

4.3 The licence holder must immediately notify the department on becoming aware of non-compliance (or suspected non-compliance) with any condition of this licence. A notification under this condition must:

4.3.1 contain particulars of the non-compliance, including the identified or potential impacts associated with the non-compliance;

4.3.2 identify the steps that have or will be taken to minimise the impacts of the non-compliance; and

4.3.3 identify the steps that have or will be taken to prevent a reoccurrence or minimise the risk of further non-compliance.

4.4 The licence holder must maintain a website on the internet that is publicly accessible. The licence holder must publish on the website, as soon as practicable:

4.4.1 this licence, any amendments to its conditions and information about this licence including any:

4.4.1.1 approved monitoring program (5.1);

4.4.1.2 monitoring report (5.2);

4.4.1.3 non-compliance with its conditions as reported (5.3); or

4.4.1.4 other documents related to this licence, or the activities conducted under it, as directed by the Controller.

4.5 The licence holder must have in place a Mining Management Plan to conduct Approved Mining Activities, approved by the Minister in accordance with the Mining Management Act 2001 throughout the Term of this licence. If the Mining Management Plan is revoked, the licence holder must notify the Controller within 7 days. The notification must be via email to water.regulation@nt.gov.au.

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Joanne Townsend

Controller of Water Resources

Date: 18 / 11 / 21

Definitions

"Act" means the *Water Act* (NT).

"Approved Mining Activity" means a mining activity or activities which have been approved by the Minister in accordance with the Mining Management Act 2001.

"Controller" means the Controller of Water Resources.

"Entitlement" means the amount(s) specified in Condition 2.1.

"Extraction Limit" means the quantity of water calculated according to the formula in Condition 2.5.

"Minimum Extraction Limit" means the percentage of the Extraction Limit that is either:

(a) If a percentage is set out in a relevant Water Allocation Plan, that percentage, or
(b) Otherwise, 90%.

"Period" means a period of time specified in Condition 2.1.

"Quarter" means financial year quarters: 30 September, 31 December, 31 March, 30 June

"Regulations" means the *Water Regulations* (NT).

APPENDIX B RAINFALL DATA

Date	Total (mm)	Cumulative (mm)	Date	Total (mm)	Cumulative (mm)	Date	Total (mm)	Cumulative (mm)
1/5/2022 to 13/11/2022 No rainfall recorded at Observation Hill Dam								
14/11/2022	12.8	12.8	9/01/2023	0.0	759.6	6/03/2023	13.3	1212.5
15/11/2022	4.5	17.3	10/01/2023	0.0	759.6	7/03/2023	30.2	1242.7
16/11/2022	0.3	17.6	11/01/2023	0.0	759.6	8/03/2023	6.8	1249.5
17/11/2022	0.0	17.6	12/01/2023	0.0	759.6	9/03/2023	13.2	1262.6
18/11/2022	42.3	59.9	13/01/2023	0.0	759.6	10/03/2023	0.1	1262.7
19/11/2022	0.0	59.9	14/01/2023	11.7	771.3	11/03/2023	0.0	1262.7
20/11/2022	65.3	125.2	15/01/2023	2.3	773.5	12/03/2023	0.0	1262.7
21/11/2022	2.0	127.2	16/01/2023	0.0	773.6	13/03/2023	0.0	1262.7
22/11/2022	0.0	127.2	17/01/2023	2.5	776.1	14/03/2023	12.4	1275.1
23/11/2022	25.0	152.1	18/01/2023	0.0	776.1	15/03/2023	3.3	1278.4
24/11/2022	0.0	152.2	19/01/2023	8.2	784.3	16/03/2023	0.1	1278.5
25/11/2022	19.5	171.7	20/01/2023	7.8	792.1	17/03/2023	5.7	1284.3
26/11/2022	0.1	171.8	21/01/2023	10.9	802.9	18/03/2023	2.5	1286.8
27/11/2022	1.6	173.4	22/01/2023	0.0	802.9	19/03/2023	7.1	1293.8
28/11/2022	6.6	179.9	23/01/2023	0.7	803.6	20/03/2023	0.1	1293.9
29/11/2022	18.5	198.4	24/01/2023	0.7	804.4	21/03/2023	0.3	1294.2
30/11/2022	16.8	215.2	25/01/2023	2.6	806.9	22/03/2023	2.5	1296.7
1/12/2022	0.0	215.2	26/01/2023	7.1	814.0	23/03/2023	0.0	1296.7
2/12/2022	0.0	215.2	27/01/2023	19.9	833.9	24/03/2023	0.0	1296.7
3/12/2022	0.0	215.2	28/01/2023	1.1	835.0	25/03/2023	0.5	1297.1
4/12/2022	0.0	215.2	29/01/2023	0.0	835.0	26/03/2023	1.8	1299.0
5/12/2022	0.0	215.2	30/01/2023	0.4	835.4	27/03/2023	0.0	1299.0
6/12/2022	0.0	215.2	31/01/2023	23.3	858.7	28/03/2023	15.3	1314.2
7/12/2022	0.0	215.2	1/02/2023	7.9	866.6	29/03/2023	0.0	1314.3
8/12/2022	0.0	215.2	2/02/2023	13.6	880.2	30/03/2023	4.6	1318.8
9/12/2022	0.0	215.2	3/02/2023	4.1	884.3	31/03/2023	17.2	1336.1
10/12/2022	4.9	220.0	4/02/2023	6.6	890.9	1/04/2023	0.0	1336.1
11/12/2022	2.4	222.5	5/02/2023	0.1	891.1	2/04/2023	0.0	1336.1
12/12/2022	0.0	222.5	6/02/2023	16.7	907.8	3/04/2023	11.0	1347.1
13/12/2022	46.7	269.2	7/02/2023	0.0	907.8	4/04/2023	0.7	1347.8
14/12/2022	4.2	273.4	8/02/2023	0.0	907.8	5/04/2023	0.0	1347.8
15/12/2022	0.0	273.5	9/02/2023	6.3	914.1	6/04/2023	0.0	1347.8
16/12/2022	24.8	298.2	10/02/2023	2.2	916.3	7/04/2023	8.0	1355.8
17/12/2022	0.3	298.5	11/02/2023	0.2	916.4	8/04/2023	2.3	1358.0
18/12/2022	32.6	331.0	12/02/2023	10.6	927.0	9/04/2023	4.1	1362.1
19/12/2022	0.1	331.1	13/02/2023	10.3	937.3	10/04/2023	8.0	1370.1
20/12/2022	9.5	340.5	14/02/2023	0.0	937.3	11/04/2023	4.4	1374.5
21/12/2022	37.0	377.6	15/02/2023	0.0	937.3	12/04/2023	0.0	1374.5
22/12/2022	28.6	406.2	16/02/2023	0.0	937.3	13/04/2023	7.0	1381.5
23/12/2022	40.5	446.7	17/02/2023	0.0	937.3	14/04/2023	27.7	1409.2
24/12/2022	42.6	489.3	18/02/2023	0.0	937.3	15/04/2023	12.1	1421.3
25/12/2022	0.0	489.3	19/02/2023	0.0	937.3	16/04/2023	31.1	1452.4
26/12/2022	7.4	496.7	20/02/2023	2.2	939.5	17/04/2023	0.0	1452.4
27/12/2022	16.3	512.9	21/02/2023	9.1	948.5	18/04/2023	0.0	1452.4
28/12/2022	14.0	527.0	22/02/2023	11.3	959.8	19/04/2023	0.0	1452.4
29/12/2022	58.4	585.4	23/02/2023	28.8	988.6	20/04/2023	0.0	1452.4
30/12/2022	31.2	616.5	24/02/2023	64.9	1053.5	21/04/2023	0.0	1452.4
31/12/2022	44.1	660.6	25/02/2023	71.3	1124.8	22/04/2023	0.0	1452.4
1/01/2023	21.2	681.8	26/02/2023	16.3	1141.1	23/04/2023	0.0	1452.4
2/01/2023	40.6	722.4	27/02/2023	11.0	1152.1	24/04/2023	0.0	1452.4
3/01/2023	12.5	734.8	28/02/2023	14.3	1166.4	25/04/2023	0.8	1453.2
4/01/2023	9.7	744.5	1/03/2023	5.7	1172.1	26/04/2023	0.0	1453.2
5/01/2023	4.6	749.1	2/03/2023	4.7	1176.8	27/04/2023	0.0	1453.2
6/01/2023	9.6	758.7	3/03/2023	22.3	1199.1	28/04/2023	0.0	1453.2
7/01/2023	0.7	759.4	4/03/2023	0.0	1199.1	29/04/2023	0.0	1453.2
8/01/2023	0.2	759.6	5/03/2023	0.1	1199.2	30/04/2023	0.0	1453.2

APPENDIX C OHD SURFACE WATER EXTRACTION RECORD

Date	Reading (m3)	Volume Used (ML)	Cumulative Volume (ML)	Comments
1/5/2022	71,641.39	-	-	Meter reading start of WAY
11/6/2022	72,808.65	1.17	1.17	Dust Suppression / Soil Conditioning
12/6/2022	73,372.95	0.56	1.73	Dust Suppression / Soil Conditioning
13/6/2022	74,046.72	0.67	2.41	Dust Suppression / Soil Conditioning
19/6/2022	78,142.03	4.10	6.50	Dust Suppression / Soil Conditioning
24/6/2022	81,584.67	3.44	9.94	Dust Suppression / Soil Conditioning
25/6/2022	82,467.69	0.88	10.83	Dust Suppression / Soil Conditioning
26/6/2022	83,097.46	0.63	11.46	Dust Suppression / Soil Conditioning
27/6/2022	84,719.02	1.62	13.08	Dust Suppression / Soil Conditioning
28/6/2022	85,517.82	0.80	13.88	Dust Suppression / Soil Conditioning
30/6/2022	85,953.51	0.44	14.31	Dust Suppression / Soil Conditioning
6/7/2022	89,137.92	3.62	17.93	Dust Suppression / Soil Conditioning
13/7/2022	93,449.00	4.31	22.24	Dust Suppression / Soil Conditioning
19/7/2022	99,264.30	5.82	28.06	Dust Suppression / Soil Conditioning
27/7/2022	105,357.18	6.09	34.15	Dust Suppression / Soil Conditioning
31/7/522	109,071.00	3.71	37.87	Dust Suppression / Soil Conditioning
1/8/2022	109,799.25	0.73	38.59	Dust Suppression / Soil Conditioning
4/8/2022	112,383.40	3.31	41.18	Dust Suppression / Soil Conditioning
10/8/2022	117,004.90	4.62	45.80	Dust Suppression / Soil Conditioning
11/8/2022	118,191.85	1.19	46.99	Dust Suppression / Soil Conditioning
17/8/2022	124,298.95	6.11	53.09	Dust Suppression / Soil Conditioning
25/8/2022	133,314.22	9.02	62.11	Dust Suppression / Soil Conditioning
29/8/2022	138,773.50	14.47	67.57	Dust Suppression / Soil Conditioning
31/8/2022	141,533.72	2.76	70.33	Dust Suppression / Soil Conditioning
7/9/2022	148,799.32	7.27	77.59	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
8/9/2022	150,023.78	1.22	78.82	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
14/9/2022	156,859.31	6.84	85.65	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
22/9/2022	166,771.18	9.91	95.57	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
28/9/2022	172,504.26	5.73	101.30	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
30/9/2022	174,229.81	1.73	103.02	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
6/10/2022	176,625.71	2.40	105.42	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
7/10/2022	-	-	105.42	New flow meter installed
14/10/2022	53,873.00	5.387	110.81	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
19/10/2022	83,776.04	2.990	113.80	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
24/10/2022	119,617.80	3.584	117.38	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
27/10/2022	151,096.27	3.148	120.53	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
2/11/2022	232,335.95	8.124	128.65	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
3/11/2022	245,029.80	1.269	129.92	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
10/11/2022	321,095.65	7.607	137.53	Dust Suppression / Soil Conditioning / Soil Binder / Hydromulch
24/11/2022	476,629.74	15.553	153.08	Dust Suppression / Soil Conditioning
1/12/2022	499,790.83	2.316	155.40	Dust Suppression / Soil Conditioning
8/12/2022	545,292.69	4.550	159.95	Dust Suppression / Soil Conditioning
11/12/2022	578,702.69	3.341	163.29	Dust Suppression / Soil Conditioning
10/1/2023	864,007.37	28.530	191.82	Dust Suppression / Soil Conditioning
15/2/2023	1,547,556.73	68.355	260.18	Dust Suppression / Soil Conditioning / RWD First Fill
21/2/2023	1,652,836.37	10.528	270.70	Dust Suppression / Soil Conditioning / Processing
1/3/2023	1,764,222.86	11.139	281.84	Dust Suppression / Soil Conditioning / Processing
17/3/2023	2,019,728.58	25.551	307.39	Dust Suppression / Soil Conditioning / Processing
1/4/2023	2,646,213.70	62.649	370.04	Dust Suppression / Soil Conditioning / Processing
3/4/2023	2,701,587.00	5.537	375.58	Dust Suppression / Soil Conditioning / Processing
4/4/2023	2,723,811.00	2.222	377.80	Dust Suppression / Soil Conditioning / Processing
1/5/2023	3,313,342.97	58.953	436.75	Dust Suppression / Soil Conditioning / Processing

APPENDIX D SURFACE WATER EXTRACTION LICENCE MONITORING PLAN – OBSERVATION HILL DAM

Surface Water Extraction Licence Monitoring Plan Observation Hill Dam

Lithium Developments (Grants NT) Pty Ltd

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3	Helen Dwyer	Helen Dwyer	DEPWS	29/09/2022

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1 INTRODUCTION

1.1 Finniss Lithium Project Summary

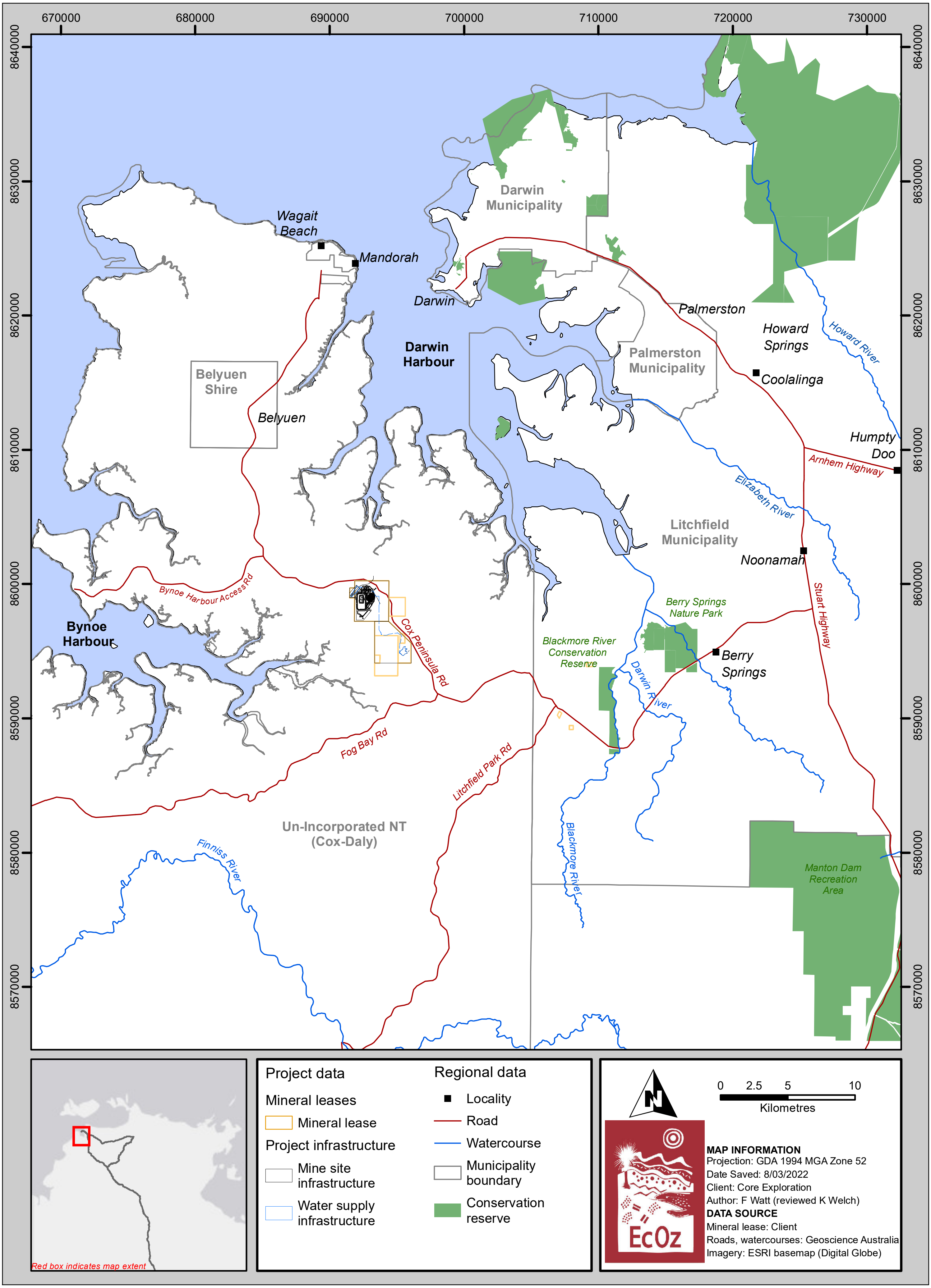
Core Lithium Limited (Core) is an Australian Stock Exchange ASX-listed company (ASX: CXO) targeting lithium production through the development of the Finniss Lithium Project (the Project). Core owns 100 percent (%) of the Project, located near Darwin in the Northern Territory (NT) (Figure 1-1).

Lithium Developments (Grants NT) Pty Ltd (Lithium Developments) is a 100% owned subsidiary of Core and is the operator of the Finniss Lithium Project – Grants open-cut mine (Grants). Construction activities at Grants commenced 30 September 2021. The operation will consist of an open cut pit (200 m final depth) and a processing facility on Mineral Lease (ML) 31726 (Figure 1-2). The key activities at Grants will include:

- Mining of approximately two (2) million tonnes (Mt) of spodumene (a lithium-bearing ore) using simple drill and blast mining methods.
- Crushing, screening and Dense Media Separation (DMS) processing of ore to increase the lithium concentration in the product from 1.5 % to 5.5 % Li_2O.
- Establishment of an onsite waste rock dump (WRD) and co-located tailings storage facility (TSF) to accept waste rock and tailings from the mining and processing activities.
- Haulage of the product in road trains along public roads to Darwin Port for export. The processed lithium concentrate will be transported via Cox Peninsula Road and Stuart Highway to Darwin Port, for shipping to China.
- Rehabilitation and closure of the site.

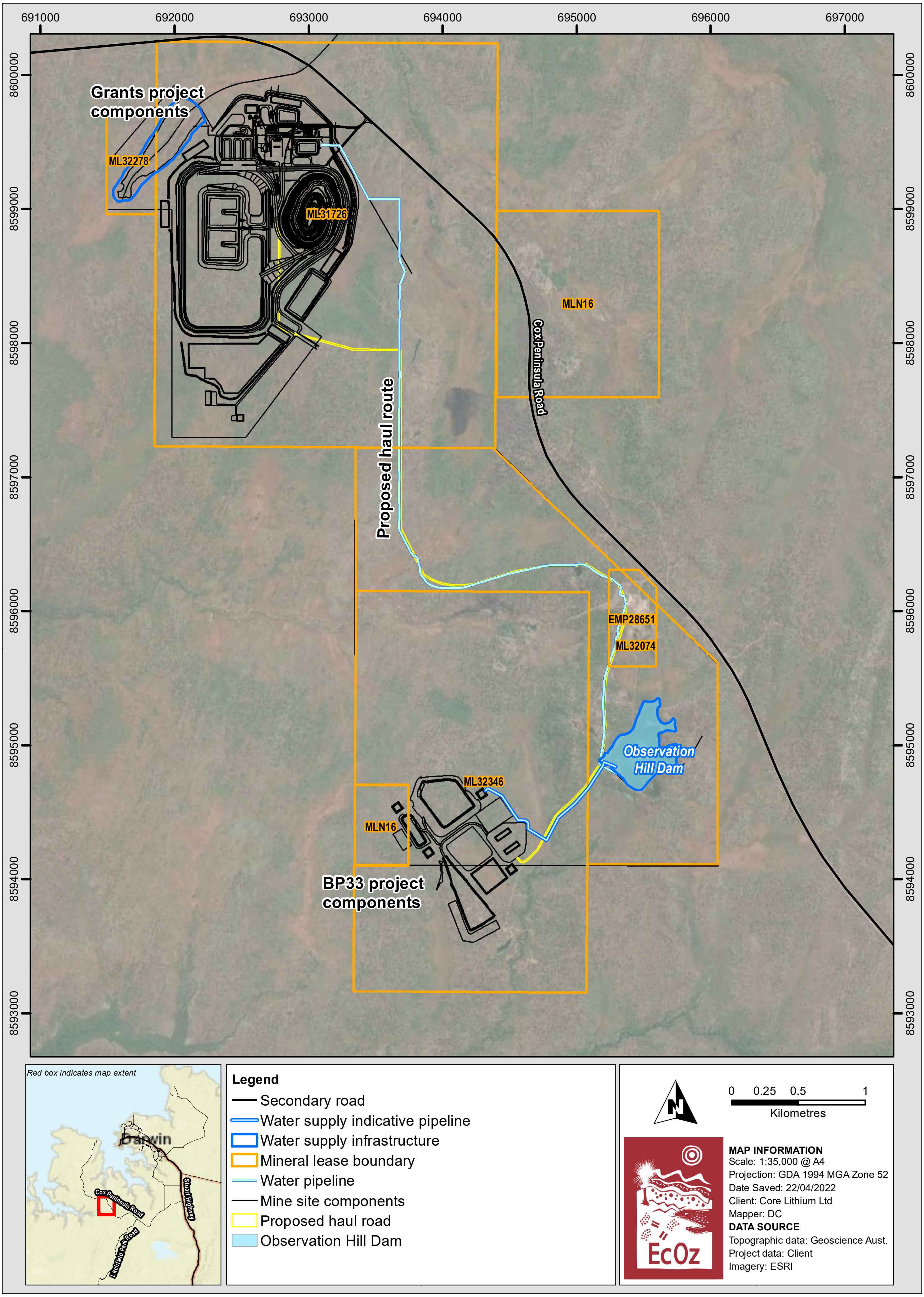
An old mine dam (Observation Hill Dam [OHD]) is located 5 km to the south of the mine site on ML32074. The dam is used for drinking water and as a back-up water supply for mining should onsite sources be insufficient. Water is transported to the site via a six (6) kilometre (km) long buried pipeline which traverses across both ML32074 and ML31726. A secondary water supply dam is planned on an ephemeral watercourse that flows through ML31726, immediately to the west of the mine site. The life of mine is three to four years.

In addition to Grants, Lithium Developments propose to develop and operate an underground lithium mine at the BP33 resource (BP33) located approximately 4km south of Grants, and 1.5km southwest of OHD (Figure 1-2). Operations at BP33 have not commenced to date and are expected to occur in late 2022 or 2023. Once operational, ore mined from BP33 will be hauled to the Grants processing facility.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22022 - Grants Project - ESCP amendment\01 Project Files\EMR Maps\EMR Figure 1-1 Map of location and regional setting of Grants Lithium Project.mxd

Figure 1-1. Map of location and regional setting of Finniss Lithium Project



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ20208 - BP33 Supplementary Environmental Report\01 Project Files\Report maps\Figure 1-1. Map of Finniss Lithium Project location and components.mxd

Figure 1-2. Map of Finniss Lithium Project site layout

1.2 Water Extraction Licence

Lithium Developments was granted a Licence to Take or Use Surface Water (Licence No: 8151018) (herein referred to as Surface Water Extraction Licence [SWEL] 8151018) on 18 November 2021, pursuant to Section 45 of the *Water Act 1992*. The licence allows for the extraction of surface water from OHD to facilitate mining activities including dust suppression, processing, and amenities. Lithium Developments is obligated to meet the requirements outlined as conditions of SWEL 8151018.

The entitlement volumes for extraction of surface water from OHD vary for set periods, as shown in Table 1-1 below (reproduced from Table 1 of SWEL 8151018). Lithium Developments will ensure that any extraction is within the entitled volumes for the relevant time period.

Table 1-1. Entitlement extraction volumes for Observation Hill dam

Entitlement (ML)	Period
310	Commencement date to 30 April 2022
310	1 May 2022 to 31 October 2022
61	1 November 2022 to 30 April 2023
121	1 May 2023 to 30 April 2024
121	1 May 2024 to 30 April 2025

1.3 Purpose and Scope

This Monitoring Plan has been developed to satisfy Condition 4.1 of SWEL 8151018. The Monitoring Plan outlines the monitoring parameters, methodology and frequency for monitoring downstream impacts associated with water extraction from OHD on both surface water flows and riparian vegetation. The Monitoring Plan includes Trigger Action Response Plans (TARPs) for both surface water flow monitoring and riparian vegetation monitoring, which stipulate triggers for action/investigation of potential impacts from surface water extraction to ensure early intervention and allow for adaptive management.

The Monitoring Plan will be implemented immediately following the Controllers approval and will be reviewed annually (as per Section 5) to ensure continuous improvement.

2 SITE SETTING

2.1 Catchment Hydrology

OHD is located in the Charlotte River catchment of Bynoe Harbour. The dam catchment is situated at the headwaters of an ephemeral drainage line that flows south and discharges into the lower reaches of the Charlotte River, approximately 3 km downstream. Site inspections of the dam and downstream watercourse in dry season and wet season conditions over the period 2017-2020 have observed that flows downstream of the dam typically commence in December/January and cease by May, after which some isolated pools persist into the late dry season. The catchments and surface watercourses are shown in Figure 2-1.

Figure 2-2 shows the local drainage features within the vicinity of Grants and OHD, and the location of surface water monitoring sites which have been monitored for water quality for a number of years.

WRM (2022) have developed a Technical Memorandum for Surface Water Extraction from Observation Hill Dam, which details the characteristics of OHD and the catchment, and assesses potential downstream impacts from water extraction, which has informed this Monitoring Plan (see Appendix A).

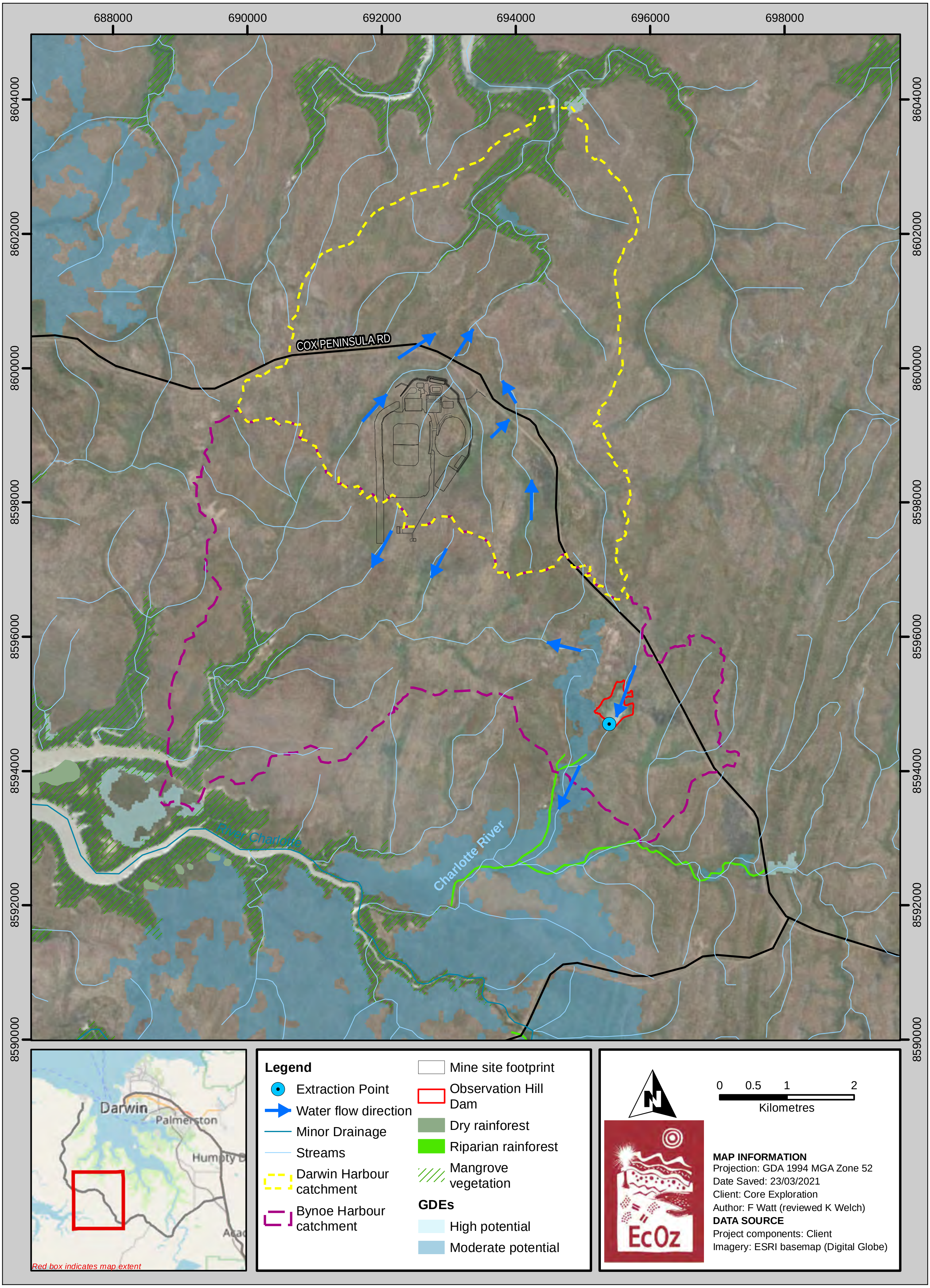


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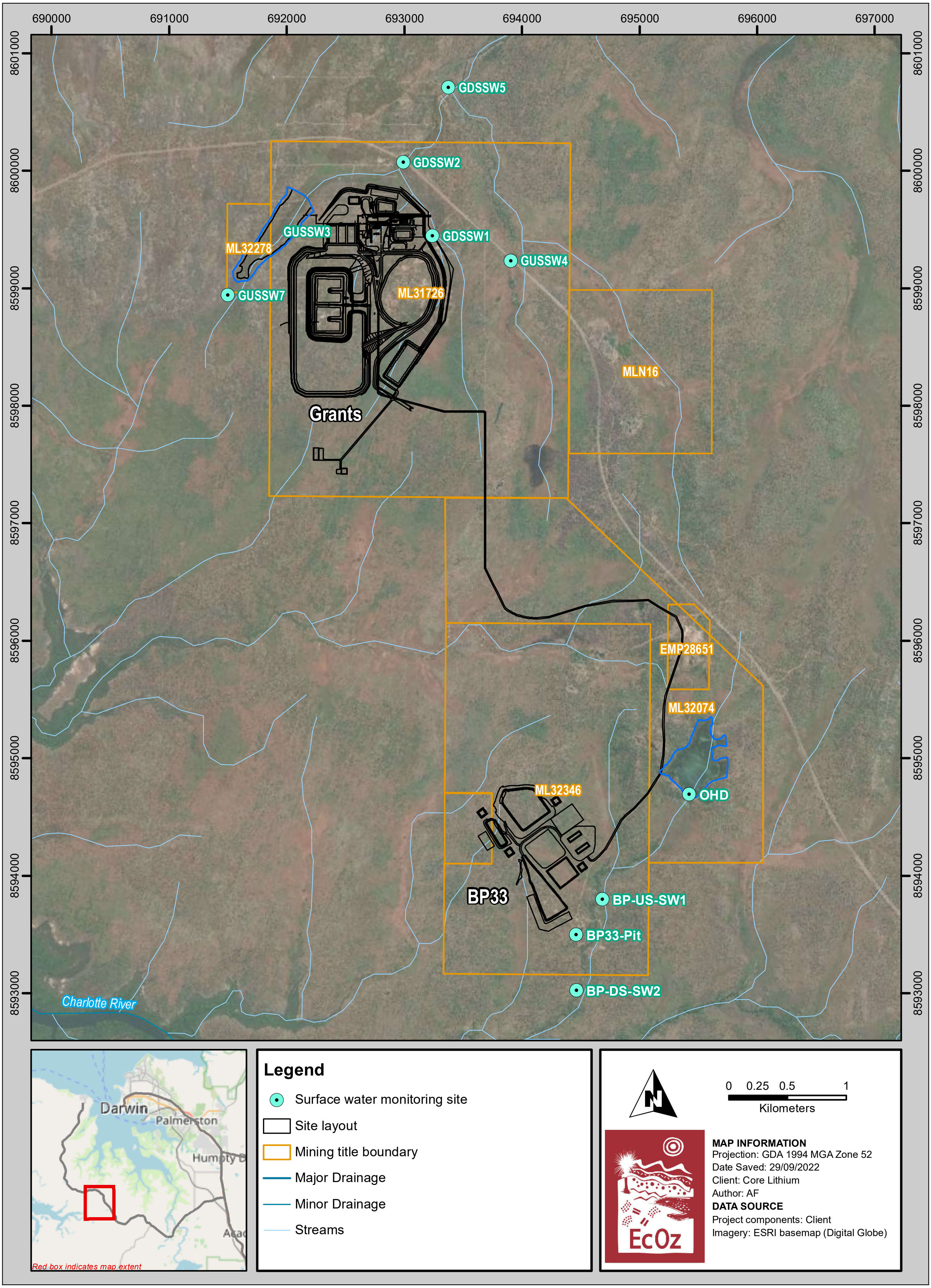
Figure 2-1. Map of Finniss Lithium Project catchment areas



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21190 - Grants Waste Discharge Licence - Core Lithium\01 Project Files\Report maps\Map of sampling locations.mxd

Figure 2-2. Map of local drainage features and surface water quality monitoring sites

2.2 Observation Hill Dam wall raise

The current estimated full storage volume for OHD is 364 ML. Lithium Developments propose to raise the dam wall by approximately 1.5 m to increase storage capacity to around 620 ML. It is expected that the dam wall raise would be completed during the 2023 dry season.

The SWEL entitlements have been calculated based on the assumption that the dam wall raise will occur. The location of the proposed new embankment, and resulting enlarged inundation area, are shown on Figure 2-3. Refer to Appendix A for detail.

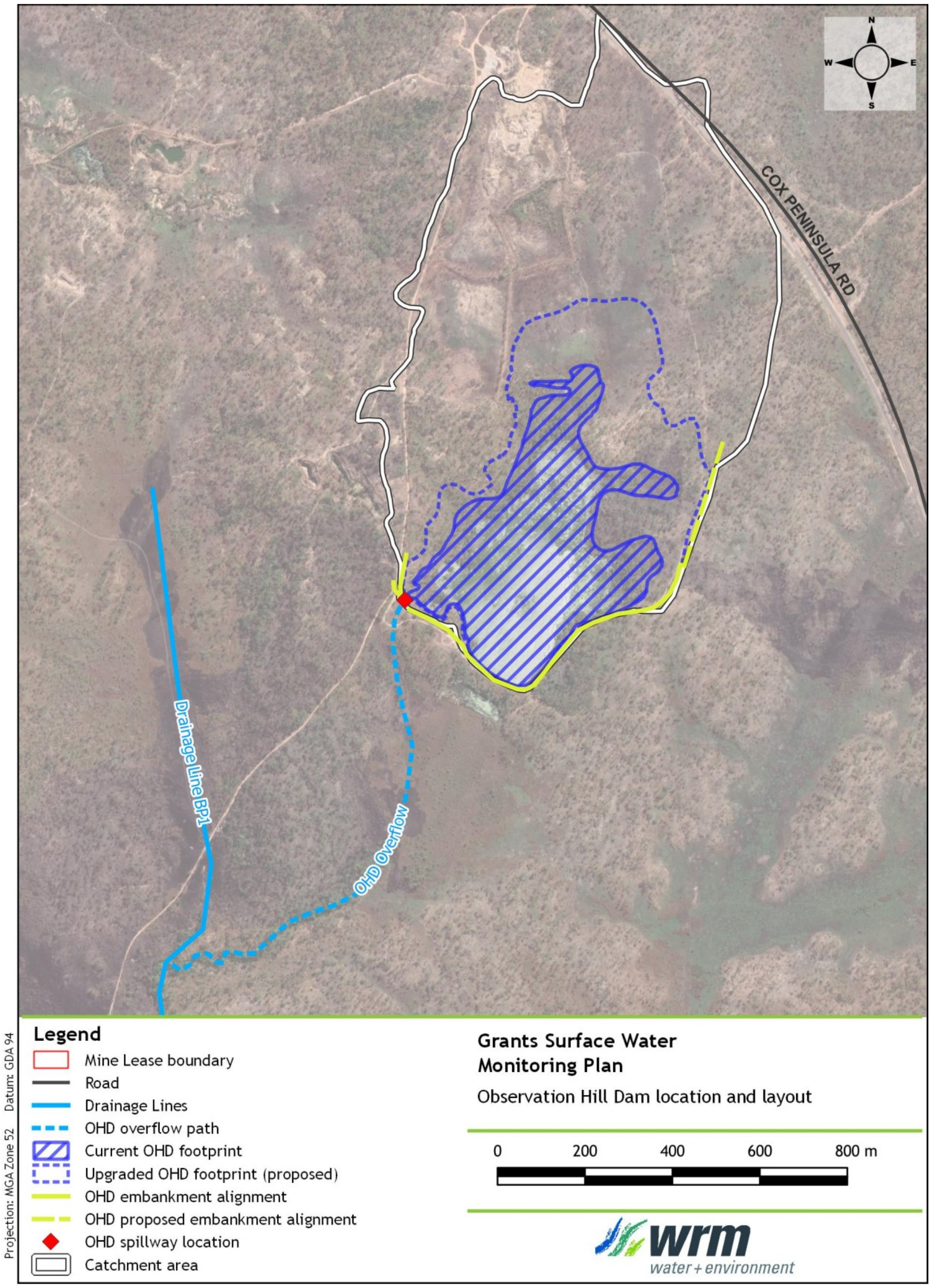


Figure 2-3. Map of Observation Hill Dam location and layout

2.3 Drainage Line BP1

Drainage Line BP1 has a catchment area of approximately 365 ha to the BPDS SW2 monitoring locations (Figure 2-2). Of this catchment area, 93.8 ha is impounded by OHD. The catchment is mostly natural with some grassed areas that were cleared by preliminary exploration activities. The channel is poorly defined, particularly in the upper section of the reach.

Two existing surface water quality monitoring sites are located along Drainage Line BP1; BPUS SW1 and BPDS SW2. BPDS SW2 will be monitored for surface water flows with a continuous water level logger, as outlined in Section 4.1.

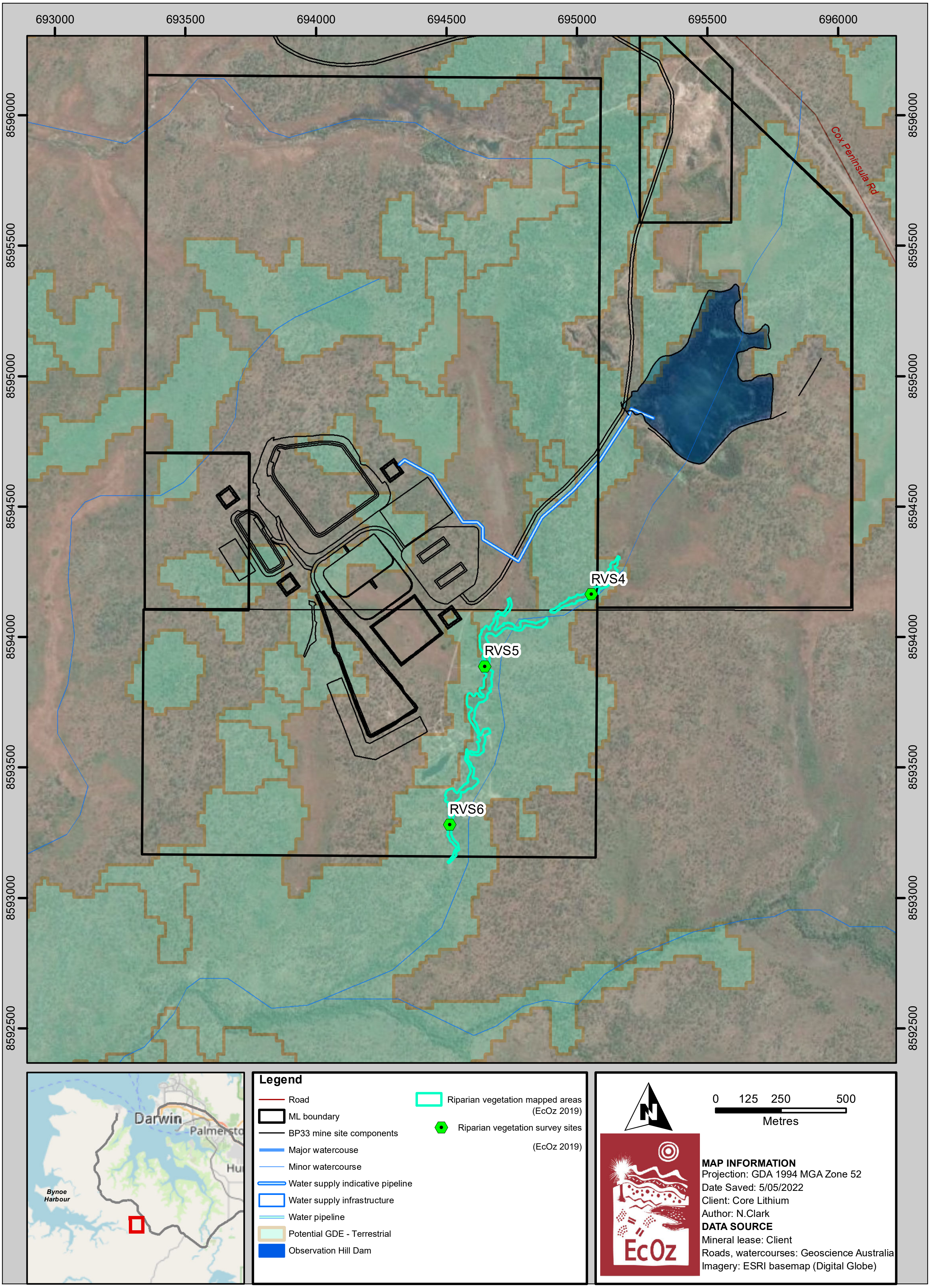
2.4 Riparian Vegetation

Previous surveys and assessments undertaken for the Grants Environmental Impact Statement (EIS) identified the presence of an ephemeral drainage line downstream of OHD which supports closed riparian vegetation identified as a potential Groundwater Dependent Ecosystem (GDEs) (Figure 2-4) based on desktop modelling. These riparian vegetation communities downstream of OHD could be susceptible to impacts associated with changes to surface water flows. The Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019) baseline study was undertaken to further assess the vegetation prior to mining activities commencing (refer Appendix B).

The intent of the baseline survey was to produce a vegetation map and record vegetation characteristics and condition of the sensitive vegetation communities downstream of OHD, which is now near the proposed BP33 underground mine.

Two types of baseline surveys were undertaken; an aerial drone survey to look at the overall riparian vegetation health and assist in mapping the riparian vegetation extent, and on-ground field survey to assess vegetation structure and composition within the mapped riparian vegetation extent.

Additional baseline surveys will be undertaken during 2022 to support implementation of this plan. Further details of additional baseline studies are provided in Section 2.4.1.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 2. Map of baseline studies for BP33 project area.mxd

Figure 2-4. Map of baseline riparian monitoring area and vegetation monitoring sites (EcOz, 2019)

2.4.1 Gaps in Riparian Vegetation Baseline Studies

Based on the existing information available, some gaps were identified in the baseline surveys and are proposed to be addressed as outlined below.

- The drone survey was only undertaken post wet-season. It is recommended to undertake additional drone flight for BP33 project area in the dry season to account for seasonality differences.
- The orthomosaic images obtained from drone mapping only used false colour imagery (i.e. green indicating to examine vegetation health). Further remote sensing analysis is required to quantify vegetation health and compare data between 2019 and 2022.
- No upstream of Charlotte's River riparian vegetation site assessments undertaken outside of the modelled groundwater drawdown (CloudGMS, 2021) for BP33 project area. A site will be established outside of the modelled 1m contour groundwater drawdown zone of influence (ZOI) to be used as a baseline reference site and assessed prior to significant water extraction from OHD and BP33 mining operations.
- No vegetation site assessment data was collected post-wet season. To account for seasonality differences, it is recommended to undertake biannual vegetation site assessment monitoring post-wet season for the 2022 baseline surveys. This data can be used for future reference if additional monitoring is required in accordance with the trigger action response plan (TARP) (Section 0).
- Though some data was obtained while undertaking vegetation site-based assessments post wet-season 2019, there was a lack of quantitative data collected - ground cover percentage, presence of recruitment, number of alive vs dead plants, erosion scoring etc. These attributes will assist in monitoring the condition of riparian vegetation and data comparison.
- Further investigation is required to determine the extent of the riparian vegetation within the identified ZOI of the BP33 predicted groundwater drawdown modelling. The ZOI has been defined by the one metre groundwater drawdown contour shown in Figure 4-2. It is assumed that drawdown of less than that would only affect water availability for a short period of time in the mid-late dry season when groundwater levels are naturally lowered. The ZOI encompasses a 4.5 km section of stream order one ephemeral watercourse.
- Additional baseline surveys will be conducted biannually during 2022 to address these gaps. A baseline assessment report will be developed to include outcomes of the 2019 monitoring and the 2022 monitoring and the RVMP revised as required.

3 ASSESSMENT OF POTENTIAL DOWNSTREAM IMPACTS

3.1 Potential Hydrological Impacts

3.1.1 Overview

An assessment of the maximum potential impacts due to water extraction from OHD was assessed as part of Grant's Mining Management Plan (Enviroconsult, 2019) for an average rainfall year. This study found that, over a full wet season of average rain (~1,652 mm), the reduction in average flows downstream of OHD due to an annual water extraction volume of 738 ML/year (daily average of 2.02 ML/d) would be 45% during the wet season. This is considered to be the maximum allowable impact on downstream flows due to water extraction for this climatic sequence per Special Condition 4.1(iii) of the WEL.

Note that:

- The maximum annual water entitlement is 620 ML, which is less than the modelled "worst-case" maximum based on a standard daily pump rate of 2.02 ML/day (i.e. modelling is conservative)
- 2.02 ML/day is the estimated peak water use, based on dry season demand for dust suppression, and actual water use will vary depending on seasonal conditions and mine operations and demand. Water use will be lower in the wet season when dust suppression is not required, or required infrequently.
- Once the mine is fully operational, water extraction from OHD will primarily be for the purpose of supplying potable water and addressing any water deficit that occurs due to changes in the availability of water from the other sources (e.g. groundwater inflows into Grants pit and rainfall).
- The current pump at OHD has an extraction rate of up to 4.00 ML/d, but pumped rates will be limited to ensure extracted volumes remain within entitlements as per Table 1 of SWEL 8151018.

An operational Trigger Action Response Plan (TARP) has been developed to continually monitor the pumped extraction volumes from OHD to ensure that the water extraction entitlements presented in Table 1 of SWEL 8151018 are not exceeded (refer to Appendix A).

3.1.2 Modelled Downstream Impacts for Varying Climatic Conditions

The WRM technical memorandum (Appendix A) presents potential downstream impacts of water extraction from OHD from a range of climatic conditions, based on previous water balances and modelling undertaken by Enviroconsult (2019) and a Goldsim model developed by WRM. Figure 4-1 in Appendix A shows the likely (i.e. taken as needed) and maximum downstream impacts (assessed immediately downstream of the OHD spillway) ranked according to the probability of exceedance. The figure shows that, if water is extracted from OHD as needed (assuming that the site water demand assumptions are correct), is it unlikely that the downstream impacts of OHD will exceed the maximum downstream impacts reported by Enviroconsult (2019). Taking water as need from OHD would result in a ~6% flow reduction downstream in an average climate year, and would only result in 100% flow reduction in the driest 2% of climatic conditions. Conversely, if OHD was pumped at a constant rate of 2.02 ML/d, there is a ~45% reduction in downstream flows in an average climate year; i.e. the maximum reduction in downstream flows assessed through the EIS process. Additionally, pumping at a constant rate may result in a downstream flow reduction of 100% (i.e. no overflows occurring during the wet season), for the driest 40% of climatic conditions. If the current maximum pump rate (4.00 ML/d) is maintained for extended periods, there would be a potential for the maximum allowable downstream impact to be exceeded.

WRM used the maximum allowable downstream flow reductions presented in Figure 4.1 of Appendix A to calculate the minimum OHD spill days, which are presented in Figure 3-1. The relationship between OHD spill days and wet season rainfall can be used as a tool to predict whether the extraction rates would cause an exceedance of the maximum allowable downstream impact, and has been used to inform the TARP for surface water flows presented in Section 4.2.

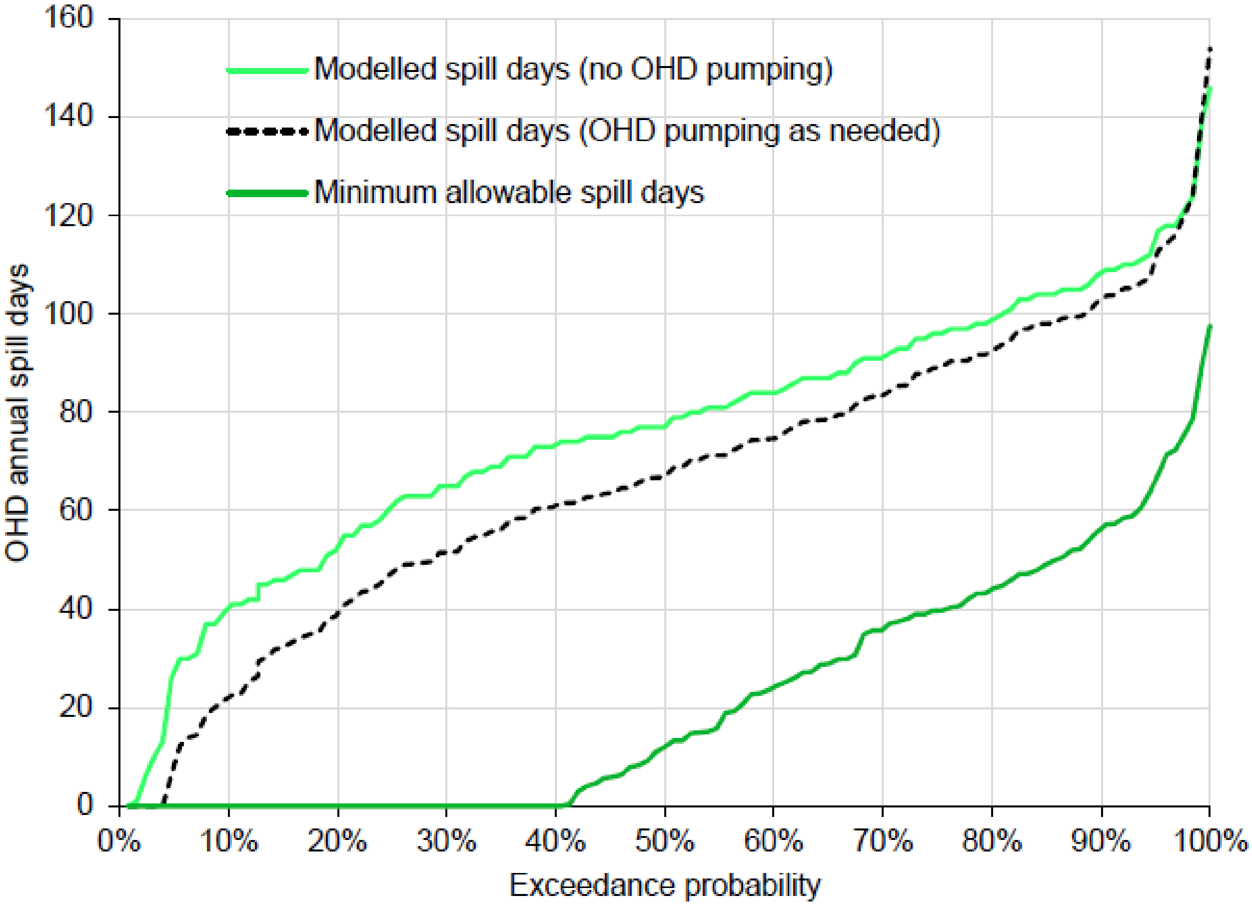


Figure 3-1. Minimum annual spill days required during OHD water extraction

3.2 Potential Riparian Vegetation Impacts

Healthy riparian zones are essential for maintaining healthy ecosystems and economic productivity along rivers (Dixon & Douglas 2015). When maintaining a riparian vegetation system, it is vital to retain a diverse vegetation cover to assist in maintaining the functions that a riparian vegetation community provides i.e. supporting aquatic habitats, shading the river and regulating the temperature, bank stabilisation, filtering of sediments and improving water quality of river by reducing contaminants (Dixon & Douglas 2015).

Riparian vegetation is able to access water multiple ways i.e. through the upper un-saturated zone as a result from recent rain events, the groundwater at depth via the capillary fringe above an unconfined aquifer, and through creek water (generally a combination of groundwater and rain water in the wet season, but may be predominantly groundwater in the dry season) (SKM 2012) (Figure 3-2). There are particular species that are more likely to be sensitive to declines in available ground water such as monsoon forest species that grow in areas where there is perennial water supply.

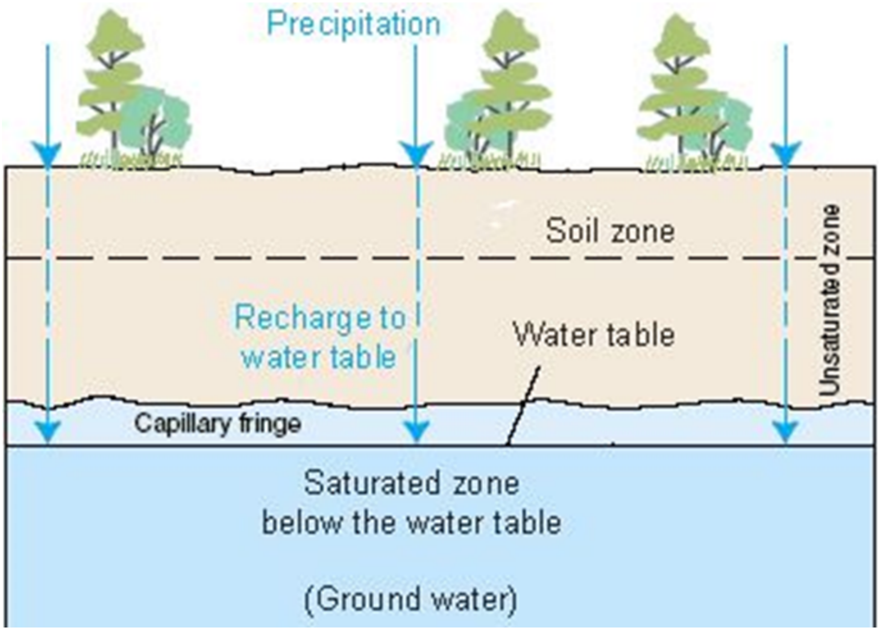


Figure 3-2. Diagram showing the capillary fringe (SKM 2012)

Riparian vegetation recruitment and germination depends on the level of surface water and ground water regimes as plants depend on predictable patterns in terms of structure and diversity according to water availability in the landscape (Eamus & Lamontagne 2006). Riparian tree recruitment typically occurs after large floods when viable plant material is transported onto point bars and the floodplains of naturally flowing rivers (Eamus, D., & Lamontagne 2006). If dry season flow is modified, or the water table recedes too quickly, new cohorts fail to recruit and the species composition may alter over time (Figure 3-3). Ultimately the intent of monitoring the riparian vegetation (Section 0) is to detect changes over time.

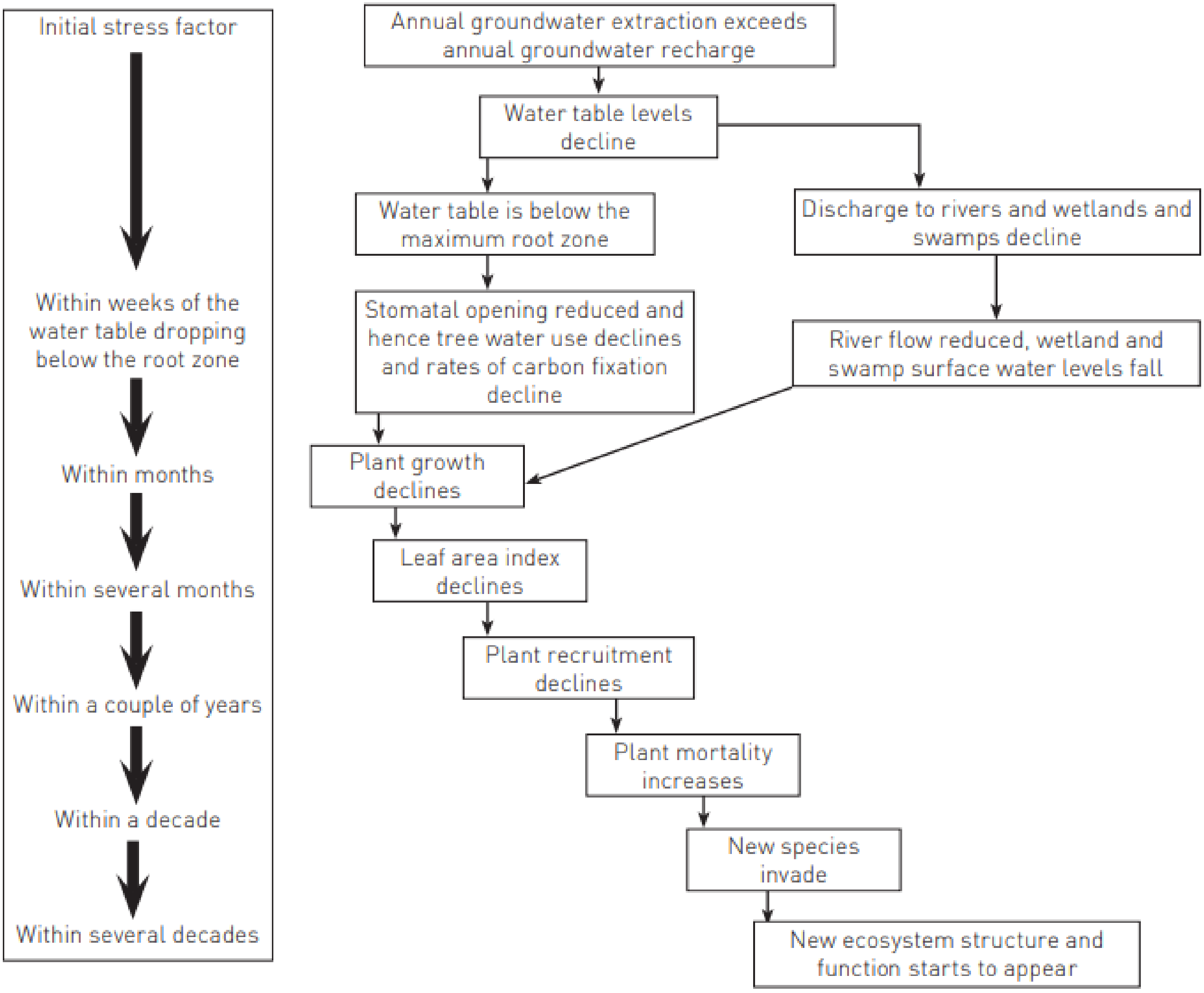


Figure 3-3. Diagram showing the potential consequences of groundwater drawdown affect (Eamus, D., & Lamontagne 2006)

4 MONITORING PROGRAMS

4.1 Surface Water Level Monitoring

Monitoring of surface water levels at and downstream of OHD will form a key component of the surface water management system and ensure compliance with SWEL 8151018. Monitoring of water levels will assist in demonstrating that the site water management system is effective in meeting its objective of minimal impact on downstream flows and will allow for early detection of any impacts and appropriate corrective action.

Water levels will be monitored at the OHD spillway (OHD DS), and at the downstream location BPDS SW2 on a continuous basis to:

- Inform the assessment of potential impacts on downstream flows, based on spillway data
- Monitor flows downstream to assess impact of extraction on flows in Drainage Line BP1
- Provide flow data to assist in interpretation of riparian vegetation monitoring data (discussed in Section 4.3.

Water levels at these sites will be recorded using a suitable continuous water level logger, and rating curves will be developed to relate recorded water levels to flows.

Additionally, water levels in OHD will be monitored via manual survey pickups of the water level on a weekly basis and as part of routine water quality monitoring to provide information on operational decisions and water supply volumes.

Rainfall data will be sourced from Bureau of Meteorology (BoM) Station 014264 located at the Territory Wildlife Park, to inform the assessment of potential impacts of surface water extraction as presented in Table 4-2.

The locations of the proposed surface water flow monitoring locations are shown in Figure 4-1 and summarised in Table 4-1.

Table 4-1. Surface water level monitoring locations

Name	Location	Coordinates (GDA 94 Zone 52)		Monitoring Measure	Sample Frequency	Sample Methodology	Site type
		Easting	Northing				
OHD DS	OHD Spillway	695 185	8 594 842	Water level / flow	Continuous	Logger	Compliance
BPDS SW2	Drainage Line BP1 D/S of OHD	694 461	8 593 025	Water level / flow	Continuous	Logger	Information
OHD	OHD	695 422	8 595 695	Water level / storage	Weekly	Manual survey pickup	Information

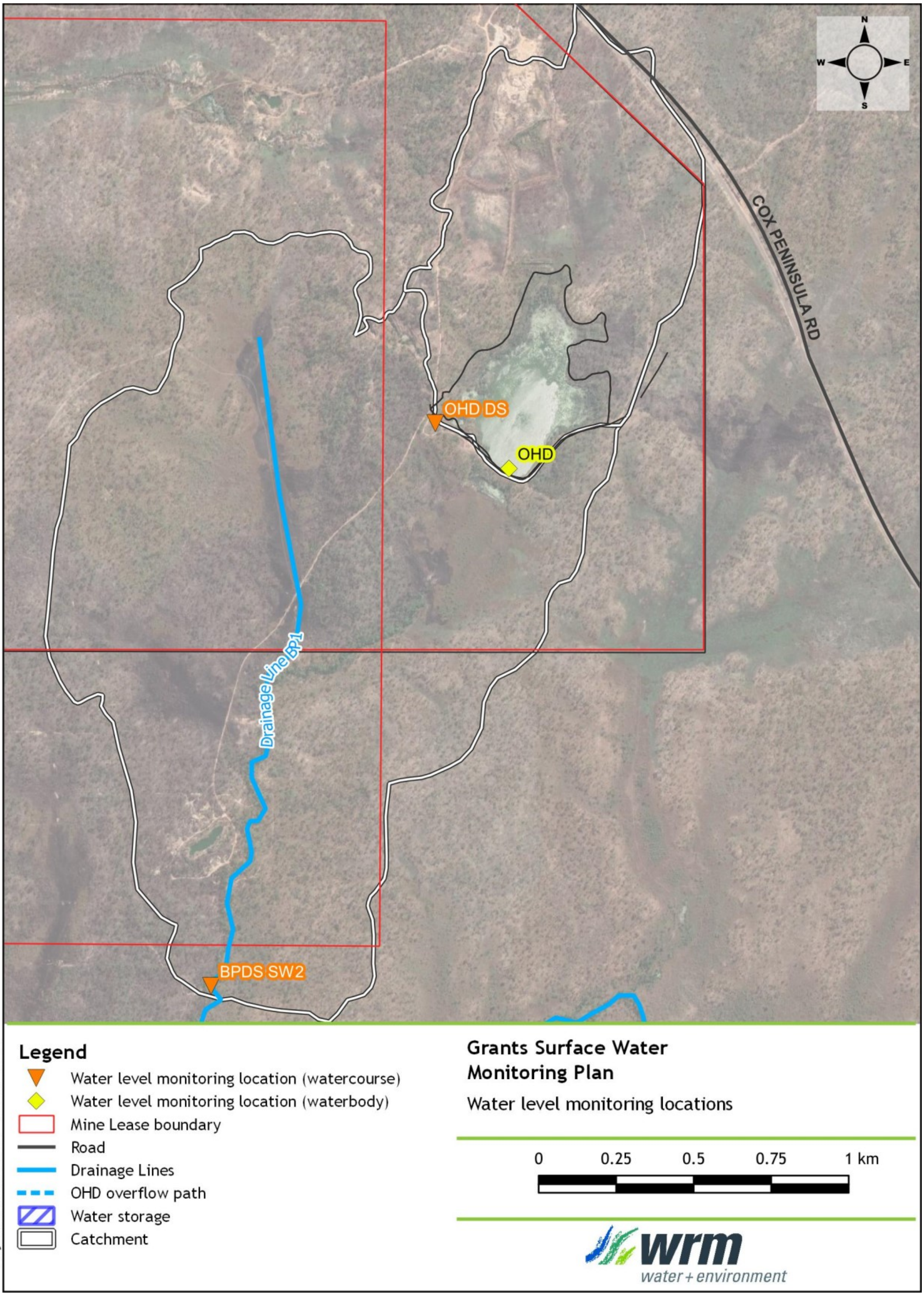


Figure 4-1. Surface water level monitoring locations

4.2 Surface Water Level Monitoring Performance Criteria

The performance criteria to be applied to the surface water level monitoring program is presented in Table 4-2.

The performance criteria assess the potential downstream risk based on the cumulative rainfall and spill days from OHD since the onset of the wet season (1 November of each year). As discussed in Section 3.1.2, the impact on flows downstream of OHD due to extraction of surface water would vary depending on the cumulative rainfall each wet season, recorded at BOM Station 014264. The potential impact category was informed by the relationship between spill days and rainfall derived from Figure 3-1, and range from Level 1 (likely no or minimum impact on the downstream flows) to Level 4 (potential for impact on the downstream environment, based on >45% reduction in flows).

The number of spill days will be informed by the level data from monitoring site OHD DS, and hence this site is considered the compliance site when assessing impacts to surface water flows. Rainfall and level data from OHD DS will be assessed against the performance criteria in Table 4-2 on a monthly basis during the wet season. The TARP which will be implemented based on the performance criteria as detailed in Table 4-4.

Table 4-2. Surface water level monitoring performance criteria

		Cumulative rainfall from 1 November*			
		<1,300mm	**1,300-1,500mm**	**1,500 – 1,700mm**	**>1,700mm**
Number of spill days from OHD from 1 November	**>60**	Level 1	Level 1	Level 1	Level 1
	51-60	Level 1	Level 1	Level 1	Level 2
	41-50	Level 1	Level 1	Level 1	Level 3
	31-40	Level 1	Level 1	Level 2	Level 4
	21-30	Level 1	Level 1	Level 3	Level 4
	5-20	Level 1	Level 2	Level 4	Level 4
	<5	Level 2	Level 3	Level 4	Level 4

*Recorded at BOM Station 014264

Table 4-3. Trigger Action Response Plan for Surface Water Level Monitoring

Level	Trigger*	Action	Response
Level 1 (normal)	Water level data from OHD DS indicates >60 spill days from OHD from 1 November, regardless of rainfall **OR** Cumulative rainfall and spill days in Table 4 2 indicate Level 1 risk (varies depending on rainfall)	• Continue to monitor water levels at OHD DS and BPDS SW2.	• No response required.
Level 2 (early warning)	Water level data from OHD DS indicates number of spill days since 1 November is: <5 spill days for <1,300 mm of rainfall **OR** <20 spill days for 1,300-1,500 mm of rainfall **OR** <40 spill days for 1,500-1,700mm of rainfall **OR** <60 for >1,700 mm of rainfall As per Table 4-2.	• Continue to monitor water levels at OHD DS and BPDS SW2. • Review the OHD operational rules for water extraction. • Review rainfall outlooks to determine if imminent rainfall will reduce risk to downstream flows.	• Amend operational rules for water extraction from OHD as required to minimise impacts on downstream flows.
Level 3 (imminent risk)	Water level data from OHD DS indicates number of spill days since 1 November is: <5 for 1,300-1,500 mm of rainfall **OR** <30 for 1,500-1,700mm of rainfall **OR** <50 for >1,700 mm of rainfall As per Table 4-2	• Continue to monitor water levels at OHD DS and BPDS SW2. • Review rainfall outlooks to determine if imminent rainfall will reduce risk to downstream flows. • Investigate and initiate options to reduce water use onsite, including options to recycle water. • Investigate and initiate options to source water from alternate locations. • Ensure that the site demands are being drawn from the mine water dams and sediment dams as a priority.	• Amend operational rules for water extraction from OHD as required to minimise impacts on downstream flows. • Investigate potential impacts on downstream environment including riparian vegetation. • Implement actions recommended from investigation.

Level	Trigger*	Action	Response
Level 4 (potential for downstream impacts)	Water level data from OHD DS indicates number of spill days since 1 November is <20 for 1,500-1,700 mm of rainfall **OR** <40 for >1,700mm of rainfall As per Table 4-2	• Cease water extraction from OHD. • Reduce non-essential water consumption as much as possible on site to limit operational impacts. • Ensure that the site demands are being drawn from the mine water dams and sediment dams as a priority. • Investigate options for potential additional water sources (including C5 Dam, bore water).	• Investigate potential impacts on downstream environment including riparian vegetation • Implement actions recommended from investigation.

*These figures will be reviewed following the 2022-2023 wet season and refined as required following collection of site specific flow data.

4.3 Riparian Vegetation Monitoring

4.3.1 Overview

Information obtained from the baseline studies and the identified information gaps have been used to develop the Riparian Vegetation Monitoring Program. The Monitoring Program outlines objectives and parameters that can be used to assess the riparian vegetation health during the drawdown and reduced surface flows from OHD as part of operations. For each monitoring type, the following headings have been used:

- Objective
- Survey method – these may include ongoing methods previously used in the baseline surveys or additional (new) methods
- Record keeping - maintenance of data for analysis
- Data analysis.

The following best practice and standards for vegetation monitoring been adopted and assisted in developing this RVMP:

- Brocklehurst et al 2007. *Northern Territory Guidelines and field methodology for vegetation survey and mapping*
- Dixon, I., & Douglas, M (2015). *A Field Guide to Assessing Australia's Tropical Riparian Zones*, Tropical Savannas Cooperative Research Centre for Tropical Savannas Management.
- Eamus, D., & Lamontagne (2006). Groundwater use by riparian vegetation in the wet-dry tropics of Northern Australia, Australian Journal of Botany.
- Florabank (1999-2000) Florabank guidelines and codes of practice www.florabank.org.au/ Greening Australia. Revised 2016. Accessed March 15, 2016
- Lloyd, J., & Cook, S (1996). NT Sampling and Processing Manual, Natural Resources Division, *Department of Lands, Planning and Environment*
- International Erosion Control Association (IECA) (2008). *Best Practice Erosion and Sediment Control.* Picton, NSW. Available at: https://www.austieca.com.au/documents/item/57
- Society for Ecological Restoration (SER) (2018). *National Standards for the Practice of Ecological Restoration in Australia*. 2nd edition, Australia.
- Han., Y., Jung, S., & Kwon, O (2017). *How to utilize vegetation survey using drone image and image analysis software*, Journal of Ecology and Environment 41:18.
- Ancin-Murguzur, F., & Munoz, L., Monz C., &. Hausne V. (2019). *Drones as a tool to monitor human impacts and vegetation changes in parks and protected areas,* Remote Sensing in Ecology and Conservation.
- Wegmann, M., Leutner, B., & Dech, S. (2017). Remote Sensing and GIS for Ecologists using Open Source Software, *Pelagic publishing*

4.3.2 Drone Survey

Objective

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey is to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover.

Methodology

- Create new drone flight path based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI. The new flight path will be an extension of the existing baseline survey

(EcOz 2019) to capture the riparian vegetation extent downstream of OHD to the 1m contour groundwater drawdown ZOI (see Figure 4-2 for indicative drone survey boundary). The indicative flight path will be field verified during 2022 baseline surveys prior to establishing a set flight path.

- Previously Drone Deploy (Software program) was used to design the flight path, however WebODM will be used for this monitoring. WebODM was selected as it contains the correct platform selected for to measure plant health.
- Drone will be flown in the middle of the day to avoid sun light interference i.e. shading. Observations will also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- When importing drone data to create the orthomasoaic, the same methods as per methods in baseline report outlined in section 3 (Appendix A) will be applied, except using WebODM.
- The boundary of the riparian vegetation will then be delineated using the orthomosaic imagery and remote sensing techniques.
- Drone data analysis will be undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.
- These values will be categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, will then be calculated.
- Investigate other environmental factors that may affect results i.e. amount of rainfall between October – April compared to rainfall amounts based on baseline studies to discern environmental factors.

Frequency

The drone survey will occur biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring during 2022, then the monitoring will be reduced to annual (in the late dry season only).

Record Keeping

- Vegetation monitoring database comprised of:
  - The riparian vegetation area size (ha) based on drone mapping for each drone survey.
  - VARI calculations for each survey conducted including varying colour bands and associated class intervals, the area (ha) that occurs within the class intervals and a percentage (%) of pixels that lie within these class intervals.
  - Additional observations that may need to be recorded if further on-ground investigation is require.
- Spatial data
  - All drone images captured during the drone surveys organised in folders.
  - A zip-file of all tiff files derived from drone surveys (both orthomosaic and plant health image).

Data Analysis

Before After/Control Impact (BACI) approach will be applied by performing statistical analysis (VARI) to test whether there is a significant difference between the baseline health data and the riparian vegetation health based on ongoing drone survey assessments.

4.3.3 Riparian Vegetation Site Assessments

Objective

Monitoring and evaluating riparian vegetation diversity and composition at established vegetation sites within ZOI, and an additional site established outside of the ZOI (reference site) to detect changes in riparian vegetation according to diagram presented in Figure 3-3 (Eamus, D., & Lamontagne 2006).

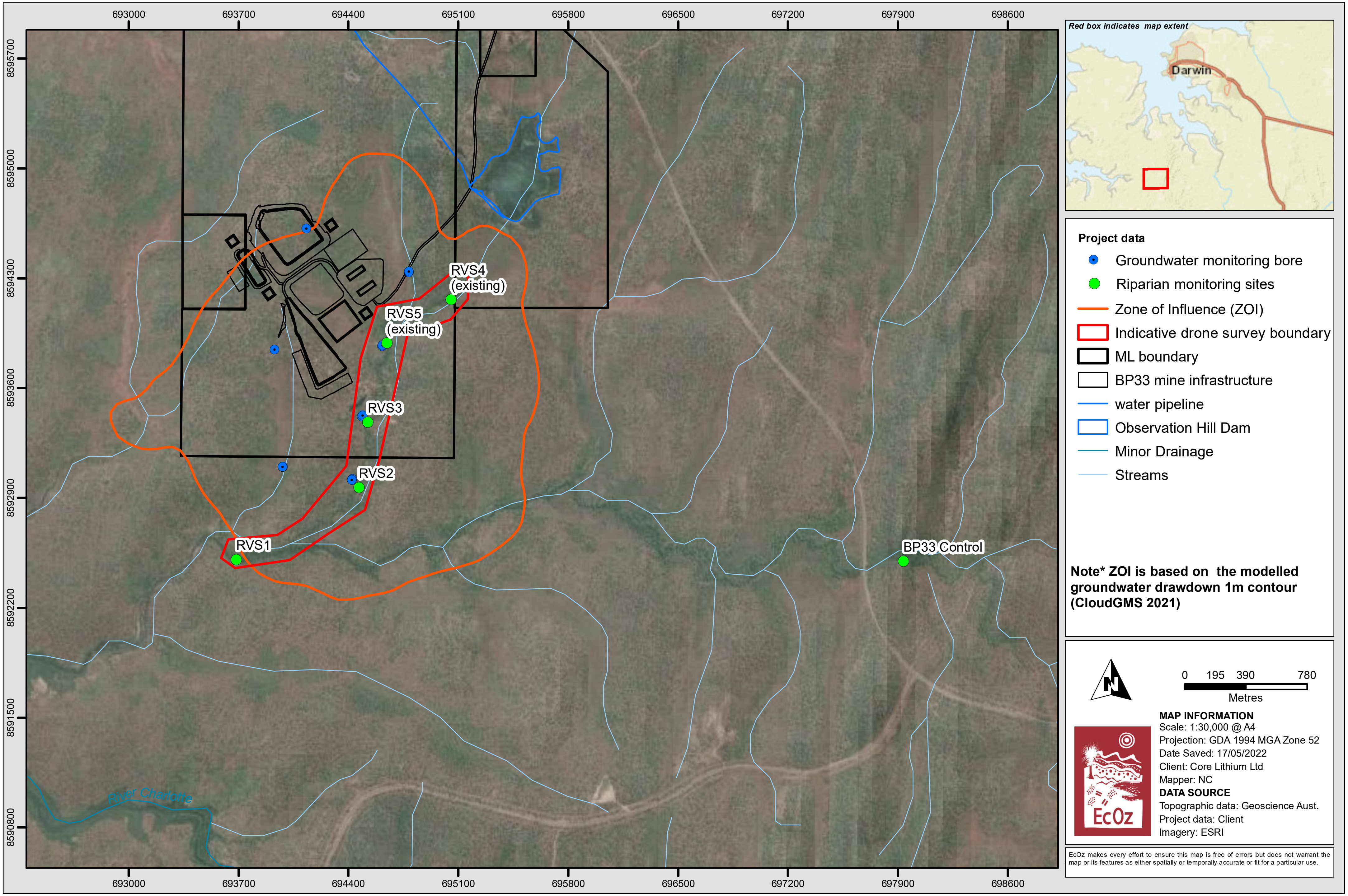
Methodology

Site Selection

- Two existing sites RVS4 and RVS5 will continue to be monitored using the updated monitoring method within this RVMP. Site RVS4 has been kept in the monitoring plan to detect immediate impacts from reduced SW flows downstream OHD. Existing site RVS5 has been retained as it is nearby a groundwater monitoring bore.
- Three new monitoring sites (RVS1, RVS2 and RVS3) will be established downstream of OHD within the ZOI (Figure 5). The location of these sites are suitable for monitoring as they lie within the potential GDE areas, align near existing bores for groundwater level monitoring (RVS3 and RVS2) and spatially correspond to immediate groundwater drawdown impacts (RVS3 located closest to the underground) and longer term potential impacts (RVS1 located near the 1m contour) (Figure 4-2).
- One new reference site upstream of Charlottes Creek (BP33 Control), in a similar riparian zone within the potential GDE area will be established with baseline monitoring commencing post-wet season 2022 (Figure 4-2). This site is outside of the predicted ZOI. The site was selected using various resources including up to date aerial imagery, mine components, and Land Units of the Greater Darwin Region (Fogarty et al. 1984).
- Sampling site locations for other BP33 project studies, such surface water, groundwater and biota monitoring have also been considered when selecting the new riparian vegetation monitoring sites. The precise locations will be verified in field during the 2022 post wet season survey.

Frequency

- Monitoring is to occur at all sites biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring, then monitoring will be reduced to annual (in the late dry season only).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 6. Map of all baseline monitoring sitesv2.mxd

Figure 4-2. Map of riparian vegetation monitoring sites, indicative drone imagery boundary and modelled groundwater drawdown 1m contour

Vegetation Monitoring

Vegetation site assessment monitoring methods have been adopted utilising the potential consequences of the groundwater drawdown affect as presented in the diagram outlined Figure 3-3. As indicated, the effect may take several years before physical changes become apparent. Monitoring methods are outlined below:

- A plot size of 20 x 20m will be established at each new riparian monitoring site, using star pickets. Existing plots RVS4 and RVS5 will be re-monitored at established plots (existing star pickets present).
- In each plot the dominant layer/emergent layer species will be recorded; this includes all seedlings (woody plants under 1m in height), saplings (woody plants between 1m and 3m high and < 2cm diameter at breast height, or DBH) and trees (woody plants with stems ≥ 2cm DBH and greater than 3m high) will be identified (both native plants and invasive plants included). For each individual the height will be estimated and the % cover will be measured. All individual woody plants within the plot will also be marked alive or dead, whether the plant is fruiting/flowering. Note, deciduous trees will not be recorded as dead during the dry-season monitoring.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) will be tagged on hand held GPS for future ongoing measurements. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* (observed at RVS4, RVS5).
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) will be recorded. The results from this method will be used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation will be recorded to a standard that is equivalent to Level 5 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity will be monitored by traversing along a 100m transect from the middle monitoring site and visually estimate the canopy cover (or by using a densitometer) of the native vegetation to indicate how continuous the canopy cover is along the transect. Note, a break in the continuity must be at least 5 m between tree crowns and span the entire width of the transect (Figure 4-3). If one tree is missing within a wide riparian zone it will not be counted as a break in the canopy continuity because the break must span the entire width of the riparian zone.

Table 4-4 summarises monitoring methods and how they will be used to measure the potential consequences of the reduction in surface flows and/or groundwater drawdown.

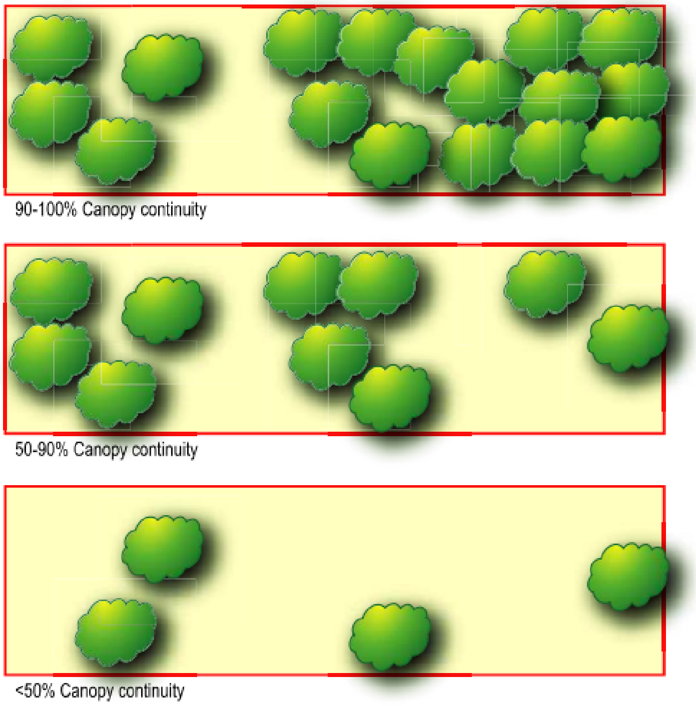


Figure 4-3. An example pictorial used for measuring canopy continuity (Dixon & Douglas 2015).

Table 4-4. Summary of monitoring methods that will be used to measure potential impacts of the reduction of surface water flows and groundwater drawdown

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree tagging	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 5 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

Photo point monitoring

- Four cardinal photo monitoring points (north, east, south, west) will be obtained within each plot.

Record keeping

- Vegetation monitoring database – comprised of seedling, sapling, and tree data for individual species and associated heights, DBH's and records of vegetation health e.g. % dead or sick plants.
- Ground cover data - percent cover and species richness.
- Photo monitoring point database.

Data analysis

The data collected based on monitoring methods outlined Table 4-4 will be statistically analysed using the Before After/Control Impact (BACI) approach. BACI will be applied by performing statistical analysis to test whether there is a significant difference between the baseline health data and riparian vegetation assessment data at the same sites, and riparian vegetation assessment data compared to reference site data.

Data captured for analysis includes:

- Species composition (%) using individual dominant/emergent plant data.
- Average heights of individual plants across riparian vegetation sites compared to reference site.
- Canopy cover (%) for each dominant, and emergent species across riparian vegetation assessment sites compared to reference site data.
- Plants alive or dead (%) across all riparian vegetation sites compared to reference site data.
- The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site.
- The ground cover percentages (vegetation type, soil, rock, litter).
- Type of ground cover percentages in the form of herbs/vines/grasses/ferns and sedges).

4.3.4 General Observations

Monitoring of other environmental factors is critical as they are contributing factors that can severely impact the health of riparian vegetation. Objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is discussed below.

Weeds

Weed data collection will be conducted in accordance with the Northern Territory Weed Management Branch (WMB 2015), Northern Territory Weed Data Collection Manual.

The percentage cover of weed species (declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat will be visually estimated for each weed species.

A GPS will be used to record locations of identified weed species, and will record the following information:

- Weed name
- Distribution - size (20, 50 or 100m diameter)
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1-5, 1 (absent) to 5 (>50%)
- Growth stage (seedling, juvenile, adult)
- Seeded (has the weed seeded?)
- Treatment (has the weed been treated and if so with what method of treatment)
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data will also be recorded outside of the plots to obtain surrounding data while traversing along the riparian area to visit each monitoring site.

Fire

Broad scale

Fire scar mapping and scoring will be determined by drone survey and mapped with NAFI each year to investigate frequencies and severity across the mapped riparian area.

Site (plot) based

At each plot an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and for recently burnt sites the severity will be scored from 1 to 4. Categories for characterisation of fire are:

- No evidence of fire
- Evidence of groundcover fire only
- Evidence of burnt saplings
- Evidence of fire in canopy layer.

Erosion

Broad scale

- Monitoring the presence of erosion (on a broader scale basis) may be more effective using remote sensing with the use of the drone imagery captured as per section 2.2. Monitoring erosion using monitoring plots can often mean that issue areas can be missed.
- It is recommended to flag any potential erosion issues identification with aerial imagery and follow-up with on-ground monitoring so that erosion risks are to be measured and remedial actions implemented.

Site (plot) based

At each plot note the presence or absence of erosion will be recorded, and if present the following characteristics will be recorded:

- Types of erosion i.e. gullying, sheet erosion etc
- The amount of bare ground above
- Tree root exposure – any roots exposed due to disturbance
- Slumping
- Fallen trees/woody debris
- Presence of surrounding erosion
- Width of riparian zone – measure or estimate the width of the riparian zone (facing downstream) for both sides of banks.

Aquatic life

Presence of aquatic life within the water will also be recorded. This will involve a record of aquatic fauna and flora at the nearest water access point from each of the vegetation monitoring plots.

Surface water flows

Presence of water flows at the time of surveying will be documented. Surface water flows will be assessed in accordance with the surface water flows monitoring plan (WRM 2022).

Sedimentation

Presence of sedimentation within the water and on the riparian vegetation.

Contamination

- Presence of potential contamination (foam/scum/oils) and odour will be documented.

Climatic conditions

Weather observation will be documented during the monitoring. The annual rainfall, evaporation and temperature will be recorded from the same station and discussed for survey data comparison.

The following monitoring will be undertaken in accordance with the Grants and BP33 water management plans:

- surface and groundwater quality
- sediment monitoring
- macroinvertebrate monitoring
- groundwater levels will be assessed in accordance with the GDE Management plan (Groundwater Enterprises and RDM Hydro 2022).

Record keeping

All observations and data captured will be uploaded after each monitoring event, mapped as required and all records maintained in excel database.

4.3.5 Summary of Riparian Vegetation Monitoring Requirements

Table 4-5 outlines the RVMP schedule, prior to any significant disturbance and for the duration of the OHD SWEL, BP33 life of mine and three years post operations when the groundwater levels are predicted to return to pre-mining conditions (CloudGMS 2021).

Table 4-5. Riparian vegetation monitoring schedule

Monitoring	When	Monitoring undertaken	Frequency of monitoring	Locations
Baseline drone survey	End of Wet season (May) and end of dry season (October) 2022	Drone flight path to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Baseline riparian vegetation site assessment survey	End of Wet season (May) and end of dry season (October) 2022	Site assessment at all identified locations to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Drone survey	End of dry season (October) 2023 onwards	Drone flight	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Riparian vegetation site assessment survey	End of dry season (October) 2023 onwards	Site assessments	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control

4.4 Riparian Monitoring Program Performance Criteria and TARP

A TARP relating to the results of the Riparian Vegetation Monitoring Program is presented in Table 4-6**.** The TARP incorporates triggers and responses from the surface water monitoring program (Section 4.1) and GDE Management Plan quantitative triggers and limits and/or adaptive management actions.

Table 4-6. Riparian vegetation monitoring program performance criteria and Trigger Action Response Plan

Level	Trigger	Performance Indicator		Action	Response
		Drone Survey	Riparian Vegetation Site Assessment		
Level 1 (normal)	No reduction in riparian vegetation extent and/or structure/ composition compared to baseline	Vegetation biomass using VARI analysis comparable to baseline mapping.	No change in in general vegetation health compared to reference sites i.e. no tree mortality or physical changes to health of plants through the use of on-ground assessment and photo monitoring points.	No action required	No response required
Level 2 (early warning)	10% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	There is no greater than a 10% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping	Vegetation structure and composition – there is no greater than 10% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites Groundcover – there is no greater than 10% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites Tree mortality – there is no greater than 10% tree mortality of tagged plants recorded compared to the representative reference sites General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 90% of the dominant species present within each strata) Tree canopy continuity – there is no greater than 10% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Continue to monitor in accordance with RVMP Investigate other potentially contributing environmental factors and likely reason for reduction in riparian vegetation extent. Conduct drone monitoring in GDE reference site Implement action in surface water flows monitoring program (Table 4-3) TARP Level 2. Investigate management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022).	Implement response in surface water flows monitoring program (Table 4-3) TARP Level 2. Report on the outcomes of the actions undertaken to the regulator.
Level 3a (elevated risk)	25% reduction in riparian vegetation extent	There is no greater than a 25% loss of the 3.6 ha vegetation biomass	Vegetation structure and composition – there is no greater than 25% reduction in the number of plants, saplings, and recorded within the plots of	Implement action in surface water flows monitoring program (Table 4-3) TARP	Implement response in surface water flows monitoring program (Table

Level	Trigger	Performance Indicator		Action	Response
	and/or structure/ composition compared with baseline	using VARI analysis comparable to baseline mapping	that recorded at the representative reference sites Groundcover – there is no greater than 25% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites Tree mortality – there is no greater than 25% tree mortality of tagged plants recorded compared to the representative reference sites General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 75% of the dominant species present within each strata) Tree canopy continuity – there is no greater than 25% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Level 3. Further investigate extent of riparian vegetation reduction within ZOI, including assessment of the drainage line flowing east to west within the ZOI. Conduct biannual riparian vegetation site assessment (end of wet season and end of dry season) and compare seasonal variability to 2022 baseline data.	4-3) TARP Level 3. Report on the outcomes of the investigation of riparian vegetation health within ZOI to regulator. Report on the outcomes of the seasonal variability (additional monitoring at end of wet season and dry season) to regulator. Report on outcomes of the investigation of management actions as outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) to the regulator.
Level 3b (imminent risk)	50% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	There is no greater than a 50% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping	Vegetation structure and composition – there is no greater than 50% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites Groundcover – there is no greater than 50% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites Tree mortality – there is no greater than 50% tree mortality of tagged plants recorded compared to the representative reference sites General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 50% of the dominant species present within each strata) Tree canopy continuity – there is no greater than 50% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Implement action in surface water flows monitoring program (Table 4-3) TARP Level 3. Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. Further investigate extent of riparian vegetation reduction outside 1m contour groundwater drawdown ZOI. Revise BP33 mine closure plan (MCP) and rehabilitation management plan (RMP) to include reinstatement of habitat values in the affected riparian areas and monitoring of ecosystem recovery and submit to Controller or Water Resources and NT EPA CEO	Implement response in surface water flows monitoring program (Table 4-3) TARP Level 3. Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Performance Indicator		Action	Response
				for approval.	
Level 4 (exceedance of approved limits)	Loss of >3.6 ha of identified GDE vegetation extent and/or structure/ composition	There is no greater than a 100% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping.	Vegetation structure and composition – there is no greater than 100% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites Groundcover – there is no greater than 100% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites Tree mortality – there is no greater than 100% tree mortality of tagged plants recorded compared to the representative reference sites General vegetation description using NVIS level 5 does not align with the representative reference site descriptions (i.e. indicating new ecosystem structures and functions have appeared) Tree canopy continuity – there is no greater than 100% reduction in tree canopy cover (%) along transect compared to the representative reference sites	Implement action in surface water flows monitoring program (Table 4-3) TARP Level 4. Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. Implement approved RMP. Notify NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.	Implement response in surface water flows monitoring program (Table 4-3) TARP Level 4. Report on the outcomes of the actions undertaken to the regulator.

5 REPORTING AND REVIEW

A monitoring report will be developed as per condition 4.2 of SWEL 8151018 and include data collected in accordance with the monitoring program under condition 4.1 for the previous water accounting year (1 May to 30 April). The report will:

- Include data collected on surface water flows and riparian vegetation monitoring, for the previous water accounting year.
- Outline management actions taken in response to quantitative triggers or limits, established in Section 4.2 and 4.4.
- Include a summary of updated surface water modelling using the most recent monitoring data.
- Discuss the measured and modelled impacts of water taken under the licence on downstream riparian vegetation and surface water flows.

A copy of the Monitoring Report will be published on Core's website such that it is publicly available.

This Monitoring Plan will be reviewed annually, based on the results of surface water flows and biannual riparian vegetation monitoring, to ensure continuous improvement of the monitoring program in accordance with Condition 4.1 of the SWEL (8151018). Data management and reporting is key to inform the review process. The triggers for surface water flows (presented in Table 4-3) will be refined in the next review of this Monitoring Plan once site specific data is obtained on surface water flows over the coming wet season.

Table 5-1. Data and report review schedule

Task	Timing	Responsibility
Review surface water flows data; assess performance against spill days and rainfall matrix	Monthly during wet season May (annually) after the water accounting year	Lithium Developments Environmental Team
Record of total extraction from OHD – provided to Water Resources	Quarterly (within two weeks of the end of each quarter of each year)	
Review riparian vegetation monitoring data	Annually after late dry season monitoring event	
Monitoring Report	Annually - within two weeks of 30 June of each year	
Monitoring Plan review	August annually	

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APPENDIX A OBSERVATION HILL DAM SURFACE WATER MONITORING PROGRAM (TECHNICAL MEMORANDUM)

APPENDIX B MANGROVE AND RIPARIAN VEGETATION ASSESSMENT REPORT

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APPENDIX E BASELINE RIPARIAN VEGETATION MONITORING REPORT

Baseline Riparian Vegetation Monitoring Report
Finniss Lithium Project

CORE LITHIUM

www.ecoz.com.au

DOCUMENT CONTROL RECORD

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Author(s)	Nicole Clark, Anna Lemon

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Recipients are responsible for eliminating all superseded documents in their possession.

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1 INTRODUCTION

This document presents the methodology and results of the post wet-season (May 2022) and post dry-season (October 2022) baseline surveys of riparian vegetation downstream of Observation Hill Dam (OHD) and the Proposed BP33 underground lithium mine within the Finniss Lithium Project, BP33 outlined within the Riparian Vegetation Monitoring Plan (RVMP) (EcOz 2022). The RVMP was developed and implemented to monitor potential impacts associated with surface water extraction from OHD under Surface Water Extraction Licence (SWEL) 8151018 and operation of the proposed Finniss Lithium Project, BP33 underground lithium mine (BP33) located on the Cox Peninsula (Figure 1-1). Riparian vegetation health downstream of OHD and surrounding BP33 could be affected by changes to:

- surface water flows associated with extraction of water from the Observation Hill Dam (OHD)
- groundwater drawdown associated with dewatering of BP33 underground mine.

Riparian vegetation monitoring is required as a condition of the following approvals and licences:

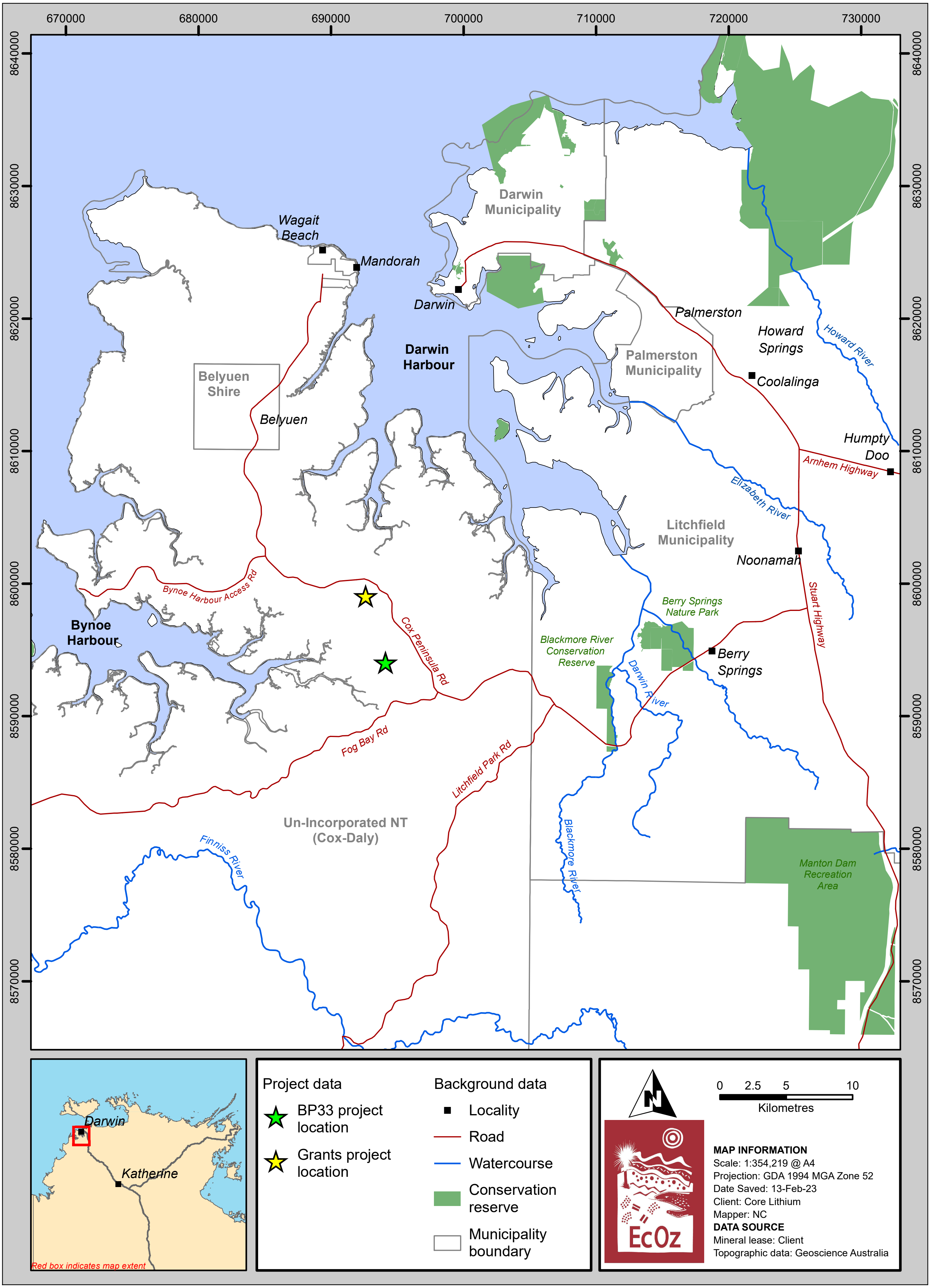
- Environmental Approval 2020/001-001 for BP33 underground lithium mine (Condition 6)
- SWEL 8151018 (Condition 4.1).

Riparian communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

The report includes monitoring parameters, methods and results of the baseline condition of riparian vegetation.

1.1 Background

The previous baseline survey, The Mangrove and Riparian Vegetation Assessment Grants Lithium Project was undertaken by EcOz Environmental Consultants (EcOz 2019) and where applicable, results derived from this survey will be added to the compared to the baseline dataset for future comparison. It is noted, only two sites (RVS4 & RVS5) can be used for future comparison as all other sites (RVS1, RVS2, RVS3, RVS6 and reference site) were monitored at different locations and considered baseline monitoring sites in this report.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19171 - BP33 NOI\01 Project Files\Report maps\Figure 1-1. Map of project location and regional setting.mxd

Figure 1 1. Location map of proposed Finniss Lithium Project, BP33 underground lithium mine

1.2 Climate

BP33 underground lithium mine lies within the wet-dry tropics. The wet season is typically November to March/April, and the dry season April to October. Figure 1-2 shows average monthly rainfall generated for the area from BOM (2022) indicating rainfall (mm) amount prior to post-wet season and post-dry season surveys.

The wettest months are typically January and February. Usually no rain falls during the dry season months of June, July and August.

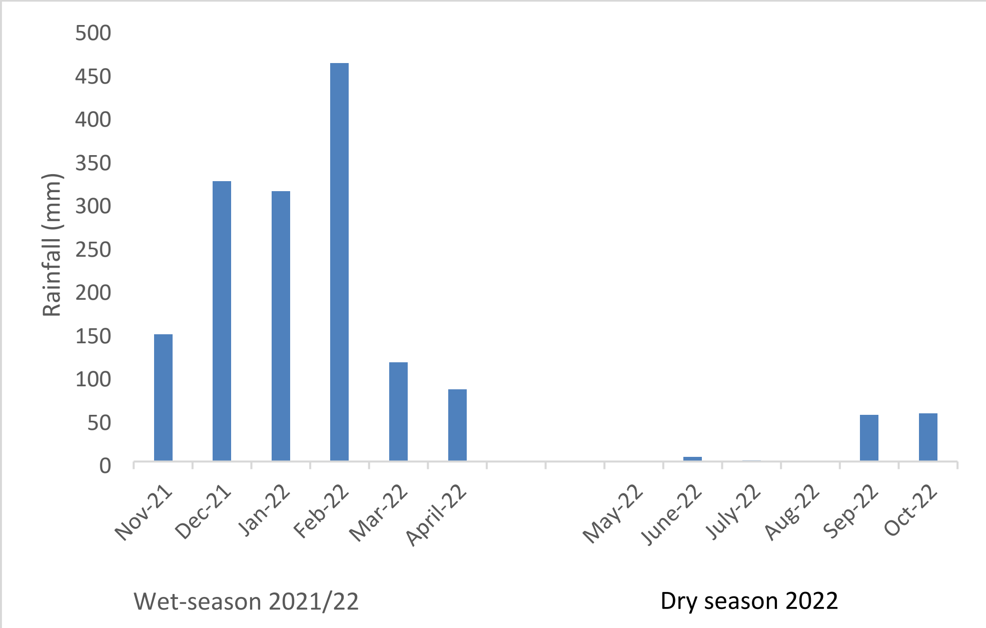


Figure 1-2. Average monthly rainfall generated for the area from BOM (2022) indicating rainfall (mm) amount prior to post-wet season and post-dry season surveys undertaken in 2022.

2 METHODOLOGY

2.1 Vegetation site assessment

The vegetation site assessment monitoring methods have been adopted utilising the potential consequences of the groundwater drawdown affect (Eamus, D., & Lamontagne 2006) (See Appendix A, Figure 4Table 2-2). The methods are largely outlined in the RVMP (Appendix A), though some minor changes to the methods were made since this plan was adopted. A summary of the updated methods applied to vegetation site assessments is addressed in this report (see section 2.2.3).

2.1.1 Site selection

Two existing sites from the EcOz (2019) baseline survey, RVS4 and RVS5 have been retained and will continue to be monitored. Additionally, three new riparian vegetation monitoring sites and one reference site have been selected to be monitored. Site selection is presented in Table 2-1.

Table 2-1. Summary of vegetation site selection

Site	Site selection
RVS1	• New monitoring site downstream of OHD just outside of the Zone of Impact (ZOI) (see RVMP, Figure 5) • Site selection based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI (see RVMP, Figure 5). • Suitable for monitoring as the sites lies within potential GDE areas
RVS2	• New monitoring site downstream of OHD • Suitable for monitoring as the sites lies within potential GDE areas • Align near existing bore for groundwater level monitoring and spatially correspond to immediate groundwater
RVS3	• New monitoring site downstream of OHD • Suitable for monitoring as the sites lies within potential GDE areas • Aligns near existing bore for groundwater level monitoring and spatially correspond to immediate groundwater
RVS4	• Existing baseline monitoring site (EcOz 2019) and designed to detect immediate impacts from reduced SW flows downstream of OHD. • Continue to be monitored using the updated monitoring method within this RVMP (Appendix A).
RVS5	• Existing baseline monitoring site and has been retained as it is nearby a groundwater monitoring bore SW1 and BPG3i (Appendix A). • Continue to be monitored using the updated monitoring method within RVMP (Appendix A).
Reference site	• New reference site upstream of Charlottes Creek (BP33 Control), in a similar riparian zone within the potential GDE area, established with baseline monitoring commencing post-wet season 2022. This site is outside of the predicted ZOI. The site was selected using various resources including up to date aerial imagery, mine components, and Land Units of the Greater Darwin Region (Fogarty et al. 1984).

2.1.2 Vegetation monitoring

Monitoring methods are outlined below:

- A plot size of 20 x 20m was established at each new riparian monitoring site, using star pickets. Existing plots RVS4 and RVS5 was re-monitored at established plots (existing star pickets present).
- In each plot the dominant layer/emergent layer species was recorded; this includes all seedlings (woody plants under 1m in height), saplings (woody plants between 1m and 3m high and < 2cm diameter at breast height, or DBH) and trees (woody plants with stems ≥ 2cm DBH and greater than 3m high) identified (both native plants and invasive plants included). For individual species occurring within upper and mid stratum, the height was estimated and the % cover measured. All individual woody plants within the plot was recorded alive or dead, whether the plant is fruiting/flowering. Note, deciduous trees are not recorded as dead during the dry-season monitoring.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) were recorded. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* (observed previously at RVS4, RVS5).
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) were recorded. The results from this method is used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation was recorded to a standard that is equivalent to Level 6 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity was monitored through the use reviewing drone imagery and looking for any gaps in the riparian corridor.

Table 2-2 summarises monitoring methods and how they are used to measure the potential consequences of the reduction in surface flows and/or groundwater drawdown. It is noted, within the RVMP (EcOz 2022) it was mentioned NVIS level 5 would be recorded as part of the data collection, however this was since altered to NVIS level 6 to obtain a more complex description of the riparian vegetation community.

Table 2-2. Summary of monitoring methods that are used to measure potential impacts of the reduction of surface water flows and groundwater drawdown

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree records	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 6 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

2.2 General observations

2.2.1 Objective

Monitoring of other environmental factors is critical as they are contributing factors that can severely impact the health of riparian vegetation. Objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is discussed below.

2.2.2 Other environmental factors

Weeds

Weed data collection is conducted in accordance with the Northern Territory Weed Management Branch (WMB 2015), Northern Territory Weed Data Collection Manual.

The percentage cover of weed species (declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat is visually estimated for each weed species.

A GPS is used to record locations of identified weed species, and record the following information:

- Weed name
- Distribution - size (20, 50 or 100m diameter)
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1-5, 1 (absent) to 5 (>50%)
- Growth stage (seedling, juvenile, adult)
- Seeded (has the weed seeded?)
- Treatment (has the weed been treated and if so with what method of treatment)
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data will was recorded outside of the plots to obtain surrounding data while traversing along the riparian area to visit each monitoring site.

Fire - broad scale and site based monitoring

Broadscale

Fire scar mapping and scoring is determined by drone survey and mapped with NAFI each year to investigate frequencies and severity across the mapped riparian area.

At each plot an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and for recently burnt sites the severity will be scored from 1 to 4. Categories for characterisation of fire are:

- No evidence of fire
- Evidence of groundcover fire only
- Evidence of burnt saplings
- Evidence of fire in canopy layer.

Erosion - broad scale and site based monitoring

Broadscale

- Monitoring the presence of erosion (on a broader scale basis) may be more effective using remote sensing with the use of the drone imagery captured as per section 2.2. Monitoring erosion using monitoring plots can often mean that issue areas can be missed.

- It is recommended to flag any potential erosion issues identification with aerial imagery and follow-up with on-ground monitoring so that erosion risks are to be measured and remedial actions implemented.

Site (plot) based

At each plot note the presence or absence of erosion is recorded, and if present the following characteristics recorded:

- Types of erosion i.e. gullying, sheet erosion etc
- The amount of bare ground above
- Tree root exposure – any roots exposed due to disturbance
- Slumping
- Fallen trees/woody debris
- Presence of surrounding erosion
- Width of riparian zone – measure or estimate the width of the riparian zone (facing downstream) for both sides of banks.

Aquatic life

Presence of aquatic life within the water recorded. This involves recording aquatic fauna and flora at the nearest water access point from each of the vegetation monitoring plots.

Surface water flows

Presence of water flows at the time of surveying, assessed in accordance with the surface water flows monitoring plan (WRM 2022).

Sedimentation

Presence of sedimentation within the water and on the riparian vegetation.

Contamination

Presence of potential contamination (foam/scum/oils) and odour.

Climatic conditions

Weather observation documented during the monitoring. The annual rainfall, evaporation and temperature recorded from the same weather station and discussed for survey data comparison.

2.2.3 Summary of changes made to methods

- Initially the method involved tagging or assigning a waypoint for individual, groundwater sensitive trees. This was revised since undertaking the field work as there were an abundance of these specific species present (mostly recruits <3 m tall).
- The RVMP indicated NVIS level 5 would be used when assessing riparian vegetation, though this was changed to NVIS level 6 to obtain a more complex description of the vegetation community compared to previous work. NVIS level 6 provides records of all upper canopy and mid stratum species, unlike NVIS 5, which only includes the dominant three species of each stratum.
- The method for collecting vegetation continuity was revised and with further thought, this information can be obtained from assessing the drone imagery and identifying any gaps in the vegetation as opposed to previous method, which was taking canopy cover measurement across the entire riparian corridor.

2.3 Drone survey

2.3.1 Objective

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey is to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover.

- A drone flight path based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI boundary. . The new flight path is an extension of the existing baseline survey (EcOz 2019) (Appendix A). to capture the riparian vegetation extent downstream of OHD to the modelled 1m contour groundwater drawdown ZOI. The drone flight path was established also using the selected Ground Water Dependant Ecosystem area (Appendix A, Figure 2).
- The timing of the post-wet season was selected to record maximum vegetation growth within the survey area. The timing of the post dry-season was selected in contrast of the post wet-season survey to represent seasonal changes.
- DJI Go app and Fly Litchi app was used to capture imagery at a height of 60m (75% front overlap and 65% side overlap)
- Images were stitched it together using the WebODM app to create an orthophoto.
- Drone will be flown in desirable conditions, i.e. in the morning to minimise strong winds or the middle of the day to avoid sun light interference i.e. shading. Observations will also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- Drone data analysis will be undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.
- These values will be categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, will then be calculated.
- Vegetation boundaries were delineated at a scale of 1:500 using the 5cm pixel orthomosaic aerial images captured during the drone survey. Individual trees, vegetation cover and soil colour was identified from the imagery to inform the mapping of vegetation boundaries.

3 RESULTS POST WET-SEASON SURVEY

The post wet-season riparian vegetation assessment (including both individual site assessments and the drone survey) was undertaken by Nicole Clark and Anna Lemon (EcOz Botanists) on 13 – 18 May 2022 at Core Lithium, BP33 site to assess the condition of the riparian vegetation. All sites selected as per section 2.1.1 were assessed as part of this monitoring event. Figure 3-12 represents sites monitored in the 2022 post wet-season survey. A few of the site locations were changed in the field (based on the initial proposed locations) due to a recent fire. These were only slight changes and will not affect the results. As there was evidence of fire at some sites when undertaking vegetation assessment site surveys, zoomed in drone images are provided for each site to see the extent and have this information recorded for future monitoring events.

3.1 Vegetation site assessment

3.1.1 RVS1

Site description

The upper stratum comprised of *Xanthostemon eucalyptoides*, *Melaleuca argentea* mid open forest (12-14 m) with a sub-stratum of emerging *Syzygium armstrongii* (10-12 m). The mid stratum contained a mixed low open forest with *Leptospermum madidum* subsp. *sativum*, *Pandanus aquaticus* and *Barringtonia acutangula* subsp. *acutangula* and *Carallia brachiata*. *Acacia holosericea*, *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii* were sparsely represented within the mid stratum with <2% cover each. Ground cover was mostly comprised of sedges including *Fimbristylis* sp. which accounted for ~40% cover. Low grass cover with *Eriachne triseta* and sparse *Pseudopogonatherum contortum* was restricted to the edges of the creek bank.

NVIS description

U1+ ^*Xanthostemon eucalyptoides*, *Melaleuca argentea* \^tree\7\c; U2 ^*Syzygium armstrongii* \^tree\7\r; M ^*Leptospermum madidum* subsp. *sativum*, *Pandanus aquaticus*, *Barringtonia acutangula* subsp. *acutangula*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\c; G1 ^*Eriachne triseta* \^tussock grass \2\i; G2 ^ Herb sp., *Fimbristylis* sp., \sedge, forb, *Lindsaea ensifolia*/ fern\1\c. Other species noted: *Cyclophyllum schultzii* f. *schultzii*, *Myrsine benthamiana*.

Vegetation height and cover

Species	Upper		Middle		Recruit	
	Height (m)	Cover %	Height (m)	Cover %	Height (m)	Cover %
Melaleuca argentea	12-14	15	-	-	-	-
Xanthostemon eucalyptoides	12-14	15-20	-	-	-	-
Syzygium armstrongii	10-12	5	-	-	-	-
Leptospermum madidum	-	-	4-8	20	-	-
Barringtonia acutangula	-	-	3-4	5	<3m	15
Pandanus aquaticus	-	-	3-5	5-10	-	-
Myrsine benthamiana	-	-	3-5	<1	<3m	15
Carallia brachiata	-	-	3-5	2	<3m	15
Acacia holosericea	-	-	4	2	-	-
Cyclophyllum schultzii	-	-	3-4	1	<3m	15
Fagraea racemosa	-	-	-	-	<3m	15
Total	**10-14**	**35**	**3-8**	**35-40**	**0-3**	**15**

General observations

Two aquatic plants – Eriocaulon sp. and Nymphaea sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present. Recent fire was observed north of the site in adjacent woodland, with scorch some *Acacia holosericea.* No weeds were observed.

Photo monitoring point

North

East

South

West

Figure 3-1. Photographs of the habitat at RVS1 using cardinal-directions for riparian monitoring

Figure 3-2. Drone imagery of RVS1

3.1.2 RVS2

Site description

The upper stratum is a mid open forest (10-12 m) dominated by *Melaleuca viridiflora*, with co-dominants *Syzygium armstrongii* and *Lophostemon lactifluus*. The mid stratum consists of a low open forest (4-8 m) with *Xanthostemon eucalyptoides* and co-dominants *Leptospermum madidum* subsp. *sativum* and *Acacia holosericea*. A dozen species were recruiting into the mid stratum and collectively comprised ~40% cover. Ground cover comprised of an open tussock grassland with *Eriachne triseta* and *Germania grandiflora*. Ferns, herbs and sedges were generally confined to the creek bank.

NVIS description

U+ ^*Melaleuca viridiflora*, *Syzygium armstrongii*, *Lophostemon lactifluus*, *Eucalyptus miniata*, *Melicope elleryana* \^tree\7\i; M ^*Xanthostemon eucalyptoides*, *Leptospermum madidum* subsp. *sativum*, *Acacia holosericea*, *Pandanus spiralis*, *Helicia australasica* \^tree, shrub\6\c; G1 ^*Eriachne triseta*, *Germania grandiflora* \^tussock grass \2\i; G2 ^Fern sp. \^fern\1\i. Other species noted: *Carpentaria acuminata*.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Eucalyptus miniata	10-12	3-5	-	-	-	-
Lophostemon lactifluus	10	3-5	-	-	-	-
Melaleuca viridiflora	10-12	5-10	-	-	-	-
Melicope elleryana	-	-	-	-	-	-
Syzygium armstrongii	10	5-10	3-6	1	<3	40
Acacia holosericea	-	-	3-4	3-5	<3	40
Carpentaria acuminata	-	-	6	>1	<3	40
Helicia australasica	-	-	3-5	1-3	<3	5
Leptospermum madidum	-	-	4-8	10-15	<3	40
Pandanus spiralis	-	-	3-5	1-3	<3	40
Xanthostemon eucalyptoides	-	-	6-8	10-15	<3	40
Alphitonia excelsa	-	-	-	-	<3	40
Breynia cernua	-	-	-	-	<3	40
Cyclophyllum schultzii	-	-	-	-	<3	1
Erythrophleum chlorostachys	-	-	-	-	<3	40
Exocarpos latifolius	-	-	-	-	<3	40
Total	**10-12**	**25-30**	**3-8**	**35-40**	**0-3**	**45**
**highlighted cells indicate overall % cover for combined species for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present. A recent fire had occurred in adjacent Eucalypt woodland and had burnt up to the outer edges of the riparian corridor.

Photo monitoring point

North

East

South **West**


Figure 3-3. Photographs of the habitat at RVS2 using cardinal-directions for riparian monitoring

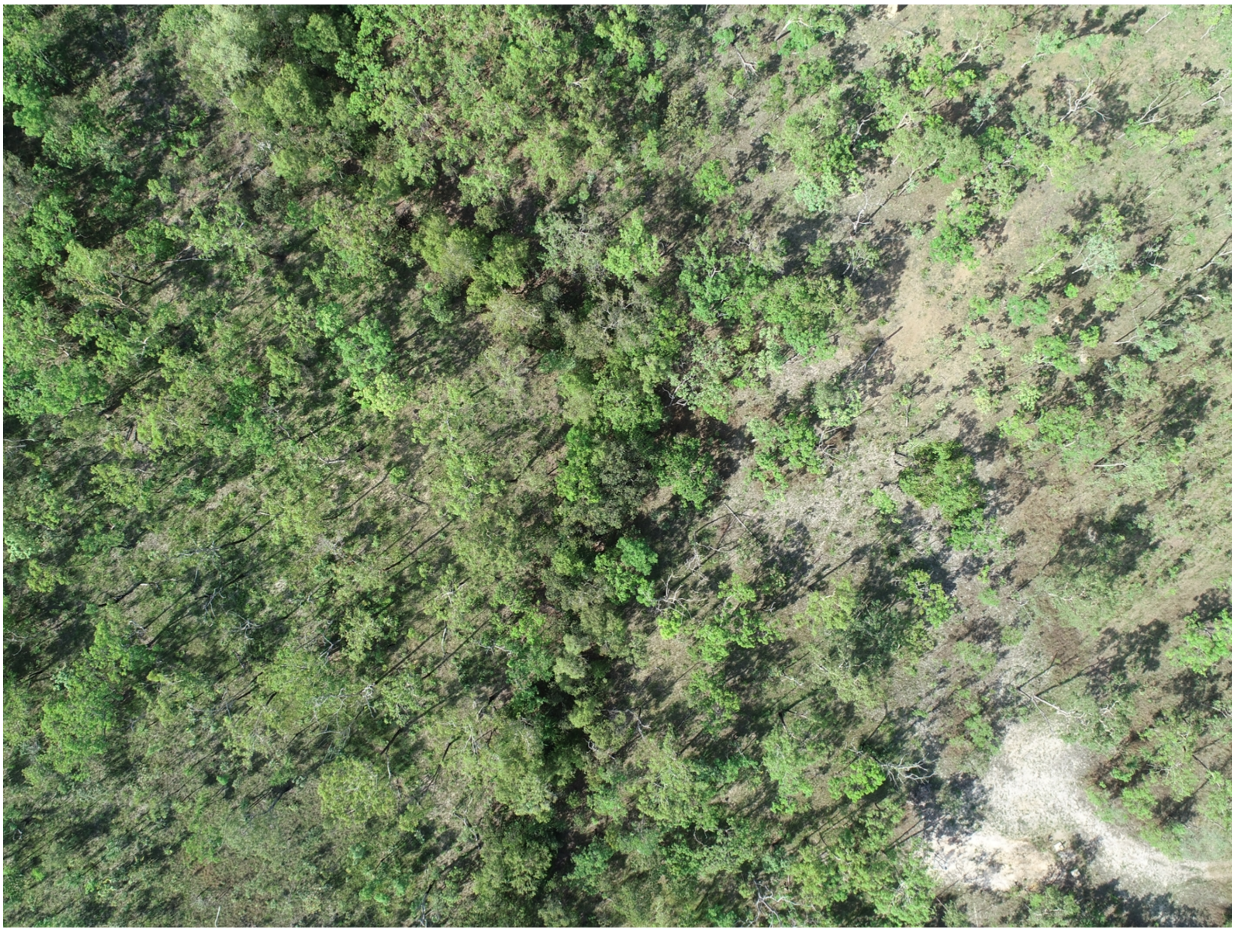


Figure 3-4. Drone imagery of RVS2

3.1.3 RVS3

Site description

The upper stratum consisted of a mid woodland (12-14 m) dominated by *Xanthostemon eucalyptoides* and *Lophostemon lactifluus*, with a mix of less dominant species *Melaleuca viridiflora*, *Erythrophleum chlorostachys* and *Syzygium armstrongii*. Two mid stratums were present within the system, with the taller stratum comprising of a mixed low woodland (5-10 m) with *Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura* and *Carallia brachiata*. The lower mid stratum contained a mix of shrubs and small trees with *Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* (2-5 m). The ground stratum was mostly a tussock grassland outside of the creek line with *Eriachne triseta* and *Germania grandiflora*, and ferns were typically growing along the creek bank.

NVIS description

U+ ^*Xanthostemon eucalyptoides*, *Lophostemon lactifluus*, *Melaleuca viridiflora*, *Erythrophleum chlorostachys*, *Syzygium armstrongii* \^tree\7\i; M1 ^*Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura*, *Carallia brachiata* \^tree\6\c; M2 ^*Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* \^shrub, tree\6\i; G1 ^*Eriachne triseta*, *Germania grandiflora* \^tussock grass \2\c; G2 ^Fern sp. \ ^fern\1\i. Other species noted: *Helicia australasica*, *Alphitonia excelsa*, *Livistona humilis*.

Vegetation structure

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Erythrophleum chlorostachys	12-14	<5	3	15	<3	10-15
Lophostemon lactifluus	12-14	5-10	-	-	-	-
Melaleuca viridiflora	12-14	5	4-5	15	<3	10-15
Syzygium armstrongii	12-14	5	-	-	<3	10-15
Xanthostemon eucalyptoides	12-14	5-10	3-8	5-10	<3	10-15
Acacia auriculiformis	-	-	8-10	5	-	-
Acacia holosericea	-	-	3-5	10-15	<3	10-15
Alphitonia excelsa	-	-	4-5	15	<3	10-15
Carallia brachiata	-	-	4-6	15	<3	10-15
Cyclophyllum schultzii	-	-	2-5	15	<3	10-15
Denhamia obscura	-	-	6-8	15	-	-
Leptospermum madidum	-	-	5-7	5	-	-
Livistona humilis	-	-	3-4	15	<3	10-15
Pandanus aquaticus	-	-	3	15	-	-
Pandanus spiralis	-	-	4	15	<3	10-15
Breynia cernua	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Total	**12-14**	**25-30**	**3-10**	**45-50**	**0-3**	**10-15**
**highlighted cells indicate overall % cover for combined species for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present. A large patch of *Cenchrus pedicellatus* (Annual Mission Grass) is situated adjacent (north-east) the site near cleared access tracks.

Photo monitoring point

North

East

South

West

Figure 3-5. Photographs of the habitat at RVS3 using cardinal-directions for riparian monitoring

Figure 3-6. Drone imagery of RVS3

3.1.4 RVS4

Site description

The upper stratum consisted of a mid open forest (12-16 m) with *Syzygium armstrongii* and *Xanthostemon eucalyptoides*, with emerging *Corymbia polycarpa* (10-12 m). The mid stratum was fairly complex with two distinct height ranges. The taller of the mid stratums comprised of low open forest (5-10 m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Syzygium angophoroides*, *Gmelina schlechteri* and *Pandanus spiralis*. The lower mid stratum (2-5 m) contained a mix of small trees comprising of *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii*, *Melaleuca viridiflora* and *Carallia brachiata*. *Acacia holosericea* was also present and formed a small component of the lower mid stratum. The ground stratum was a tussock grassland containing *Eriachne triseta* and *Chrysopogon latifolia*. Smaller ferns and sedges were typically confined to the creek bank, and *Dianella odorata* and *Flagellaria indica* were also present within the creek.

NVIS description

U+ ^*Syzygium armstrongii*, *Xanthostemon eucalyptoides*, *Corymbia polycarpa* \^tree\7\c; M1 ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Syzygium angophoroides*, *Gmelina schlechteri*, *Pandanus spiralis* \^tree\6\c; M2 ^*Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii*, *Melaleuca viridiflora*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\c; G2 ^Fern sp., Sedge sp. \ ^fern, sedge\1\i. Other species noted: *Flagellaria indica*, *Dianella odorata*.

Vegetation structure

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Corymbia polycarpa	10-12	5	-	-	-	-
Syzygium armstrongii	14-16	20	6-8	10	<3	10-15
Xanthostemon eucalyptoides	12-14	15	4-8	25-30	-	-
Acacia holosericea	-	-	2-4	15-20	-	-
Carallia brachiata	-	-	2-4	15-20	-	-
Cyclophyllum schultzii	-	-	2-5	15-20	<3	10-15
Flagellaria indica	-	-	6	15-20	-	-
Gmelina?	-	-	6-8	15-20	-	-
Melaleuca viridiflora	-	-	2-4	15-20	-	-
Myrsine benthamiana	-	-	3-6	15-20	<3	10-15
Pandanus spiralis	-	-	4-6	15-20	<3	10-15
Syzygium angophoroides	-	-	6-8	15-20	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Melicope elleryana	-	-	-	-	<3	10-15
Total	**12-16**	**40**	**2-8**	**50-55**	**0-3**	**10-15**
**highlighted cells indicate overall % cover for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present. A recent fire had occurred in adjacent Eucalypt woodland and had burnt up to the top of the bank of the riparian corridor (approximately 5-10 m from the creek).

Photo monitoring point

North

East

South

West

Figure 3-7. Photographs of the habitat at RVS4 using cardinal-directions for riparian monitoring

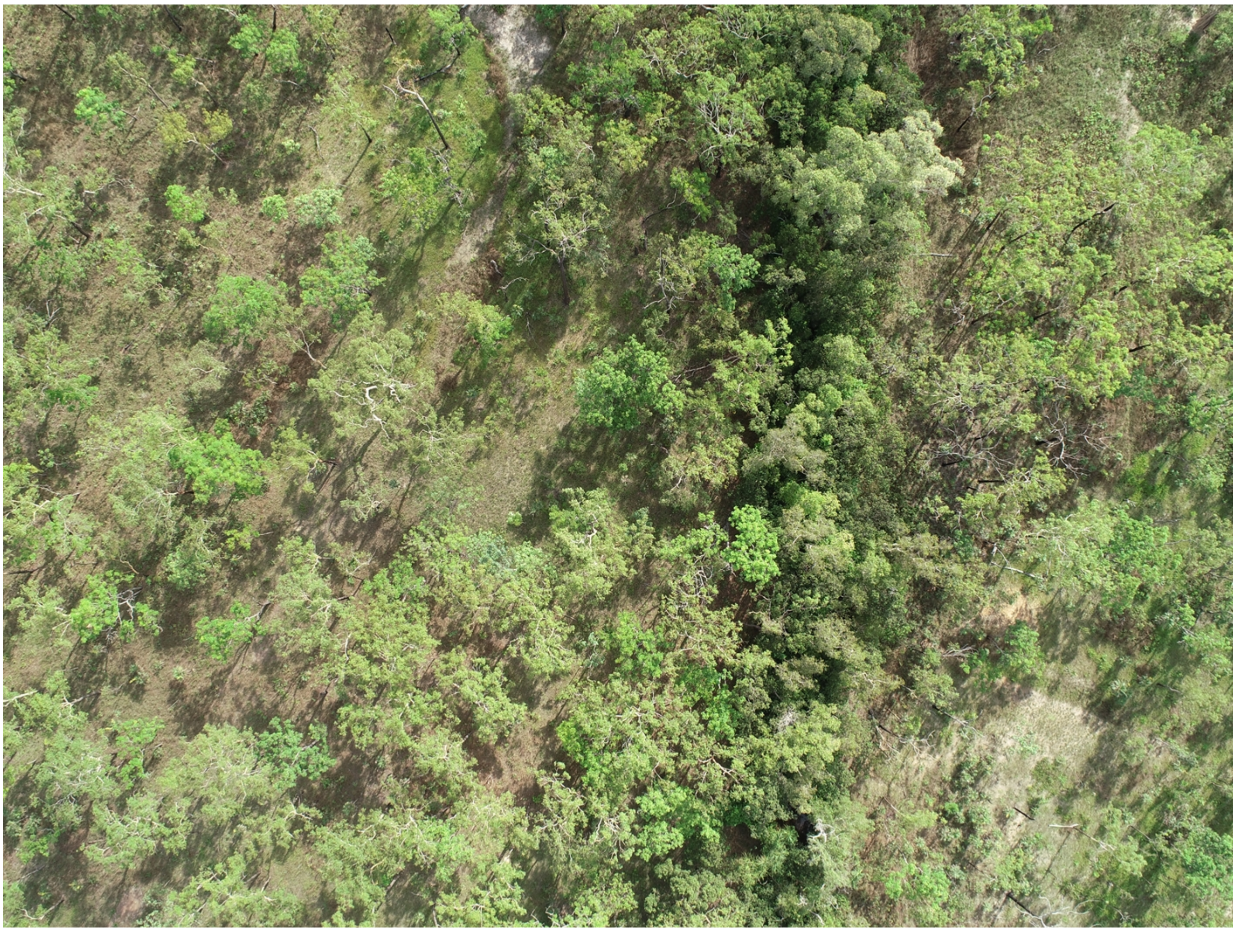


Figure 3-8. Drone imagery of RVS4

3.1.5 RVS5

Site description

The upper stratum is comprised of a mid woodland (12-14 m) with *Syzygium armstrongii* and *Xanthostemon eucalyptoides*, over low woodland (8-10 m) of *Melaleuca viridiflora* and *Lophostemon lactifluus*. The mid stratum was a mixed low open forest (3-8 m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus*. Under this was a lower mid stratum (2-5 m) of the same structure with *Helicia australasica*, *Acacia holosericea* and *Pandanus spiralis*. The ground stratum is a tussock grassland with *Eriachne triseta* and *Chrysopogon latifolia* with ferns present along the creek bank.

NVIS description

U1 ^*Syzygium armstrongii*, *Xanthostemon eucalyptoides* \^tree\7\i; U2 ^*Melaleuca viridiflora*, *Lophostemon lactifluus* \^tree\6\i; M1+ ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus* \^tree\6\c; M2 ^*Helicia australasica*, *Acacia holosericea*, *Pandanus spiralis* \^tree\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\i; G2 ^ *Lindsaea ensifolia* \^fern\1\r. Other species noted: *Cyclophyllum schultzii* f. *schultzii*.

Vegetation structure

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-10	5	4-6	5	<3	5-10
Melaleuca viridiflora	8-10	15	-	-	-	-
Syzygium armstrongii	10-12	15	6-8	15	<3	5-10
Xanthostemon eucalyptoides	12-14	10	4-8	15	<3	5-10
Acacia holosericea	-	-	3-5	3	<3	5-10
Carallia brachiata	-	-	6-8	5	<3	5-10
Cyclophyllum schultzii	-	-	5-6	<1	<3	5-10
Helicia australasica	-	-	3-6	10	<3	5-10
Leptospermum madidum	-	-	4-6	10	<3	5-10
Pandanus spiralis	-	-	3-5	2	<3	5-10
Erythrophleum chlorostachys	-	-	-	-	<3	5-10
Melicope elleryana	-	-	-	-	<3	5-10
Myrsine benthamiana	-	-	-	-	<3	5-10
Total	**10-14**	**45**	**3-8**	**60-65**	**0-3**	**5-10**
**highlighted cells indicate overall % cover for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present.

Photo monitoring point

North

East

South

West

Figure 3-9. Photographs of the habitat at RVS5 using cardinal-directions for riparian monitoring

Figure 3-10. Drone imagery of RVS5

3.1.6 Reference site

Site description

The upper stratum was a mid open forest (14-18 m) of *Melaleuca argentea* and *Syzygium armstrongii*, over a low-mid woodland (8-12 m) with *Xanthostemon eucalyptoides*, *Lophostemon lactifluus* and *Melicope elleryana*. The mid stratum comprised of a low open forest (3-8 m) with *Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides* and *Cyclophyllum schultzii* f. *schultzii*. The ground stratum comprised of a tussock grassland dominated by *Eulalia mackinlayi* which was dominant on the embankment, with sedges and herbs growing closer to the waters' edge.

NVIS description

U+ ^*Melaleuca argentea*, *Syzygium armstrongii*, *Xanthostemon eucalyptoides* \^tree\7\c; U2 ^*Lophostemon lactifluus*, *Melicope elleryana* \^tree\6\i; M ^*Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides*, *Cyclophyllum schultzii* f. *schultzii* \^tree, shrub\6\i; G1 ^*Eulalia* sp. \^tussock grass \2\i; G2 ^Sedge sp., Herb sp. \sedge, forb\1\i.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	**Cover %**	**Height**	**Cover %**	**Height**	**Cover %**
Lophostemon lactifluus	8-10	5	-	-	-	-
Melaleuca argentea	16-18	15	-	-	-	-
Syzygium armstrongii	14-16	15	-	-	<3	10-15
Xanthostemon eucalyptoides	10-12	5	3-8	5	<3	10-15
Carallia brachiata	-	-	4-6	5	<3	10-15
Cyclophyllum schultzii	-	-	3-6	1	<3	10-15
Melicope elleryana	-	-	8-10	5	<3	10-15
Myrsine benthamiana	-	-	3-6	5	<3	10-15
Pandanus aquaticus	-	-	3-6	10	-	-
Barringtonia acutangula	-	-	-	-	<3	10-15
Carpentaria acuminata	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Pandanus spiralis	-	-	-	-	<3	10-15
Total	**8-16**	**40**	**3-10**	**30-35**	**0-3**	**10-15**
**highlighted cells indicate overall % cover for combined species*						

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Water was trickling, and mostly clear with no apparent sedimentation present.

Photo monitoring point

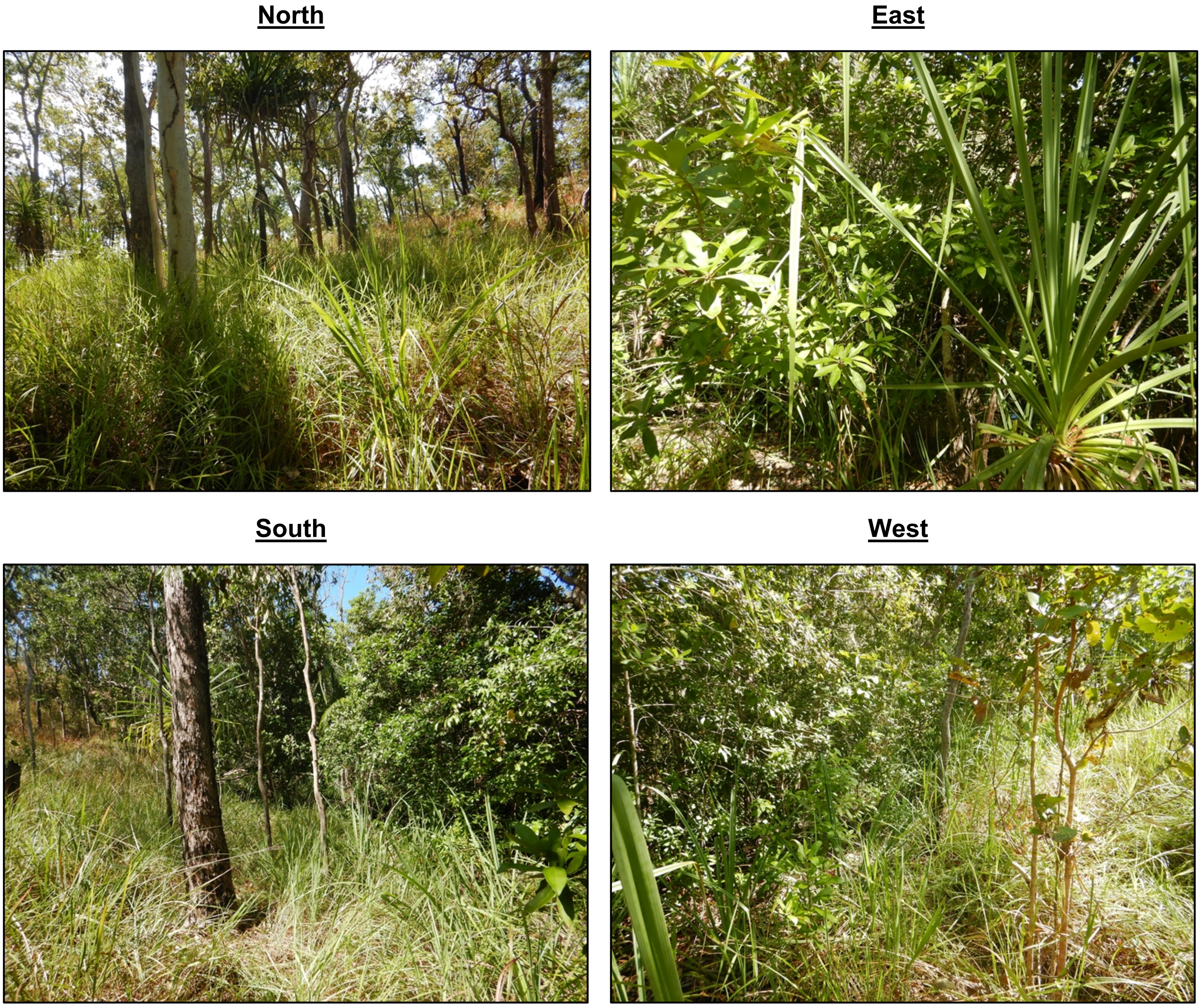
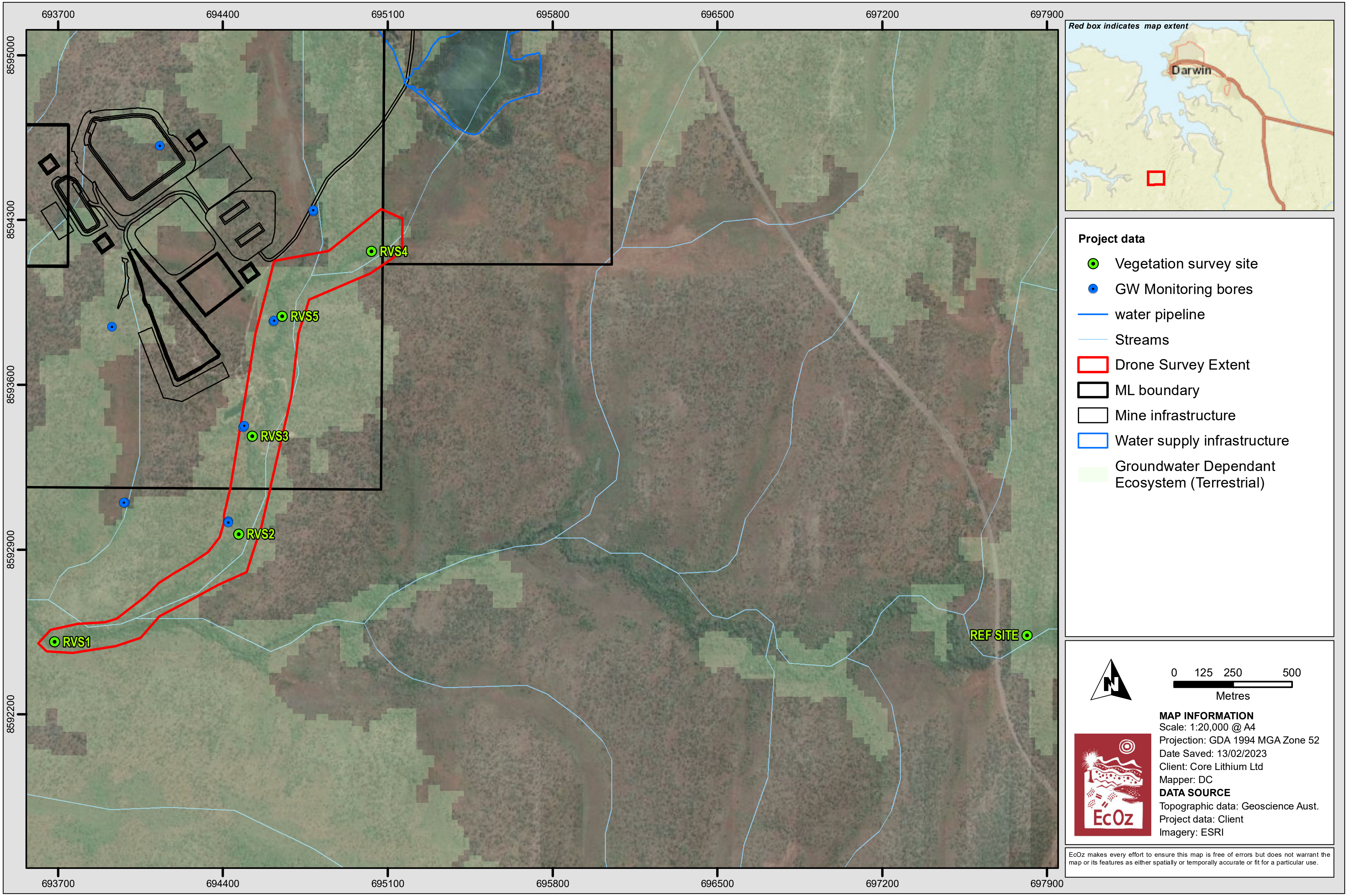


Figure 3-11. Photographs of the habitat at the reference site using cardinal-directions for riparian monitoring



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22099 - OHD SWEL riparian vegetation monitoring\2. Project Files\Report Maps\Riparian vegetation sites monitored.mxd

Figure 3-12. Riparian vegetation sites monitored in the post wet-season survey (May 2022)

3.2 Drone survey

3.2.1 Riparian vegetation boundary

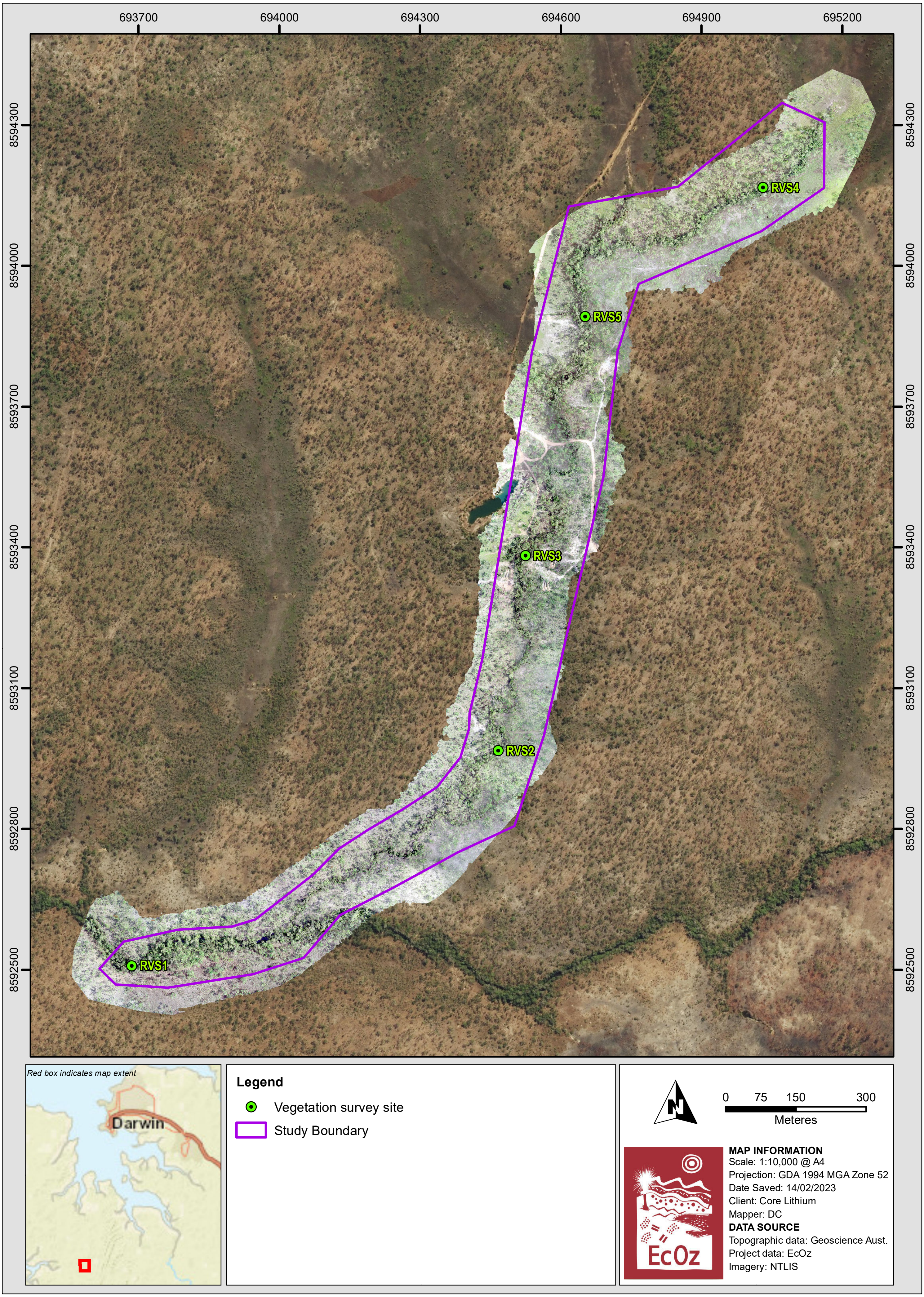
The riparian study site is approximately 2.5 km long and 150 m wide, with an area of 5 ha (Figure 3-13). The boundary of the GDE riparian vegetation community type was delineated within the study site (Figure 3-13).

3.2.2 VARI analysis

A geo-tiff displaying VARI pixel values was exported from WebODM using the built-in "Plant Health" function. The exported VARI raster was reclassified using the "Reclassify by Table" tool in QGIS, applying the following value ranges: -0.21 to 0.01 with a value of 5, 0.01 to 0.1 with a value of 4, 0.1 to 0.17 with a value of 3, 0.17 to 0.23 with a value of 2, and 0.23 to 0.6 with a value of 1 (Table 3-1). The raster was clipped to the study area polygon using QGIS's built-in masking tools. The Semi-Automatic Classification Plugin in QGIS was used to run the Classification Report postprocessing tool, determining the count, area, and percentage of each pixel value (ranging from 1 to 5) (Table 3-1). The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval). Based on the analysis, an area of 5.27 ha of the raster data falls within class intervals 1 & 2 (green band colour) indicating healthy vegetation - this equates to 13.7% of the total study area is considered healthy vegetation (Table 3-1). It appears the healthy vegetation lies within the main riparian corridor (see Figure 3-14).

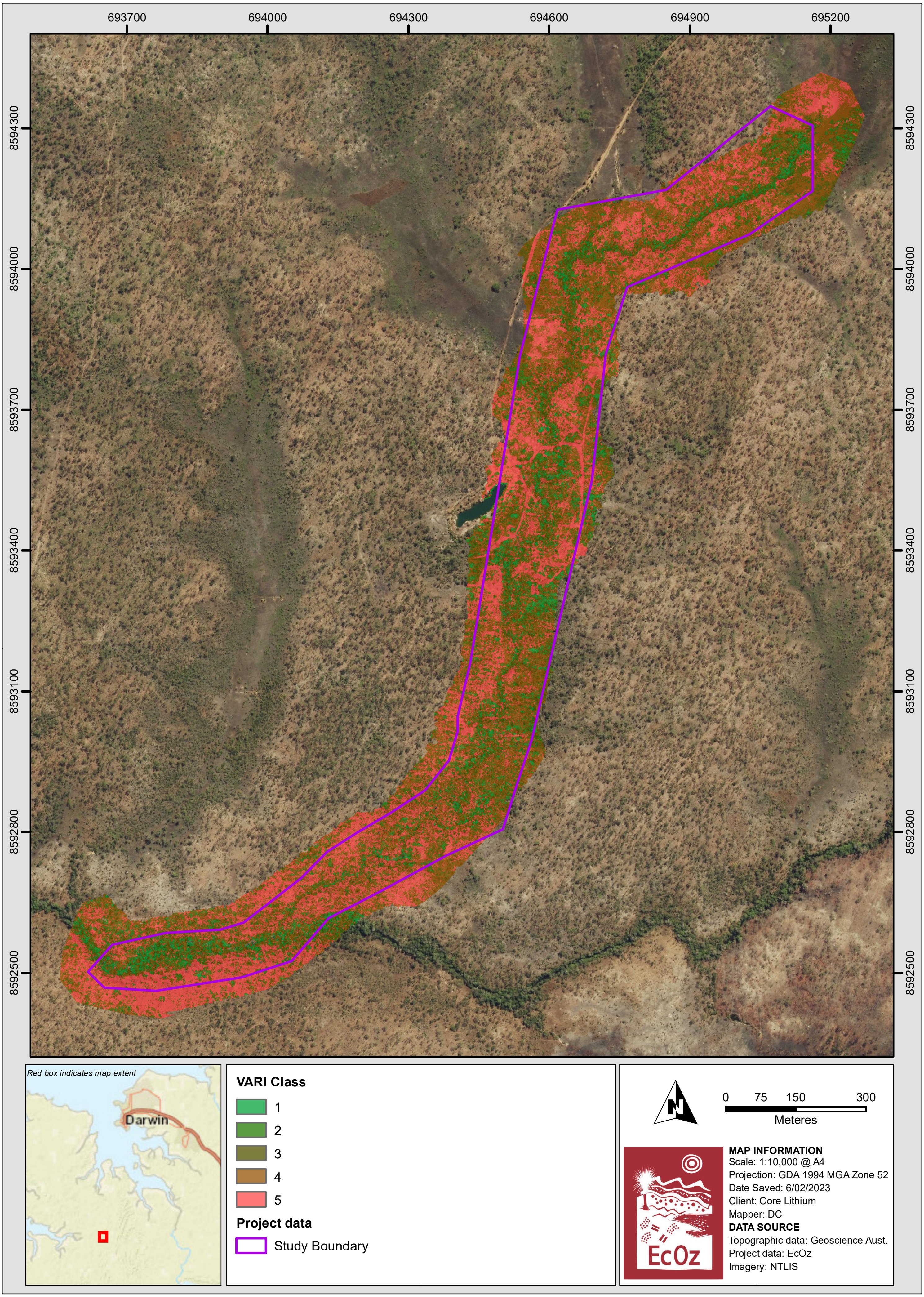
Table 3-1. VARI analysis based on post wet-season

Colour	Class	Class intervals	Percentage %	Area (ha)
	1	0.23 to 0.6	8.90	3.45
	2	0.17 to 0.23	4.70	1.82
	3	0.1 to 0.17	10.03	3.92
	4	0.01 to 0.1	21.83	8.47
	5	-0.21 to 0.01	54.52	21.15



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22099 - OHD SWEL riparian vegetation monitoring\2. Project Files\Report Maps\Post wet season imagery.mxd

Figure 3-13. Riparian vegetation drone imagery (post wet-season survey, May 2022)



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22099 - OHD SWEL riparian vegetation monitoring\2. Project Files\Report Maps\Post wet season VARI.mxd

Figure 3-14. Map of riparian corridor using VARI raster data

4 RESULTS POST-DRY SEASON SURVEY

The post dry-season riparian vegetation assessment (including both drone survey and individual site assessments) was undertaken by Nicole Clark and Anna Lemon (Botanists) on 26-27 October 2022 at Core Lithium, BP33 site to assess the condition of the riparian vegetation. All sites were monitored as per the post wet-season survey. Generally, the conditions of the vegetation was drier and limited standing water was observed. Where small bodies of water was present, no flow was detected. Site specific photo monitoring points and imagery obtained from the are also provided for future monitoring purposes.

4.1 Vegetation site assessment

4.1.1 RVS1

Site description

The upper stratum comprised of *Xanthostemon eucalyptoides*, *Melaleuca argentea* mid open forest (12-14 m) with a sub-stratum of emerging *Syzygium armstrongii* (10-12 m). The mid stratum contained a mixed low open forest with *Leptospermum madidum* subsp. *sativum*, *Xanthostemon eucalyptoides, Pandanus spiralis* and *Barringtonia acutangula* subsp. *acutangula* and *Carallia brachiata*. *Acacia holosericea*, *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii* were sparsely represented within the mid stratum with <5% cover each. Ground cover was mostly comprised of sedges including which accounted for ~40% cover. Low grass cover with *Eriachne triseta* and sparse *Pseudopogonatherum contortum* was restricted to the edges of the creek bank.

NVIS description

U1+ ^*Xanthostemon eucalyptoides*, *Melaleuca argentea* \^tree\7\c; U2 ^*Syzygium armstrongii* \^tree\7\r; M ^*Leptospermum madidum* subsp. *sativum*, *Xanthostemon eucalyptoides. Pandanus aquaticus*, *Barringtonia acutangula* subsp. *acutangula*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\c; G1 ^*Eriachne triseta* \^tussock grass \2\i; G2 ^ Herb sp., *Fimbristylis* sp., *Lindsaea ensifolia*, sedge, forb, fern\1\c.

Vegetation height and cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Melaleuca argentea	12-14	15	-	-	-	-
Xanthostemon eucalyptoides	12-14	15-20	5-8	10-15	-	-
Syzygium armstrongii	10-12	5 - 10	-	-	<3m	10-15
Leptospermum madidum	-	-	4-8	15-20	<3m	10-15
Barringtonia acutangula	-	-	3-5	5-10	<3m	10-15
Pandanus spiralis	-	-	3-6	5-10	<3m	10-15
Fagraea racemosa	-	-	-	-	<3m	10-15
Helicia australasica	-	-	-	-	<3m	10-15
Myrsine benthamiana	-	-	4	<1	<3m	10-15
Carallia brachiata	-	-	3-5	2-5	<3m	10-15
Acacia holosericea	-	-	3-4	1-5	-	-
Cyclophyllum schultzii	-	-	3-4	1	<3m	10-15
Total	**10-14**	**5-20**	**3-8**	**35-40**	**0-3**	**10-15**
**highlighted cells indicate overall % cover for combined species*						

General observations

Standing water present within the creek at the time of surveying, though water was stagnant. Fire scars were observed north of the site in adjacent woodland. Biofilm was present on the water's surface.

Photo monitoring point

North

East

South

West

Figure 4-1. Photographs of the habitat at RVS1 using cardinal-directions for riparian monitoring

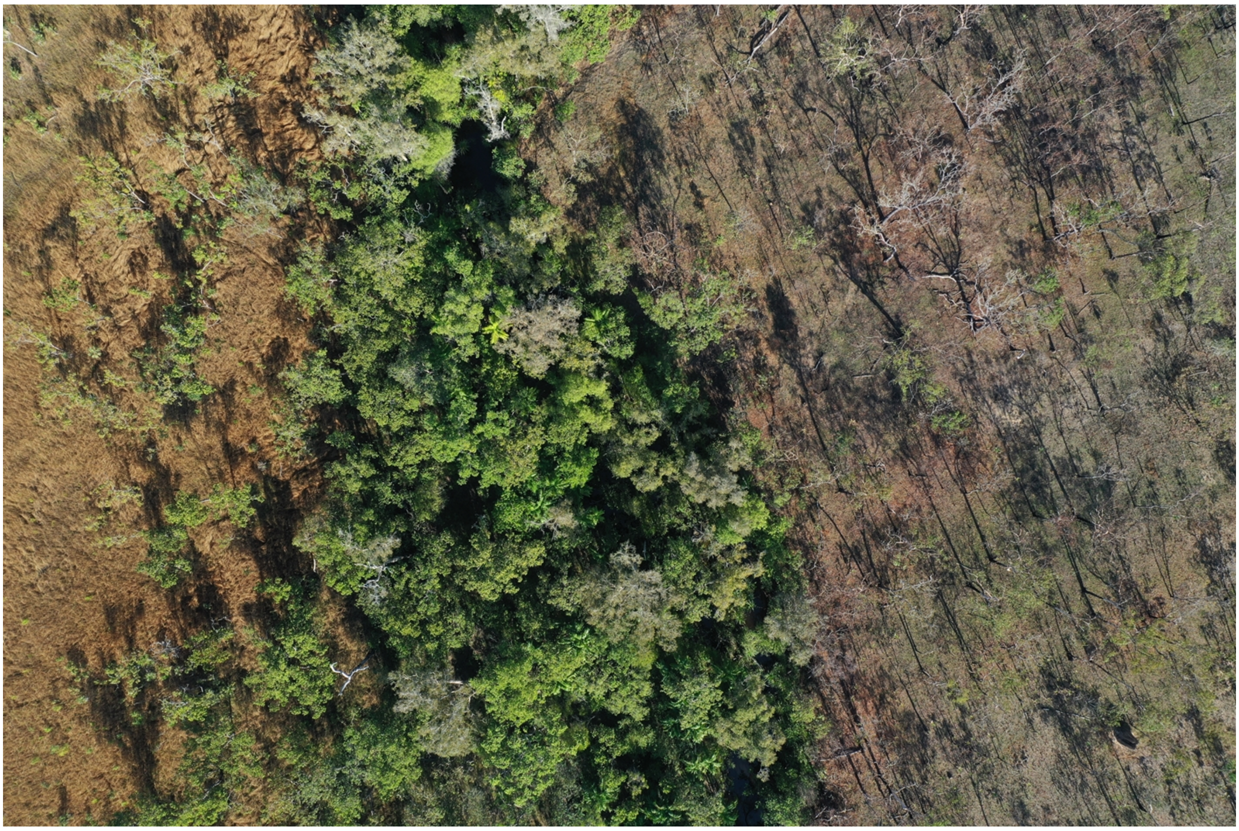


Figure 4-2. Drone imagery of RVS1

4.1.1 RVS2

Site description

The upper stratum is a mid open forest (10-12 m) dominated by *Melaleuca viridiflora*, with co-dominants *Syzygium armstrongii* and *Lophostemon lactifluus*. The mid stratum consists of a low open forest (4-8 m) with *Xanthostemon eucalyptoides* and co-dominants *Leptospermum madidum* subsp. *sativum* and *Acacia holosericea*. A dozen species were recruiting into the mid stratum and collectively comprised ~30-40% cover. Ground cover comprised of an open tussock grassland with *Eriachne triseta* and *Germania grandiflora*. Ferns, herbs and sedges were generally confined to the creek bank.

NVIS description

U+ ^*Melaleuca viridiflora*, *Syzygium armstrongii*, *Lophostemon lactifluus*, *Eucalyptus miniata*, *Melicope elleryana* \^tree\7\i; M ^*Xanthostemon eucalyptoides*, *Leptospermum madidum* subsp. *sativum*, *Acacia holosericea*, *Pandanus spiralis*, *Helicia australasica* \^tree, shrub\6\c; G1 ^*Eriachne triseta*, *Germania grandiflora* \^tussock grass \2\i; G2 ^ *Lindsaea ensifolia* \^fern\1\i. Other species noted: *Carpentaria acuminata*.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Eucalyptus miniata	10-12	3-5	-	-	-	-
Lophostemon lactifluus	10	5	-	-	-	-
Melaleuca viridiflora	10-12	5	-	-	-	-
Melicope elleryana	-	-	-	-	-	-

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Syzygium armstrongii	10	5-10	3-6	1-2	<3	30-40
Acacia holosericea	-	-	3-5	3-5	<3	30-40
Carpentaria acuminata	-	-	6	1	<3	30-40
Helicia australasica	-	-	3-5	<3	<3	30-40
Leptospermum madidum	-	-	4-8	10-15	<3	30-40
Pandanus spiralis	-	-	3-6	1-3	<3	30-40
Xanthostemon eucalyptoides	-	-	4-8	10-15	<3	30-40
Exocarpos latifolius	-	-	3-4	<1	<3	30-40
Cyclophyllum schultzii	-	-	3-4	<1	<3	30-40
Alphitonia excelsa	-	-	-	-	<3	30-40
Breynia cernua	-	-	-	-	<3	30-40
Erythrophleum chlorostachys	-	-	-	-	<3	30-40
Total	**10-12**	**20-25**	**3-8**	**35-40**	**0-3**	**35**

General observations

There was no standing water present within the creek at the time of surveying. There was a moderate amount of leaf litter documented on the creek bed floor. There was evidence of a fire scar adjacent to the riparian corridor (in the Eucalypt woodland).

Photo monitoring point

North

East

South **West**


Figure 4-3. Photographs of the habitat at RVS2 using cardinal-directions for riparian monitoring

Figure 4-4. Drone imagery of RVS2

4.1.2 RVS3

Site description

The upper stratum consisted of a mid woodland (12-15 m) dominated by *Xanthostemon eucalyptoides* and *Lophostemon lactifluus*, with a mix of less dominant species *Melaleuca viridiflora*, *Erythrophleum chlorostachys* and *Syzygium armstrongii*. Two mid stratums were present within the system, with the taller stratum comprising of a mixed low woodland (5-10 m) with *Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura* and *Carallia brachiata*. The lower mid stratum contained a mix of shrubs and small trees with *Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* (1-5 m). The ground stratum was mostly a tussock grassland outside of the creek line with *Eriachne triseta* and *Germania grandiflora*, and ferns were typically growing along the creek bank.

NVIS description

U+ ^*Xanthostemon eucalyptoides*, *Lophostemon lactifluus*, *Melaleuca viridiflora*, *Erythrophleum chlorostachys*, *Syzygium armstrongii* \^tree\7\i; M1 ^*Xanthostemon eucalyptoides*, *Acacia auriculiformis*, *Leptospermum madidum* subsp. *sativum*, *Denhamia obscura*, *Carallia brachiata* \^tree\6\c; M2 ^*Acacia holosericea*, *Pandanus aquaticus*, *Pandanus spiralis*, *Erythrophleum chlorostachys*, *Cyclophyllum schultzii* f. *schultzii* \^shrub, tree\6\i; G1 ^*Eriachne triseta*, *Germania grandiflora* \^Sorghum intrans \2\c; G2 ^ *Lindsaea ensifolia* \ ^fern\1\i.

Vegetation height and cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Erythrophleum chlorostachys	12-14	5-10	3-5	<1	<3	10-15
Melaleuca viridiflora	12-15	5-10	4-6	<1	<3	10-15
Syzygium armstrongii	12-15	5	-	-	<3	10-15
Xanthostemon eucalyptoides	10-14	5	3-10	10-15	<3	10-15
Leptospermum madidum	10-12	<5	5-8	5-10	-	-
Acacia auriculiformis	-	-	8-10	1-5	-	-
Acacia holosericea	-	-	3-5	5	<3	10-15
Alphitonia excelsa	-	-	4-5	<1	<3	10-15
Carallia brachiata	-	-	3-4	<1	<3	10-15
Cyclophyllum schultzii	-	-	3-4	1	<3	10-15
Denhamia obscura	-	-	6-8	1-3	-	-
Livistona humilis	-	-	3-4	1	<3	10-15
Pandanus aquaticus	-	-	1-4	2-5	-	-
Pandanus spiralis	-	-	1-4	1	<3	10-15
Breynia cernua	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Total	**10-15**	**25-30**	**3-10**	**25-30**	**<3**	**10-15**

General observations

There was only one small pool present within the creek at the time of survey. Some pig damage was observed. There was also one large *Syzygium armstrongii* present next to the water's edge (>60cm DBH).

Photo monitoring point

North

East

South

West

Figure 4-5. Photographs of the habitat at RVS3 using cardinal-directions for riparian monitoring

Figure 4-6. Drone imagery of RVS3

4.1.3 RVS4

Site description

The upper stratum consisted of a mid open forest (8-16 m) with *Syzygium armstrongii* and *Xanthostemon eucalyptoides*, with emerging *Corymbia polycarpa* (10-12 m). The mid stratum was fairly complex with two distinct height ranges. The taller of the mid stratums comprised of low open forest (5-10 m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Melaleuca viridiflora, Syzygium angophoroides*, *Gmelina schlechteri* and *Pandanus spiralis*. The lower mid stratum (3-5 m) contained a mix of small trees comprising of *Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii* and *Carallia brachiata*. *Acacia holosericea* was also present and formed a small component of the lower mid stratum. The ground stratum was a tussock grassland containing *Eriachne triseta*, *Chrysopogon latifolia* and *Germania grandiflora*. Smaller ferns and sedges were typically confined to the creek bank, and *Dianella odorata* and *Flagellaria indica* were also present within the creek.

NVIS description

U+ ^*Syzygium armstrongii*, *Xanthostemon eucalyptoides*, *Corymbia polycarpa, Syzygium angophoroides* \^tree\7\c; M1 ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Melaleuca viridiflora*, *Gmelina schlechteri*, *Pandanus spiralis* \^tree\6\c; M2 ^*Myrsine benthamiana*, *Cyclophyllum schultzii* f. *schultzii*, *Carallia brachiata*, *Acacia holosericea* \^tree, shrub\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\c; G2 ^ *Lindsaea ensifolia*, Sedge sp. \ ^fern, sedge\1\i. Other species noted: *Flagellaria indica*, *Dianella odorata*.

Vegetation heights and cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Corymbia polycarpa	10-12	5	-	-	-	-
Syzygium armstrongii	14-16	20	6-8	10	<3	10-15
Xanthostemon eucalyptoides	12-14	15	4-8	25	-	-
Syzygium angophoroides	8-10	5				
Acacia holosericea	-	-	4-5	15	-	-
Carallia brachiata	-	-	3-5	15	-	-
Cyclophyllum schultzii	-	-	3-5	15	<3	10-15
Flagellaria indica	-	-	8-10	15	-	-
Gmelina schlechteri	-	-	5-8	15	-	-
Melaleuca viridiflora	-	-	8-10	15	-	-
Myrsine benthamiana	-	-	3-6	15	<3	10-15
Pandanus spiralis	-	-	4-6	15	<3	10-15
Syzygium angophoroides	-	-	6-8	15	<3	10-15
Ilex arnhemensis	-	-	6-8	15	-	-
Helicia australasica	-	-	-	-	<3	10-15
Melicope elleryana	-	-	-	-	<3	10-15
Total	**8-16**	**45**	**3-10**	**50**	**<3**	**10-15**

General observations

No standing water present within creek. The last fire was observed <1 year ago.

Photo monitoring point

North

East

South **West**

Figure 4-7. Photographs of the habitat at RVS4 using cardinal-directions for riparian monitoring

Figure 4-8. Drone imagery of RVS4

Comparison between previous work

Based on the post dry-season riparian vegetation assessment undertaken (EcOz 2019), it is noted the dominant species composition was similar compared to the 2022 post-dry season survey, though no other comparisons can be made relative to vegetation structure. The vegetation data obtained previously was recorded at NVIS level 5, compared to the 2022 post-dry season survey, which was undertaken at NVIS level 6.

4.1.4 RVS5

Site description

The upper stratum is comprised of a mid open forest (12-14m tall) with *Xanthostemon eucalyptoides*, over low woodland (8-12 m) of *Syzygium armstrongii, Melaleuca viridiflora* and *Lophostemon lactifluus*. The mid stratum was a mixed low open forest (3-8m) with *Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus*. Under this was a lower mid stratum (2-5 m) of the same structure with *Helicia australasica*, *Acacia holosericea* and *Pandanus spiralis*. The ground stratum is a tussock grassland with *Eriachne triseta*, *Heteropogon triticeus*, and *Chrysopogon latifolia*. Ferns were still present, but not as prominent.

NVIS description

U1 ^ *Xanthostemon eucalyptoides* \^tree\7\i; U2 ^*Melaleuca viridiflora*, *Syzygium armstrongii, Lophostemon lactifluus* \^tree\6\i; M1+ ^*Xanthostemon eucalyptoides*, *Syzygium armstrongii*, *Carallia brachiata*, *Leptospermum madidum* subsp. *sativum*, *Lophostemon lactifluus* \^tree\6\c; M2 ^*Helicia australasica*, *Acacia holosericea*, *Pandanus spiralis* \^tree\6\i; G1 ^*Eriachne triseta*, *Chrysopogon latifolia* \^tussock grass\2\i; G2 ^ *Lindsaea ensifolia* \^fern\1\r. Other species noted: *Cyclophyllum schultzii* f. *schultzii*.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-10	5-10	6-7	<5	<3	5-10
Melaleuca viridiflora	10-12	10-15	6	<1	-	-
Syzygium armstrongii	10-12	10-15	6-8	5	<3	5-10
Xanthostemon eucalyptoides	12-14	15	4-8	15	<3	5-10
Acacia holosericea	-	-	3-5	1-3	<3	5-10
Carallia brachiata	-	-	6-8	5	<3	5-10
Cyclophyllum schultzii	-	-	3-6	1-2	<3	5-10
Helicia australasica	-	-	3-6	10-15	<3	5-10
Leptospermum madidum	-	-	4-6	5-10	<3	5-10
Pandanus spiralis	-	-	4-5	1-2	<3	5-10
Myrsine benthamiana	-	-	3-4	<1	<3	5-10
Erythrophleum chlorostachys	-	-	-	-	<3	5-10
Melicope elleryana	-	-	-	-	<3	5-10
Total	**8-14**	**45-50**	**3-8**	**50-55**	**0-3**	**5-10**

General observations

No standing water present within creek. The last fire was observed <1 year ago.

Photo monitoring point

North

East

South

West

Figure 4-9. Photographs of the habitat at RVS5 using cardinal-directions for riparian monitoring

Figure 4-10. Drone imagery of RVS5

Comparison between previous work

Based on the post dry-season riparian vegetation assessment undertaken (EcOz 2019), it is noted the dominant species composition was similar compared to the 2022 post-dry season survey, though no other comparisons can be made relative to vegetation structure. The vegetation data obtained previously was recorded at NVIS level 5, compared to the 2022 post-dry season survey, which was undertaken at NVIS level 6.

4.1.5 Reference site

Site description

The upper stratum was a mid open forest (14-18 m) of *Melaleuca argentea* and *Syzygium armstrongii*, over a low-mid woodland (8-12 m) with *Xanthostemon eucalyptoides*, *Lophostemon lactifluus* and *Melicope elleryana*. The mid stratum comprised of a low open forest (3-8 m) with *Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides* and *Cyclophyllum schultzii* f. *schultzii*. The ground stratum comprised of a tussock grassland dominated by *Eulalia mackinlayi* which was dominant on the embankment, with sedges and herbs growing closer to the waters' edge.

NVIS description

U+ ^*Melaleuca argentea*, *Syzygium armstrongii*, *Xanthostemon eucalyptoides* \^tree\7\c; U2 ^*Lophostemon lactifluus*, *Melicope elleryana* \^tree\6\i; M ^*Pandanus aquaticus*, *Myrsine benthamiana*, *Carallia brachiata*, *Xanthostemon eucalyptoides*, *Cyclophyllum schultzii* f. *schultzii* \^tree, shrub\6\i; G1 ^*Eulalia* sp. \^tussock grass \2\i; G2 ^Sedge sp., Herb sp. \sedge, forb\1\i.

Vegetation cover

Species	Upper		Middle		Recruit	
	Height	Cover %	Height	Cover %	Height	Cover %
Lophostemon lactifluus	8-10	5	-	-	-	-
Melaleuca argentea	16-18	15	-	-	-	-
Syzygium armstrongii	14-16	15	-	-	<3	10-15
Xanthostemon eucalyptoides	10-12	5-10	3-8	5-10	<3	10-15
Carallia brachiata	-	-	4-6	5	-	-
Cyclophyllum schultzii	-	-	3-6	1	<3	10-15
Melicope elleryana	-	-	8-10	5	<3	10-15
Myrsine benthamiana	-	-	3-6	1	<3	10-15
Pandanus aquaticus	-	-	3-6	5-10	-	-
Fagraea racemosa	-	-	6	<5	-	-
Corymbia polycarpa	-	-	4	<1	-	-
Barringtonia acutangula	-	-	-	-	<3	10-15
Carpentaria acuminata	-	-	-	-	<3	10-15
Helicia australasica	-	-	-	-	<3	10-15
Pandanus spiralis	-	-	-	-	<3	10-15
Total	**8-18**	**4-45**	**3-10**	**25-30**	**<3**	**10-15**

General observations

Two aquatic plants – *Eriocaulon* sp. and *Nymphaea* sp. – were both observed within the creek and biofilms were observed on the waters' surface along the edges of the system. Standing water was stagnant, with no apparent sedimentation present.

Photo monitoring point

<u>North</u>

<u>East</u>

<u>South</u>

<u>West</u>

Figure 4-11. Photographs of the habitat at the reference site using cardinal-directions for riparian monitoring

4.2 Drone survey

4.2.1 Riparian vegetation boundary

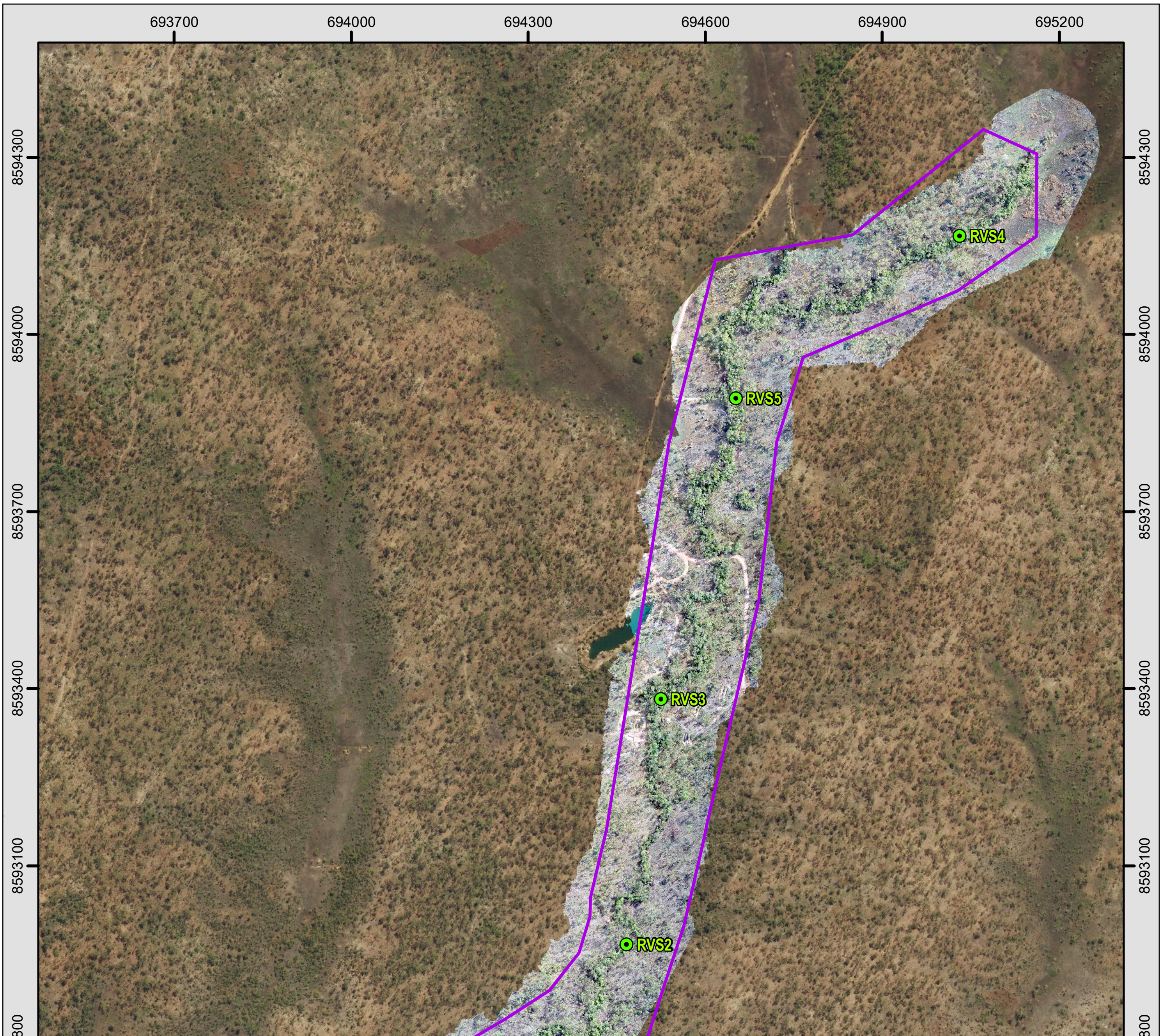
The riparian study site is approximately 2.5 km long and 150 m wide, with an area of 5 ha (Figure 4-12). The boundary of the GDE riparian vegetation community type was delineated within the study site (Figure 4-12). The vegetation site assessments all lie within the GDE riparian corridor. Zoomed in images are provided for each site are also provided for future monitoring.

4.2.2 VARI analysis

Based on the VARI analysis, an area of 5.6 ha of the raster data falls within class intervals 1 & 2 (green band colour) indicating healthy vegetation - this equates to 13.81 % of the total study area is considered healthy vegetation (Table 4-1). It appears the healthy vegetation lies within the main riparian corridor (see Figure 4-13).

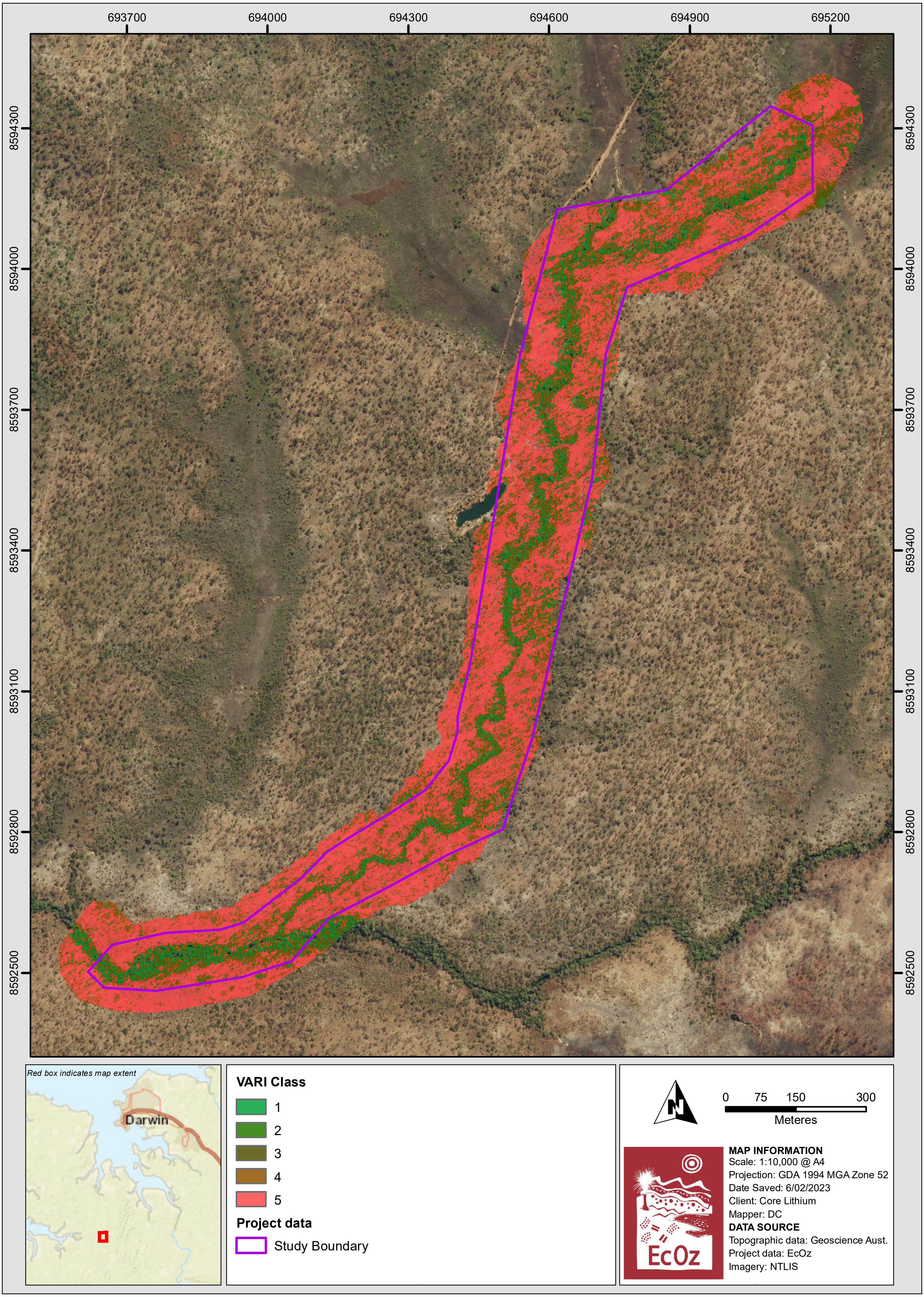
Table 4-1. VARI analysis results

Colour	Class	Class intervals	Percentage %	Area (ha)
	1	0.23 to 0.6	5.98	2.42
	2	0.17 to 0.23	7.86	3.18
	3	0.1 to 0.17	18.85	7.63
	4	0.01 to 0.1	35.87	14.51
	5	-0.21 to 0.01	31.41	12.71



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22099 - OHD SWEL riparian vegetation monitoring\2. Project Files\Report Maps\Pre wet season imagery.mxd

Figure 4-12. Riparian vegetation drone imagery (post dry-season survey, October 2022)



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22099 - OHD SWEL riparian vegetation monitoring\2. Project Files\Report Maps\Pre wet season VARI.mxd

Figure 4-13. Map of riparian corridor using VARI raster data

5 DATA ANALYSIS RESULTS

This section presents statistical analysis outlined in the RVMP (Appendix A) and presents analysis for both the post wet-season and post dry-season baseline surveys.

5.1 Species composition

5.1.1 Post wet-season

Syzygium armstrongii was represented in the upper stratum across all of the monitoring sites, including the reference site. *Xanthostemon eucalyptoides* was observed as the next abundant species, followed by *Lophostemon lactifluus* occurring at five and four sites, respectively.

Acacia holosericea, Carallia brachiate, Cyclophyllum schultzii f. schultzii and *Xanthostemon eucalyptoides* were all represented in the mid stratum across all of the monitoring sites, including the reference site. *Leptospermum madidum subsp. Sativum* and *Pandanus spiralis* were observed as the next abundant mid strata species, both occurring at four monitoring sites, respectively.

Many of the species occurring within the upper and mid strata are showing signs of recruitment. *Cyclophyllum schultzii f. schultzii* was represented in the understorey across all of the monitoring sites, and the reference site. *Helicia australasica, Pandanus spiralis* and *Syzygium armstrongii* were observed as the next abundant species, occurring at five monitoring sites, including the reference site.

See Appendix B for full data set.

5.1.2 Post dry-season

Syzygium armstrongii was represented in the upper stratum across all of the monitoring sites, including the reference site. *Xanthostemon eucalyptoides* was observed as the next abundant species, followed by *Melaleuca viridiflora.*

Cyclophyllum schultzii f. schultzii and *Xanthostemon eucalyptoides* were all represented in the mid stratum across all of the monitoring sites, including the reference site. *Pandanus spiralis* and *Acacia holosericea* were observed as the next abundant mid strata species, all occurring at five monitoring sites, excluding the reference site, *Carallia brachiate* was also recorded at five monitoring sites, including the reference site.

Many of the species occurring within the upper and mid strata are showing signs of recruitment, *Syzygium armstrongii, Helicia australasica, Cyclophyllum schultzii f. schultzii* and *Pandanus* spiralis were represented in the understorey across all of the monitoring sites, and the reference site. *Acacia holosericea, Myrsine benthamiana* and *Xanthostemon eucalyptoides* were observed as the next abundant species.

See Appendix C for full data set.

5.2 Overall plant height

Table 5-1 represents overall plant height for each site within varying stratums for both post wet-season survey and post dry season survey. In relation to the post wet-season survey, the upper strata ranged from 8-16 m tall (Table 5-1). Site RVS4 and the reference site contained the tallest trees ~16m. The mid strata is relatively consistent across the sites, ranging from 3-10 m tall. All recruits were <3 m tall.

The data represented similar height data in the post dry-season survey compared to the post wet-season survey (Table 5-1).

Table 5-1. Overall plant height for each site within varying stratums for both post wet-season survey and post dry season survey

Site	Upper		Middle		Recruit	
	Post wet-season	Post dry season	Post wet-season	Post dry season	Post wet-season	Post dry season
RVS1	10-14	10-14	3-8	3-8	0-3	0-3
RVS2	10-12	10-12	3-8	3-8	0-3	0-3
RVS3	12-14	10-15	3-10	3-10	0-3	0-3
RVS4	12-16	8-16	2-8	3-10	0-3	0-3
RVS5	10-14	8-14	3-8	3-8	0-3	0-3
Reference site	8-16	8-18	3-10	3-8	0-3	0-3

5.3 Canopy cover and recruit cover

Table 5-2 represents overall % cover of each stratum for both post wet-season survey and post dry season survey. In relation to the post wet-season survey, the % cover in the upper strata ranged between 25-40%, and the mid stratum ranged between 35-60%. The % cover of recruits ranged between 10-40%. Overall, the data represented similar structure in the post dry-season survey compared to the post wet-season survey, although the % covers were slightly higher in the post wet-season survey (Table 5-2).

Table 5-2. Canopy cover % and % cover of recruits for each site within varying stratums for both post wet-season survey and post dry season survey

Site	Upper		Middle		Recruit	
	Post wet-season	Post dry season	Post wet-season	Post dry season	Post wet-season	Post dry season
RVS1	35	5-20	35-40	35-40	15	10-15
RVS2	25-30	20-25	35-40	35-40	40	35
RVS3	25-30	25-30	45-50	25-30	10-15	10-15
RVS4	40	45	50-55	50	10-15	10-15
RVS5	45	45-50	60-65	50-55	5-10	5-10
Reference	40	40-45	30-35	25-30	10-15	10-15

5.4 Plant health

All plants were alive across monitoring plots in the post wet-season survey (Appendix B). This was consistent in the post dry-season survey, except for one unidentified tree stump, recorded at RVS3 in the mid stratum and an individual *Melaleuca viridiflora* recorded at RVS5 in the mid stratum (Appendix C).

Based on the post wet-season survey, of the total number of plants in the upper and mid stratum, 6% were flowering– these plants were *Carpentaria acuminata, Melaleuca argentea, Myrsine benthamiana, Carallia brachiata* and *Cyclophyllum schultzii f. schultzii.* Of the total number of plants in the upper and mid stratum, 13% were fruiting at the time of survey – plants included *Acacia auriculiformis, Acacia holosericea, Carallia* *brachiate, Melaleuca viridiflora, Melaleuca argentea, Pandanus spiralis, Cyclophyllum schultzii f. schultzii*, *Myrsine benthamiana* (Appendix A). In relation to the post dry-season survey, of the total number of plants in the upper and mid stratum, 25% were in flower at the time of survey – these plants were *Fagraea racemose, Cyclophyllum schultzii f. schultzii, Syzygium armstrongii, Helicia australasica, Syzygium angophoroides, Melaleuca viridiflora, Carallia brachiate, Acacia holosericea, Erythrophleum chlorostachys* and *Barringtonia acutangula subsp. Acutangular.* Of the total number of plants the upper and mid stratum, 17% were fruiting at the time of survey - these plants were *Myrsine benthamiana, Acacia holosericea, Carallia brachiate, Gmelina shirleyi, Syzygium armstrongii, Xanthostemon eucalyptoides, Acacia holosericea, Cyclophyllum schultzii f. schultzii, Carpentaria acuminata, Melaleuca viridiflora* and *Barringtonia acutangula subsp. Acutangular.*

5.5 Groundwater sensitive species

5.5.1 Upper and mid strata

The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site are presented in Table 5-3. It is noted this data was analysed by combing the upper and mid strata data.

Overall, the reference site recorded the highest portion of sensitive species. Of the total mid stratum and upper stratum species recorded, *Melicope elleryana* and *Cyclophyllum schultzii* each comprised 10% of the total mid stratum and upper stratum species recorded in the post wet-season survey. This was also consistent in the post dry-season survey, except a slightly lower portion (8.3%). RVS2 was the only site that documented all three groundwater sensitive species in the post wet-season survey. Only *Helicia australasica* was present in the post dry-season survey.

Table 5-3. Portion (%) of sensitive species recorded at monitoring sites

Site	*Melicope elleryana*		*Cyclophyllum schultzii*		*Helicia australasica*	
	Post wet-season	Post dry-season	Post wet-season	Post dry-season	Post wet-season	Post dry-season
RVS1	-	-	10	9.1	-	-
RVS2	8.3	-	-	7.7	8.3	7.6
RVS3	-	-	5.5	5.3	-	-
RVS4	-	-	7.1	6.7	-	-
RVS5	-	-	7.6	6.7	7.6	6.6
Reference	10	8.3	10	8.3	-	-

5.5.2 Recruits

The portion (%) of groundwater sensitive species observed in the recruit data across all riparian vegetation sites and the references site are presented in Table 5-4. The data indicates groundwater sensitive species are re-sprouting and there are similar potions of recruits present as there are in the canopy riparian vegetation.

Table 5-4. Portion (%) of sensitive species recorded at monitoring sites

Site	*Melicope elleryana*		*Cyclophyllum schultzii*		*Helicia australasica*	
	Post wet-season	Post dry-season	Post wet-season	Post dry-season	Post wet-season	Post dry-season
RVS1	-	-	20	11.1	-	11.1
RVS2	-	-	8.3	9.1	8.3	9.1
RVS3	-	-	8.3	8.3	8.3	8.3
RVS4	14.3	12.5	14.3	12.5	14.3	12.5
RVS4	8.3	8.3	8.3	8.3	8.3	8.3
Reference	10	11.1	10	11.1	10	11.1

5.6 Ground covers

5.6.1 Post wet-season

Figure 5-1 represents the overall ground cover across monitoring plots based on the post wet-season survey. Vegetation was the dominant ground cover across monitoring plots, followed by litter, soil and other (water) and rocks. Of the total vegetation percent cover, grass was the dominant ground cover material recorded (Figure 5-2). Appendix D provides a full summary of ground cover results.

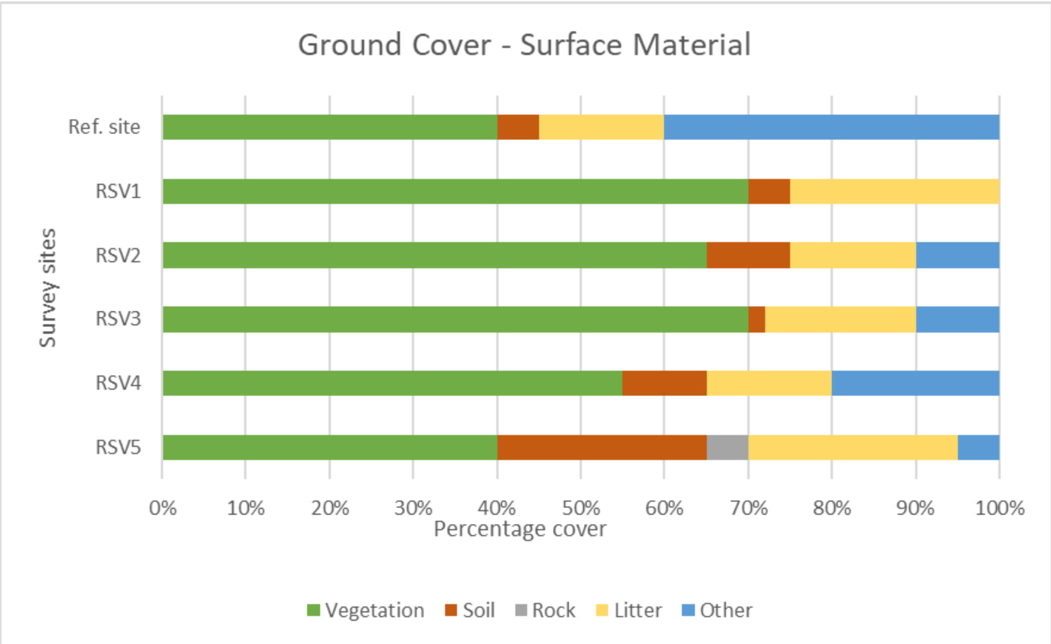


Figure 5-1. Graph showing percentage cover of ground cover by material type for each site

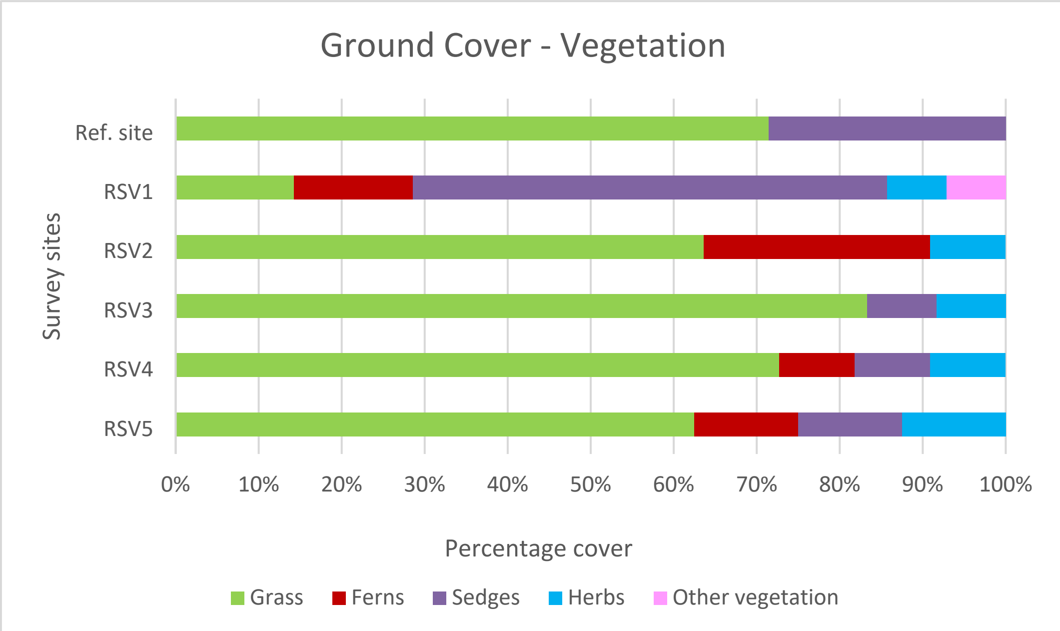


Figure 5-2. Graph showing percentage cover of ground cover by vegetation for each site

5.6.2 Post dry-season

Table 5-3 represents the overall ground cover across monitoring plots based on the post dry-season survey. Vegetation was the dominant ground cover across monitoring plots, followed by litter, soil and other (water), and rocks. Of the total vegetation percent cover, grass was the dominant ground cover material recorded (Table 5-4). Appendix E provides a full summary of ground cover results.

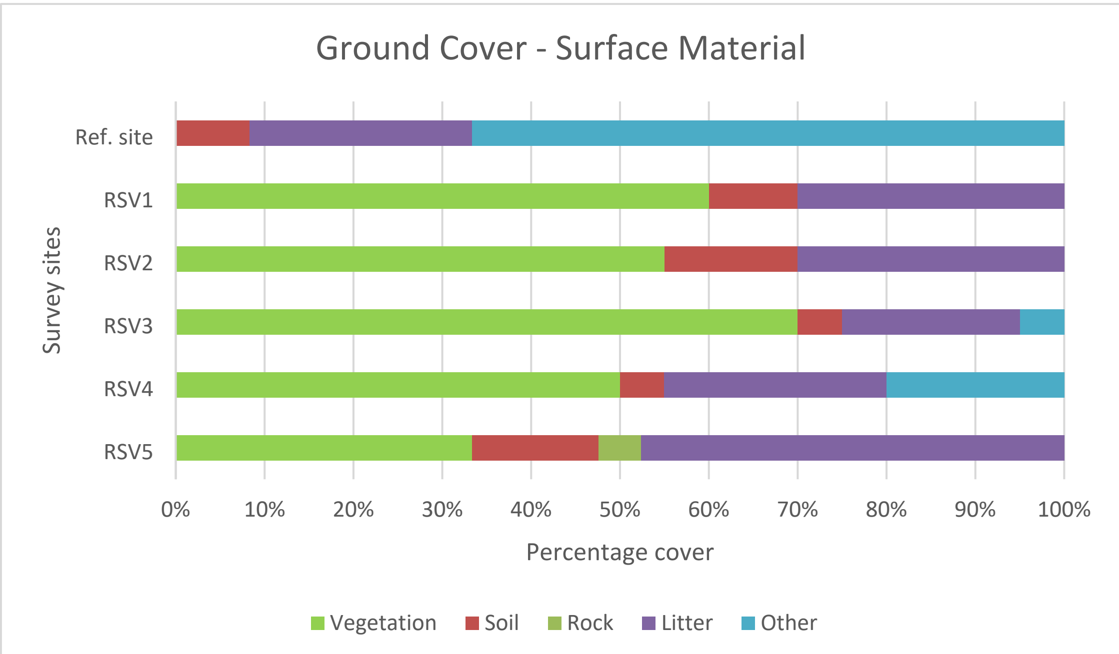


Figure 5-3. Graph showing percentage cover of ground cover by material type for each site

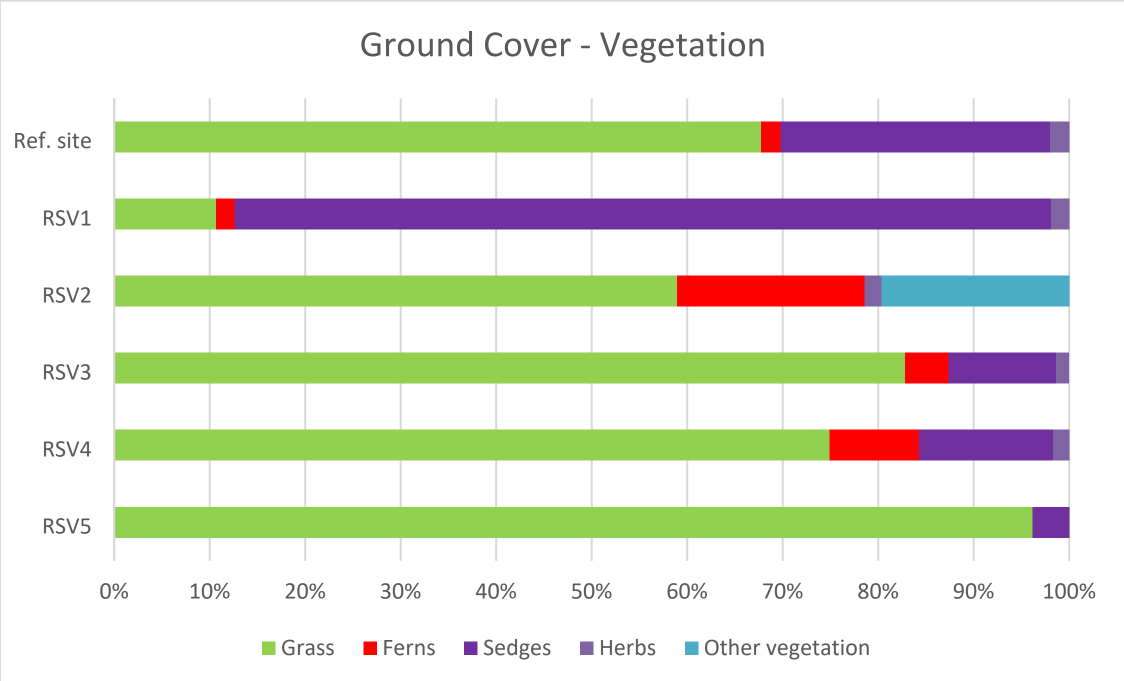


Figure 5-4. Graph showing percentage cover of ground cover by vegetation for each site

5.7 General observations

5.7.1 Post wet-season

Overall the riparian vegetation appeared in good health while undertaking the post wet-season survey (Appendix FAppendix E). The adjacent bushland had been severely burnt a few days prior to surveying, though this did not impact riparian vegetation health, except for a few patches of *Acacia Holosericea* that fell within site RVS1. No weeds were recorded within the monitoring plots. There were a few patches of Mission Grass observed adjacent to site RVS3. The creek intersecting the monitoring sties was flowing at the time of surveying with many aquatic plants, including native lilies and sedges, and aquatic animals i.e. small freshwater fish species and water insects were present in the waterway. No contamination was observed, except a slight red tinge was recorded at site RVS4 and red algal was recorded at site RVS5. A natural biofilm/sheen recorded at a few of the sites.

5.7.2 Post dry-season

The riparian appeared in good health while undertaking the post dry-season survey (Appendix F). There was some rainfall earlier in the month of October recorded around Cox Peninsula area, though conditions were dry for a week prior to surveying. The creek was mostly dry, with standing water only observed at some sites (RVS1, RVS3, RVS4 and the reference site). Many of the ferns, sedges and aquatic plants had decreased in cover and there was greater leaf litter on the surface. Appendix F provides a full description of general observation for all monitoring sites.

6 RECOMMENDATIONS

The following recommendations should be considered during and after water extraction, to assess whether any significant changes to the riparian community have occurred:

- As per the RVMP (EcOz 2022), the next monitoring event is scheduled in October 2023 (late dry season). It is recommended to continue riparian vegetation monitoring as per methods outlined in this baseline monitoring report to maintain consistent data collection for comparison.
- Conduct statistical analysis as outlined in the RVMP to compare data collected based on the on the vegetation site assessments that will be obtained in the following monitoring event and baseline surveys. For vegetation assessment sites Before After/Control Impact (BACI) will be applied to test whether there is a significant difference between the baseline health data and riparian vegetation assessment data at the same sites, and riparian vegetation assessment data compared to reference site data. Data captured for comparison will include:
  - Species composition (%) using individual dominant/emergent plant data.
  - Average heights of individual plants across riparian vegetation sites compared to reference site.
  - Canopy cover (%) for each dominant, and emergent species across riparian vegetation
  - Assessment sites compared to reference site data.
  - Plants alive or dead (%) across all riparian vegetation sites compared to reference site data.
  - The portion (%) of groundwater sensitive species, *Melicope elleryana, Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site.
  - The ground cover percentages (vegetation type, soil, rock, litter).
  - Type of ground cover percentages in the form of herbs/vines/grasses/ferns and sedges).
- Additionally, conduct Before After/Control Impact (BACI) statistical analysis (VARI) to test whether there is a significant difference between the baseline health data and the riparian vegetation health based on ongoing drone survey assessments. This will assess whether any significant changes to the riparian community have occurred.
- Adhere to the trigger action response plan (TARP) detailed in the RVMP (EcOz 2022). The TARP incorporates triggers and responses from the surface water monitoring program (WRM 2022) and GDE Management Plan and provided quantitative triggers and limits and/or adaptive management actions. There are a number of monitoring performance indicators that are relative to both vegetation site assessment survey and the drone survey.

7 REFERENCES

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EcOz (2022). Riparian Vegetation Monitoring Plan (RVMP), Finniss Lithium Project. Prepared for Core Lithium by Ecoz Environmental Consultants Pty Ltd, May 2022.

APPENDIX A RIPARIAN VEGETATION MONITORING PLAN

Riparian Vegetation Monitoring Plan

Finniss Lithium Project

Core Lithium

DOCUMENT CONTROL RECORD

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Author(s)	Nicole Clark

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Recipients are responsible for eliminating all superseded documents in their possession.

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Figures

1 INTRODUCTION

This plan documents the riparian vegetation monitoring program (RVMP) that will be implemented to monitor impacts associated with water extraction from Observation Hill Dam (OHD) under Surface Water Extraction Licence (SWEL) 8151018 and operation of the Finniss Lithium Project, BP33 underground mine located on the Cox Peninsula (Figure 1). Riparian vegetation health downstream of the mines could be affected by changes to:

- surface water flows associated with extraction of water from the OHD
- groundwater levels due to dewatering of BP33 underground mine.

Riparian vegetation monitoring is required as a condition of the following approvals and licences:

- Environmental Approval 2020/001-001 for BP33 underground lithium mine
- SWEL 8151018.

The RVMP will be implemented in conjunction with the surface water, groundwater, sediment and biota monitoring programs detailed in the Grants Water Management Plan and BP33 Water Management Plan.

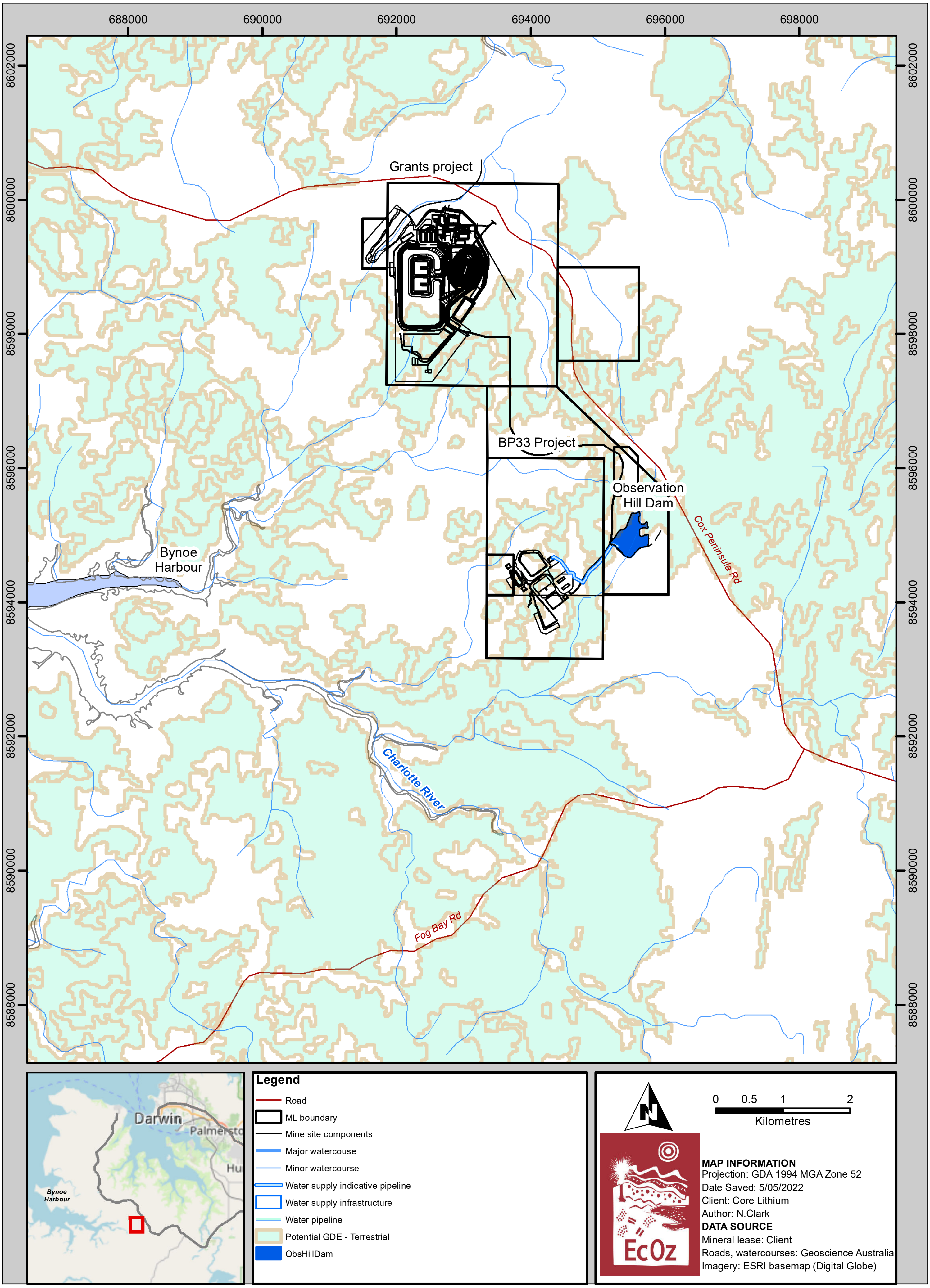
Riparian communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

The plan has been developed by EcOz botanist, Nicole Clark, whom is a suitable qualified professional. The plan includes:

- monitoring parameters, methods and frequency for monitoring downstream attributable to water under the SWEL on riparian vegetation
- a review process to ensure continuous improvement of the monitoring program.

To develop this RVMP, the following steps were undertaken:

- a desktop review of the existing baseline information available
- research of best practise methodologies in riparian monitoring including the monitoring of plant health
- addressing gaps in existing information to design a robust monitoring method.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 1. Map of the project location.mxd

Figure 1. Map of Finniss Lithium Project location

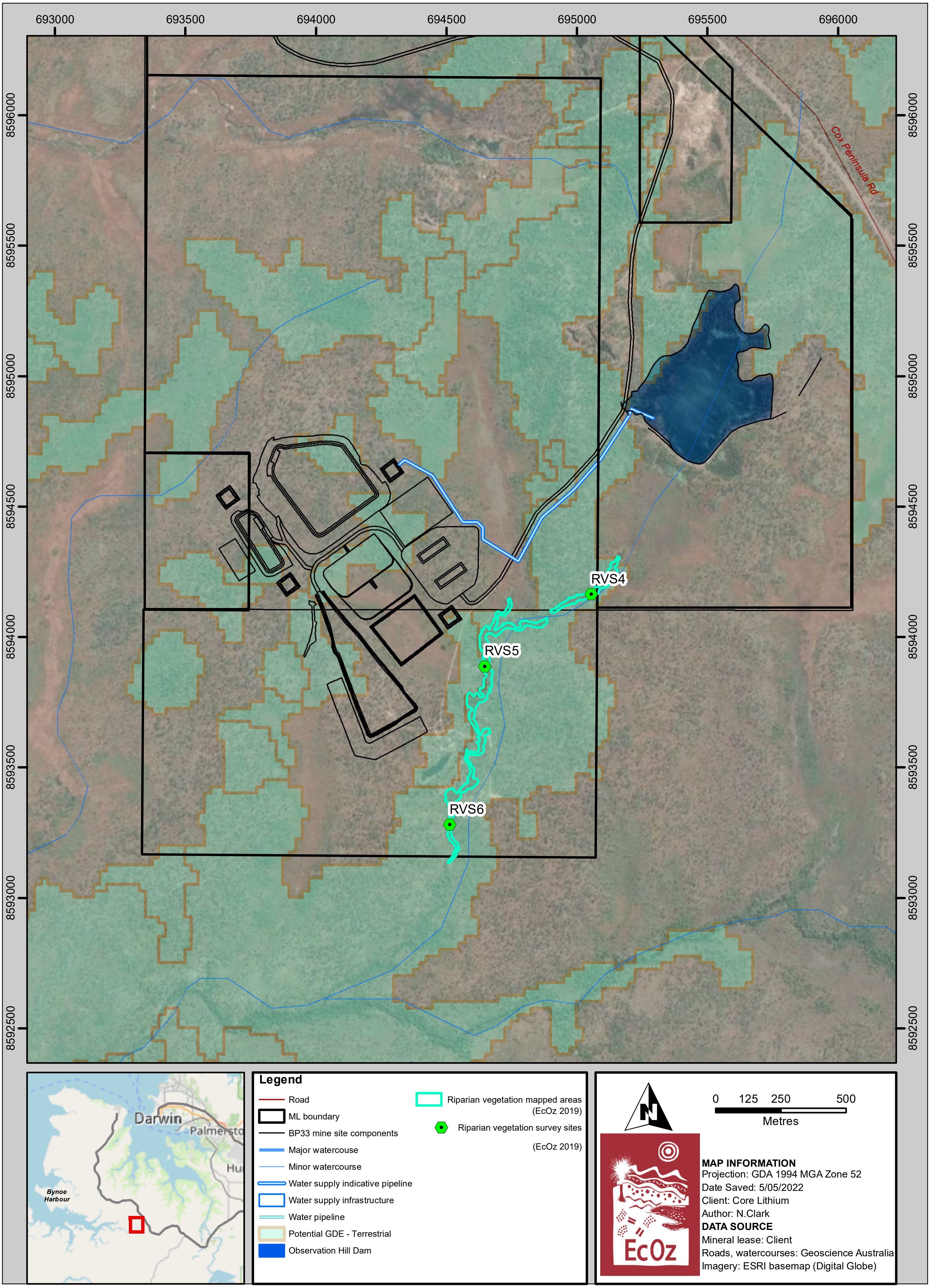
1.1 Summary of baseline surveys

Previous surveys and assessments undertaken for the Grants Environmental Impact Statement (EIS) identified presence of an ephemeral drainage line downstream of OHD which supports closed riparian vegetation identified as a potential Groundwater Dependent Ecosystem (GDEs) (see Figure 2) based on desktop modelling. These riparian vegetation communities downstream of the OHD water supply could be susceptible to impacts associated with changes to surface water flows. The Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019) baseline study (Appendix A) was undertaken to further assess the vegetation prior to mining activities commencing.

The intent of the baseline survey was to produce a vegetation map and record vegetation characteristics and condition of the sensitive vegetation communities downstream of OHD, which is now near the proposed BP33 underground mine.

Two types of baseline surveys were undertaken; an aerial drone survey to look at the overall riparian vegetation health and assist in mapping the riparian vegetation extent, and on-ground field survey to assess vegetation structure and composition within the mapped riparian vegetation extent. See Appendix A for the Mangrove and Riparian Vegetation Assessment Grants Lithium Project (EcOz 2019).

Additional baseline surveys will be undertaken during 2022 to support implementation of this plan. Further details of additional baseline studies are provided in Section 1.1.1.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 2. Map of baseline studies for BP33 project area.mxd

Figure 2. Map of baseline riparian monitoring area and vegetation monitoring sites (EcOz 2019)

1.1.1 Gaps in baseline

Based on the existing information available, a few gaps were identified in the baseline surveys and are proposed to be addressed as outlined below.

- The drone survey was only undertaken post wet-season. It is recommended to undertake additional drone flight for BP33 project area in the dry season to account for seasonality differences.
- The orthomosaic images obtained from drone mapping only used false colour imagery (i.e. green indicating to examine vegetation health). Further remote sensing analysis is required to quantify vegetation health and compare data between 2019 and 2022.
- No upstream of Charlotte's River riparian vegetation site assessments undertaken outside of the modelled groundwater drawdown (CloudGMS 2021) for BP33 project area. A site will be established outside of the modelled 1m contour groundwater drawdown zone of influence (ZOI) to be used as a baseline reference site and assessed prior to significant water extraction from OHD and BP33 mining operations.
- No vegetation site assessment data was collected post-wet season. To account for seasonality differences, it is recommended to undertake biannual vegetation site assessment monitoring post-wet season for the 2022 baseline surveys. This data can be used for future reference if additional monitoring is required in accordance with the trigger action response plan (TARP) (see section 4).
- Though some data was obtained while undertaking vegetation site-based assessments post wet-season 2019, there was a lack of quantitative data collected - ground cover percentage, presence of recruitment, number of alive vs dead plants, erosion scoring etc. These attributes will assist in monitoring the condition of riparian vegetation and data comparison.
- Further investigation is required to determine the extent of the riparian vegetation within the identified ZOI of the BP33 predicted groundwater drawdown modelling. The ZOI has been defined by the one metre groundwater drawdown contour shown Figure 5. It is assumed that drawdown of less than that would only affect water availability for a short period of time in the mid-late dry season when groundwater levels are naturally lowered. The ZOI encompasses a 4.5 km section of stream order one ephemeral watercourse.
- Additional baseline surveys will be conducted biannually during 2022 to address these gaps. A baseline assessment report will be developed to include outcomes of the 2019 monitoring and the 2022 monitoring and the RVMP revised as required.

2 RIPARIAN VEGETATION MONITORING PLAN

Healthy riparian zones are essential for maintaining healthy ecosystems and economic productivity along rivers (Dixon & Douglas 2015). When maintaining a riparian vegetation system, it is vital to retain a diverse vegetation cover to assist in maintaining the functions that a riparian vegetation community provides i.e. supporting aquatic habitats, shading the river and regulating the temperature, bank stabilisation, filtering of sediments and improving water quality of river by reducing contaminants (Dixon & Douglas 2015).

Riparian vegetation are able to access water multiple ways i.e. through the upper un-saturated zone as a result from recent rain events, the groundwater at depth via the capillary fringe above an unconfined aquifer, and through creek water (generally a combination of groundwater and rain water in the wet season, but may be predominantly groundwater in the dry season) (SKM 2012) (see Figure 3). There are particular species that are more likely to be more sensitive to declines in available ground water such as monsoon forest species that grow in areas where there is perennial water supply.

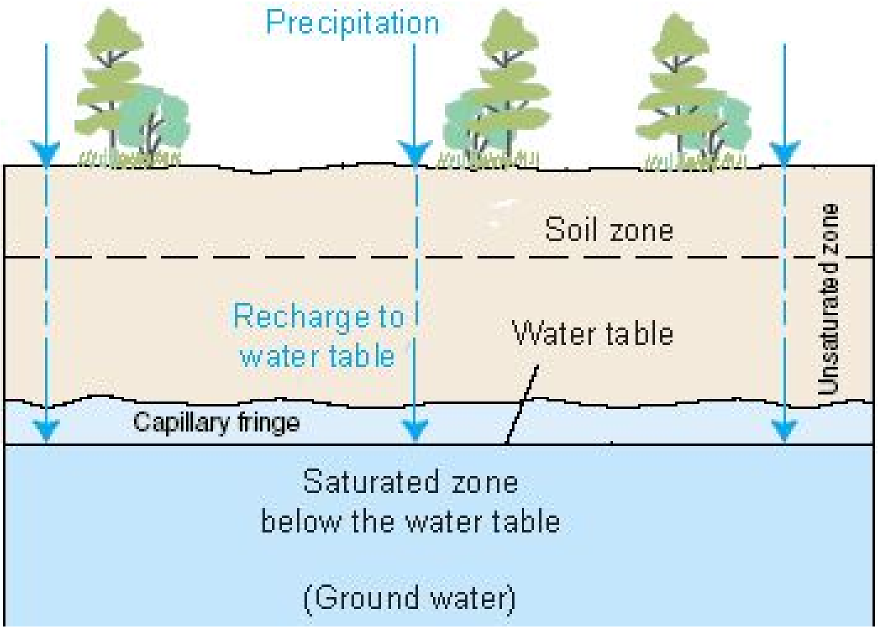


Figure 3. Diagram showing the capillary fringe (SKM 2012)

Riparian vegetation recruitment and germination heavily depends on the level of surface water and ground water regimes as plants depend on predictable patterns in terms of structure and diversity according to water availability in the landscape (Eamus & Lamontagne 2006). Riparian tree recruitment typically occurs after large floods when viable plant material is transported onto point bars and the floodplains of naturally flowing rivers (Eamus, D., & Lamontagne 2006). If dry season flow is modified, or the water table recedes too quickly, new cohorts fail to recruit and the species composition may alter over time (Figure 4). Ultimately the intent of monitoring the riparian vegetation a is to detect changes over time.

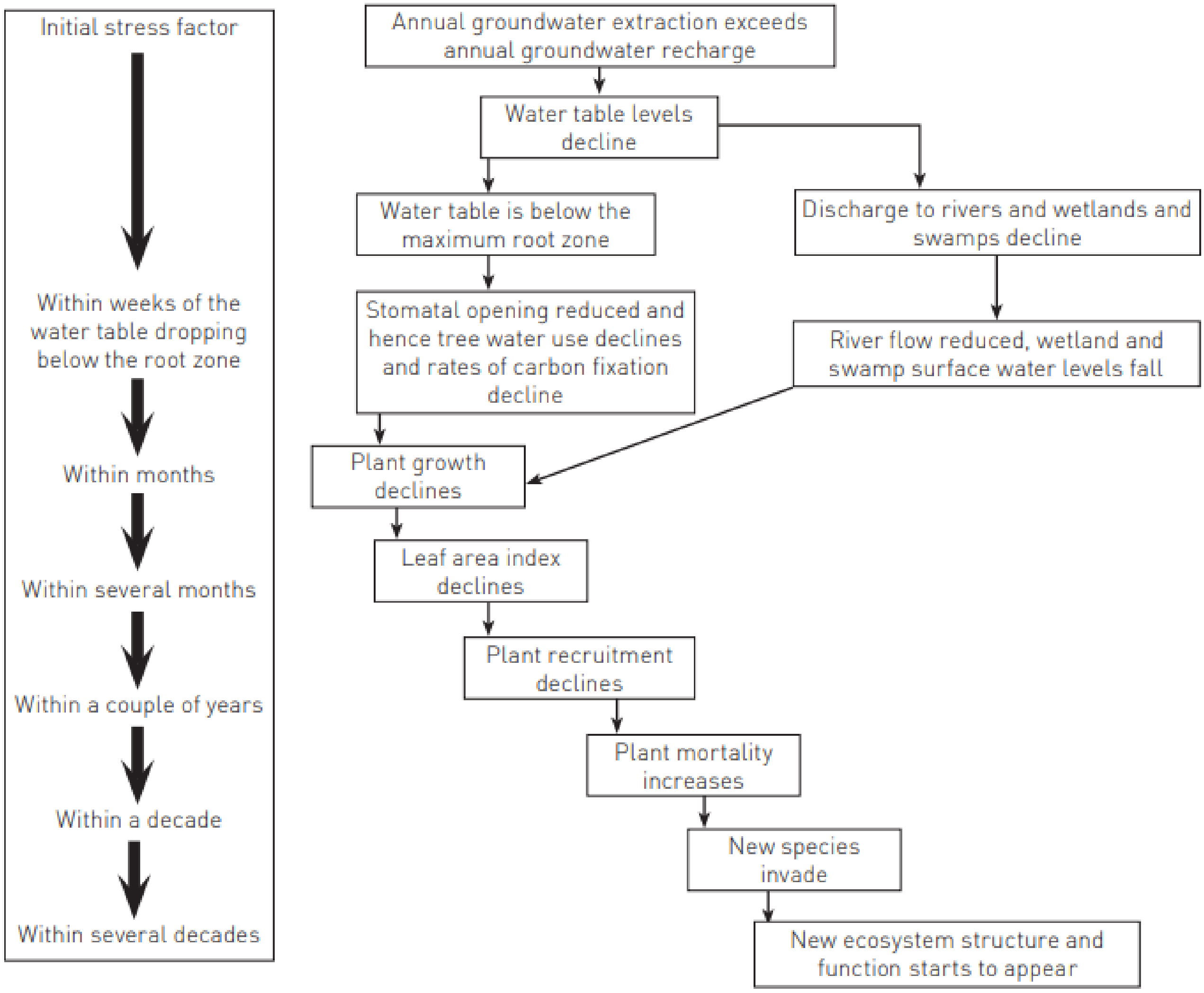


Figure 4. Diagram showing the potential consequences of groundwater drawdown affect (Eamus, D., & Lamontagne 2006)

Some of the information obtained from the baseline studies and the associated gaps identified have been used to develop this RVMP. The monitoring plan outlines objectives and parameters that can be used to assess the riparian vegetation health during the drawdown and reduced surface flows from OHD as part of operations. For each monitoring type, the following headings have been used:

- Objective
- Survey method – these may include ongoing methods previously used in the baseline surveys or additional (new) methods
- Record keeping - maintenance of data for analysis
- Data analysis.

2.1 Best practice and standards

The following best practice and standards for vegetation monitoring been adopted and assisted in developing this RVMP:

- Brocklehurst et al 2007. *Northern Territory Guidelines and field methodology for vegetation survey and mapping*
- Dixon, I., & Douglas, M (2015). *A Field Guide to Assessing Australia's Tropical Riparian Zones*, Tropical Savannas Cooperative Research Centre for Tropical Savannas Management.

- Eamus, D., & Lamontagne (2006). Groundwater use by riparian vegetation in the wet-dry tropics of Northern Australia, Australian Journal of Botany.
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- Han., Y., Jung, S., & Kwon, O (2017). *How to utilize vegetation survey using drone image and image analysis software*, Journal of Ecology and Environment 41:18.
- Ancin-Murguzur, F., & Munoz, L., Monz C., &. Hausne V. (2019). *Drones as a tool to monitor human impacts and vegetation changes in parks and protected areas,* Remote Sensing in Ecology and Conservation.
- Wegmann, M., Leutner, B., & Dech, S. (2017). Remote Sensing and GIS for Ecologists using Open Source Software, *Pelagic publishing*

2.2 Drone survey

2.2.1 Objective

The drone survey method was selected because it is a way to detect any significant retraction in riparian vegetation patch boundaries overtime. The aim of the drone survey is to map and analyse using remote sensing techniques and compare spatial data i.e. density of vegetation (vegetation health) and extent of riparian vegetation cover.

2.2.1 Methodology

- Create new drone flight path based on the BP33 predicted groundwater drawdown modelling to the 1m contour ZOI. The new flight path will be an extension of the existing baseline survey (EcOz 2019) to capture the riparian vegetation extent downstream of OHD to the 1m contour groundwater drawdown ZOI (see Figure 5 for indicative drone survey boundary). The indicative flight path will be field verified during 2022 baseline surveys prior to establishing a set flight path.
- Previously Drone Deploy (Software program) was used to design the flight path, however WebODM will be used for this monitoring. WebODM was selected as it contains the correct platform selected for to measure plant health.
- Drone will be flown in the middle of the day to avoid sun light interference i.e. shading. Observations will also be noted i.e. timing of flight, and the weather to replicate similar conditions for future surveys.
- When importing drone data to create the orthomasoaic, the same methods as per methods in baseline report outlined in section 3 (Appendix A) will be applied, except using WebODM.
- The boundary of the riparian vegetation will then be delineated using the orthomosaic imagery and remote sensing techniques.
- Drone data analysis will be undertaken using Visible Atmospherically Resistant Index (VARI) to assess vegetation health. VARI is a function within the WebODM designed to work in conjunction with red, green blue (RGB) colour band data, rather than near-infrared (NIR) data. VARI measures the reflectance of vegetation versus soil. It compares the proportions of light captured across different bands (red, green, blue) to compute numerical values for each pixel or area of a given drone map.

- These values will be categorised into a series of class intervals ranging from -1 to 1. It is a measure of how green an image is. The green band represents healthy vegetation (the higher the value in the class interval), and the red band represents bare ground (the lower the value in the class interval).
- The resultant area size (ha) within each class interval and the portion of the area that makes each colour band depicting the vegetation health, will then be calculated.
- Investigate other environmental factors that may affect results i.e. amount of rainfall between October – April compared to rainfall amounts based on baseline studies to discern environmental factors.

Frequency

- The drone survey will occur biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring during 2022, then the monitoring will be reduced to annual (in the late dry season only).

2.2.2 Record keeping

- Vegetation monitoring database comprised of:
  - The riparian vegetation area size (ha) based on drone mapping for each drone survey.
  - VARI calculations for each survey conducted including varying colour bands and associated class intervals, the area (ha) that occurs within the class intervals and a percentage (%) of pixels that lie within these class intervals.
  - Additional observations that may need to be recorded if further on-ground investigation is require.
- Spatial data
  - All drone images captured during the drone surveys organised in folders.
  - A zip-file of all tiff files derived from drone surveys (both orthomosaic and plant health image).

2.2.3 Data analysis

Before After/Control Impact (BACI) approach will be applied by performing statistical analysis (VARI) to test whether there is a significant difference between the baseline health data and the riparian vegetation health based on ongoing drone survey assessments.

2.3 Riparian vegetation site assessments

2.3.1 Objective

Monitoring and evaluating riparian vegetation diversity and composition at established vegetation sites within ZOI, and an additional site established outside of the ZOI (reference site) to detect changes in riparian vegetation according to diagram presented in Figure 4 (Eamus, D., & Lamontagne 2006).

2.3.2 Methodology

Site selection

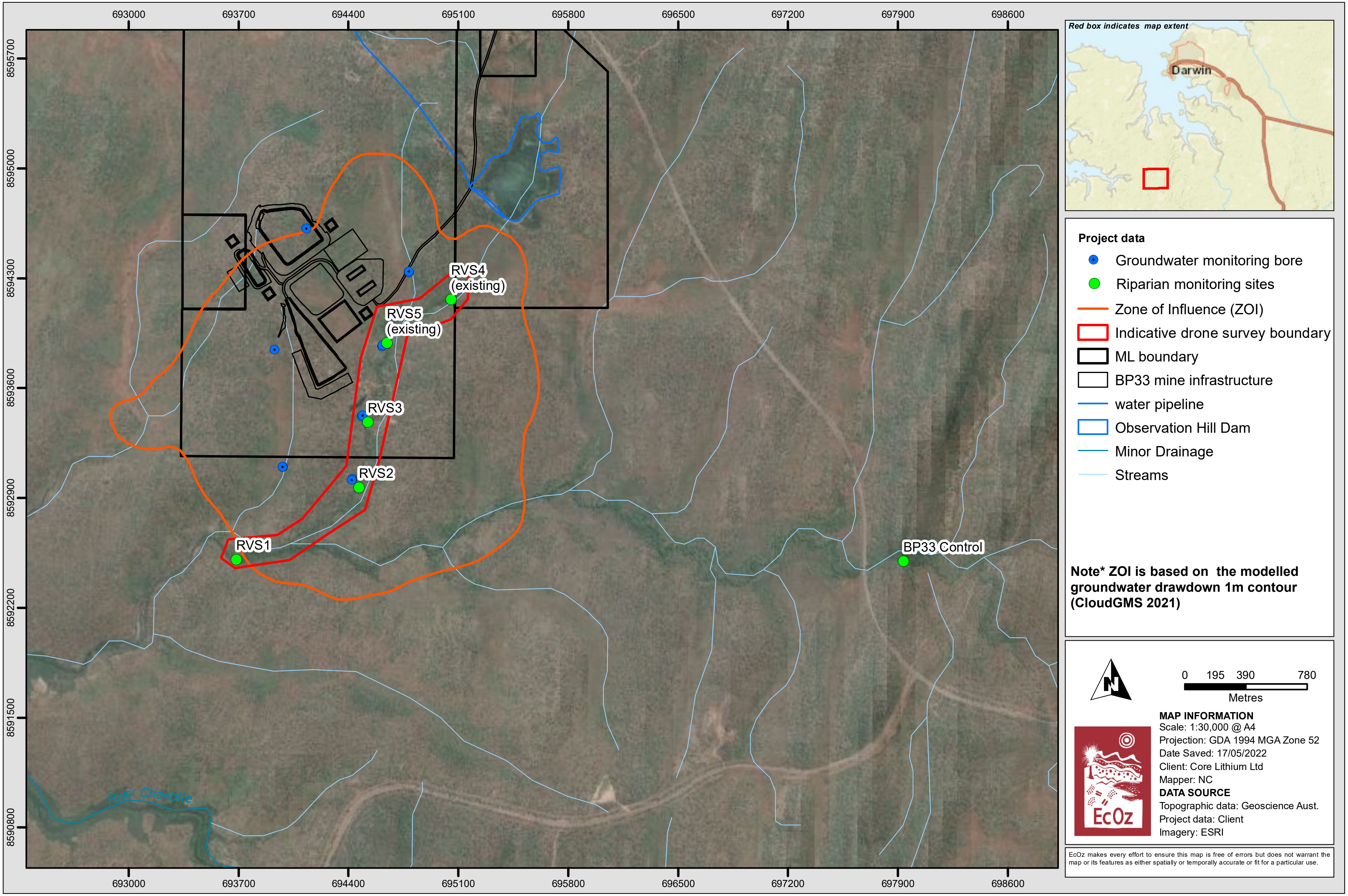
- Two existing sites RVS4 and RVS5 will continue to be monitored using the updated monitoring method within this RVMP. Site RVS4 has been kept in the monitoring plan to detect immediate

impacts from reduced SW flows downstream OHD. Existing site RVS5 has been retained as it is nearby a groundwater monitoring bore.

- Three new monitoring sites (RVS1, RVS2 and RVS3) will be established downstream of OHD within the ZOI (Figure 5). The location of these sites are suitable for monitoring as they lie within the potential GDE areas, align near existing bores for groundwater level monitoring (RVS3 and RVS2) and spatially correspond to immediate groundwater drawdown impacts (RVS3 located closest to the underground) and longer term potential impacts (RVS1 located near the 1m contour) (Figure 5).
- One new reference site upstream of Charlottes Creek (BP33 Control), in a similar riparian zone within the potential GDE area will be established with baseline monitoring commencing post-wet season 2022 (Figure 5). This site is outside of the predicted ZOI. The site was selected using various resources including up to date aerial imagery, mine components, and Land Units of the Greater Darwin Region (Fogarty et al. 1984).
- Sampling site locations for other BP33 project studies, such surface water, groundwater and biota monitoring have also been considered when selecting the new riparian vegetation monitoring sites. The precise locations will be verified in field during the 2022 post wet season survey.

Frequency

- Monitoring is to occur at all sites biannually in both end of wet season and end of dry season to capture variability in season for the initial baseline monitoring, then monitoring will be reduced to annual (in the late dry season only).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ21269 - BP33 - Mining Management Plan\01 Project Files\Riparian Monitoring Plan\Figure 6. Map of all baseline monitoring sitesv2.mxd

Figure 5. Map of proposed riparian vegetation monitoring sites, indicative drone imagery boundary and modelled groundwater drawdown 1m contour

Vegetation monitoring

Vegetation site assessment monitoring methods have been adopted utilising the potential consequences of the groundwater drawdown affect as presented in the diagram outlined Figure 4. As indicated, the effect may take several years before physical changes become apparent. Monitoring methods are outlined below:

- A plot size of 20 x 20m will be established at each new riparian monitoring site, using star pickets. Existing plots RVS4 and RVS5 will be re-monitored at established plots (existing star pickets present).
- In each plot the dominant layer/emergent layer species will be recorded; this includes all seedlings (woody plants under 1m in height), saplings (woody plants between 1m and 3m high and < 2cm diameter at breast height, or DBH) and trees (woody plants with stems ≥ 2cm DBH and greater than 3m high) will be identified (both native plants and invasive plants included). For each individual the height will be estimated and the % cover will be measured. All individual woody plants within the plot will also be marked alive or dead, whether the plant is fruiting/flowering. Note, deciduous trees will not be recorded as dead during the dry-season monitoring.
- In each plot a few selective vegetation (sensitive to groundwater changes often relying on water all year) will be tagged on hand held GPS for future ongoing measurements. Some of these species may include *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* (observed at RVS4, RVS5).
- Within each plot, ground cover percentages (vegetation type, soil, rock, litter) will be recorded. The results from this method will be used to determine percentage groundcover. Vegetation type may be in the form of herbs/vines/grasses/ferns and sedges).
- The derived vegetation description for characterisation will be recorded to a standard that is equivalent to Level 5 in the National Vegetation Information System (NVIS), and in line with the *NT guidelines and field methodology for vegetation survey and mapping* (Brocklehurst et al. 2007).
- The riparian vegetation continuity will be monitored by traversing along a 100m transect from the middle monitoring site and visually estimate the canopy cover (or by using a densitometer) of the native vegetation to indicate how continuous the canopy cover is along the transect. Note, a break in the continuity must be at least 5 m between tree crowns and span the entire width of the transect (Figure 6). If one tree is missing within a wide riparian zone it will not be counted as a break in the canopy continuity because the break must span the entire width of the riparian zone.

Table 2-1 summarises monitoring methods and how they will be used to measure the potential consequences of the reduction in surface flows and/or groundwater drawdown.

Table 2-1. Summary of monitoring methods that will be used to measure potential impacts of the reduction of surface water flows and groundwater drawdown

Monitoring method	Monitoring parameters				
	Plant growth declines	Plant recruitment declines	Plant mortality increases	New species invade	New ecosystem structure and function starts to appear
Dominant layer/emergent layer species will be recorded (native and invasive species) alive/dead	X	X	X	X	
Individual tree tagging	X		X	X	X
Ground cover % and species richness (native and invasive species)	X				
NVIS Level 5 vegetation descriptions					X
Riparian vegetation continuity	X		X		X

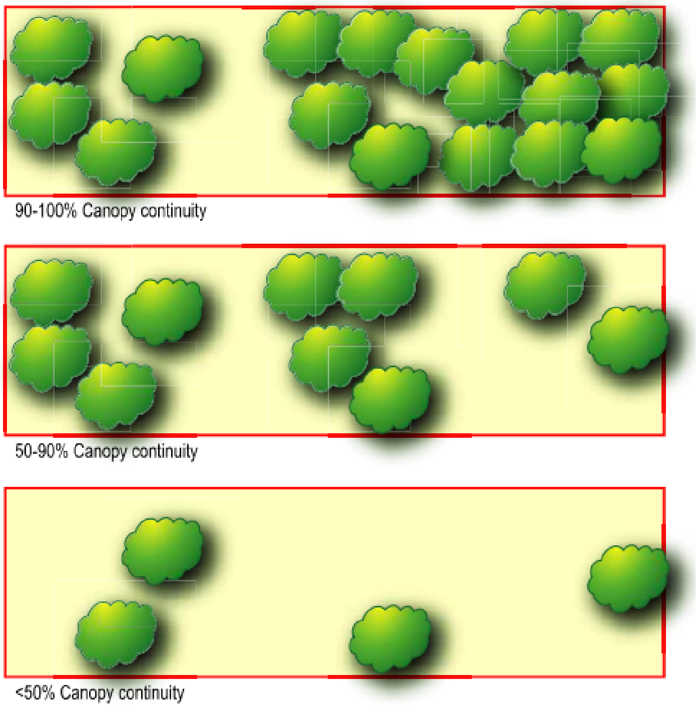


Figure 6. An example pictorial used for measuring canopy continuity (Dixon & Douglas 2015).

Photo point monitoring

- Four cardinal photo monitoring points (north, east, south, west) will be obtained within each plot.

2.3.3 Record keeping

- Vegetation monitoring database – comprised of seedling, sapling, and tree data for individual species and associated heights, DBH's and records of vegetation health e.g. % dead or sick plants.
- Ground cover data - percent cover and species richness.
- Photo monitoring point database.

2.3.4 Data analysis

The data collected based on monitoring methods outlined Table 2-1 will be statistically analysed using the Before After/Control Impact (BACI) approach. BACI will be applied by performing statistical analysis to test whether there is a significant difference between the baseline health data and riparian vegetation assessment data at the same sites, and riparian vegetation assessment data compared to reference site data.

Data captured for analysis includes:

- Species composition (%) using individual dominant/emergent plant data.
- Average heights of individual plants across riparian vegetation sites compared to reference site.
- Canopy cover (%) for each dominant, and emergent species across riparian vegetation assessment sites compared to reference site data.
- Plants alive or dead (%) across all riparian vegetation sites compared to reference site data.
- The portion (%) of groundwater sensitive species, *Melicope elleryana*, *Cyclophyllum schultzii* and *Helicia australasica* across all riparian vegetation sites compared to references site.
- The ground cover percentages (vegetation type, soil, rock, litter).
- Type of ground cover percentages in the form of herbs/vines/grasses/ferns and sedges).

2.4 General observations

2.4.1 Objective

Monitoring of other environmental factors is critical as they are contributing factors that can severely impact the health of riparian vegetation. Objective of the general observations is to monitor and record other environmental factors that have the potential to contribute to riparian vegetation impacts. This monitoring is discussed below.

2.4.2 Other environmental factors

Weeds

Weed data collection will be conducted in accordance with the Northern Territory Weed Management Branch (WMB 2015), Northern Territory Weed Data Collection Manual.

The percentage cover of weed species (declared as weeds under the *Northern Territory Weeds Management Act*) within each 20m x 20m quadrat will be visually estimated for each weed species.

A GPS will be used to record locations of identified weed species, and will record the following information:

- Weed name
- Distribution - size (20, 50 or 100m diameter)
- Density – categorised based on proportion of groundcover that if weeds on a scale of 1-5, 1 (absent) to 5 (>50%)
- Growth stage (seedling, juvenile, adult)

- Seeded (has the weed seeded?)
- Treatment (has the weed been treated and if so with what method of treatment)
- Comments, such as effectiveness of control, site observations, disturbed area.

Incidental weeds data will also be recorded outside of the plots to obtain surrounding data while traversing along the riparian area to visit each monitoring site.

Fire - broad scale and site based monitoring

Broadscale

Fire scar mapping and scoring will be determined by drone survey and mapped with NAFI each year to investigate frequencies and severity across the mapped riparian area.

At each plot an estimate of the timing of the last fire (this year, last year, more than 3 years ago) and for recently burnt sites the severity will be scored from 1 to 4. Categories for characterisation of fire are:

- No evidence of fire
- Evidence of groundcover fire only
- Evidence of burnt saplings
- Evidence of fire in canopy layer.

Erosion - broad scale and site based monitoring

Broadscale

- Monitoring the presence of erosion (on a broader scale basis) may be more effective using remote sensing with the use of the drone imagery captured as per section 2.2. Monitoring erosion using monitoring plots can often mean that issue areas can be missed.
- It is recommended to flag any potential erosion issues identification with aerial imagery and follow-up with on-ground monitoring so that erosion risks are to be measured and remedial actions implemented.

Site (plot) based

At each plot note the presence or absence of erosion will be recorded, and if present the following characteristics will be recorded:

- Types of erosion i.e. gullying, sheet erosion etc
- The amount of bare ground above
- Tree root exposure – any roots exposed due to disturbance
- Slumping
- Fallen trees/woody debris
- Presence of surrounding erosion
- Width of riparian zone – measure or estimate the width of the riparian zone (facing downstream) for both sides of banks.

Aquatic life

Presence of aquatic life within the water will also be recorded. This will involve a record of aquatic fauna and flora at the nearest water access point from each of the vegetation monitoring plots.

Surface water flows

Presence of water flows at the time of surveying will be documented. Surface water flows will be assessed in accordance with the surface water flows monitoring plan (WRM 2022).

Sedimentation

Presence of sedimentation within the water and on the riparian vegetation.

Contamination

- Presence of potential contamination (foam/scum/oils) and odour will be documented.

Climatic conditions

Weather observation will be documented during the monitoring. The annual rainfall, evaporation and temperature will be recorded from the same station and discussed for survey data comparison.

The following monitoring will be undertaken in accordance with the Grants and BP33 water management plans:

- surface and groundwater quality
- sediment monitoring
- macroinvertebrate monitoring
- groundwater levels will be assessed in accordance with the GDE Management plan (Groundwater Enterprises and RDM Hydro 2022).

2.4.3 Record keeping

All observations and data captured will be uploaded after each monitoring event, mapped as required and all records maintained in excel database.

3 MONITORING SCHEDULE

Table 3-1 outlines the RVMP schedule, prior to any significant disturbance and for the duration of the OHD SWEL, BP33 life of mine and three years post operations when the groundwater levels are predicted to return to pre-mining conditions (CloudGMS 2021).

Table 3-1. Riparian vegetation monitoring schedule

Monitoring	When	Monitoring undertaken	Frequency of monitoring	Locations
Baseline drone survey	End of Wet season (May) and end of dry season (October) 2022	Drone flight path to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Baseline riparian vegetation site assessment survey	End of Wet season (May) and end of dry season (October) 2022	Site assessment at all identified locations to capture seasonal variations at all identified locations	Biannual during 2022	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Drone survey	End of dry season (October) 2023 onwards	Drone flight	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control
Riparian vegetation site assessment survey	End of dry season (October) 2023 onwards	Site assessments	Annual 2023 onwards	RVS1, RVS2, RVS3, RVS4, RVS5, BP33 Control

4 PERFORMANCE INDICATORS AND TRIGGERS

A trigger action response plan (TARP) has been detailed in Table 4-1 below. The TARP incorporates triggers and responses from the surface water monitoring program (WRM 2022) and GDE Management Plan quantitative triggers and limits and/or adaptive management actions.

Table 4-1. Trigger action response plan

Level	Trigger	Monitoring Performance Indicator	Action	Response
Level 1 (normal)	No reduction in riparian vegetation extent and/or structure/ composition compared to baseline	Drone: • vegetation biomass using VARI analysis comparable to baseline mapping. Riparian vegetation site assessment: • No change in in general vegetation health compared to reference sites i.e. no tree mortality or physical changes to health of plants through the use of on-ground assessment and photo monitoring points	• No action required	• No response required
Level 2 (early warning)	10% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 10% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 10% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 10% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 10% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 90% of the dominant species present within each strata)	• Continue to monitor in accordance with RVMP • Investigate other potentially contributing environmental factors and likely reason for reduction in riparian vegetation extent. • Conduct drone monitoring in GDE reference site • Implement action in surface water flows monitoring program (WRM 2022) TARP Level 2. • Investigate management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022).	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 2. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		• Tree canopy continuity – there is no greater than 10% reduction in tree canopy cover (%) along transect compared to the representative reference sites		
Level 3a (elevated risk)	25% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 25% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 25% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 25% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 25% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 75% of the dominant species present within each strata) • Tree canopy continuity – there is no greater than 25% reduction in tree canopy cover (%) along transect compared to the representative reference sites	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Further investigate extent of riparian vegetation reduction within ZOI, including assessment of the drainage line flowing east to west within the ZOI. • Conduct biannual riparian vegetation site assessment (end of wet season and end of dry season) and compare seasonal variability to 2022 baseline data.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3a. • Report on the outcomes of the investigation of riparian vegetation health within ZOI to regulator. • Report on the outcomes of the seasonal variability (additional monitoring at end of wet season and dry season) to regulator. • Report on outcomes of the investigation of management actions as outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) to the regulator.
Level 3b (imminent Risk)	50% reduction in riparian vegetation extent and/or structure/ composition compared with baseline	Drone: • There is no greater than a 50% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 50% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 50% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Further investigate extent of riparian vegetation reduction outside 1m contour groundwater drawdown ZOI. • Revise BP33 mine closure plan (MCP) and rehabilitation management plan (RMP) to	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 3b. • Report on the outcomes of the actions undertaken to the regulator.

Level	Trigger	Monitoring Performance Indicator	Action	Response
		representative reference sites • Tree mortality – there is no greater than 50% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 aligns with the representative reference site descriptions (i.e. at least 50% of the dominant species present within each strata) • Tree canopy continuity – there is no greater than 50% reduction in tree canopy cover (%) along transect compared to the representative reference sites	include reinstatement of habitat values in the affected riparian areas and monitoring of ecosystem recovery and submit to Controller or Water Resources and NT EPA CEO for approval.	
Level 4 (exceedance of approved limits)	Loss of >3.6 ha of identified GDE vegetation extent and/or structure/ composition	Drone: • There is no greater than a 100% loss of the 3.6 ha vegetation biomass using VARI analysis comparable to baseline mapping Riparian vegetation site assessment: • Vegetation structure and composition – there is no greater than 100% reduction in the number of plants, saplings, and recorded within the plots of that recorded at the representative reference sites • Groundcover – there is no greater than 100% reduction of percentage cover of vegetation, and groundcover type vegetation cover recorded at monitoring sites to that of the representative reference sites • Tree mortality – there is no greater than 100% tree mortality of tagged plants recorded compared to the representative reference sites • General vegetation description using NVIS level 5 does not align with the representative reference site descriptions (i.e. indicating new ecosystem structures and functions have appeared) • Tree canopy continuity – there is no greater than 100% reduction in tree canopy cover (%) along transect compared to the representative reference sites	• Implement action in surface water flows monitoring program (WRM 2022) TARP Level 4. • Implement management actions in GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) as approved by the regulator. • Implement approved RMP. • Notify NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.	• Implement response in surface water flows monitoring program (WRM 2022) TARP Level 4. • Report on the outcomes of the actions undertaken to the regulator.

6 REVIEW PROCESS AND MANAGEMENT

A review process will be undertaken annually based on the biannual riparian vegetation monitoring to ensure continuous improvement of the monitoring program and in accordance with condition 4.1 of the SWEL (8151018) be implemented immediately following the DEPWS Water Resources Controller's approval. Data management and reporting is key to inform the review process.

The management during riparian monitoring is related to the management of water availability for the riparian vegetation/GDE's. Refer to management outlined in the GDE Management Plan (Groundwater Enterprises and RDM Hydro 2022) and the Surface Water Management Plan (WRM 2022).

7 REPORTING

A monitoring reporting will be developed as per condition 4.2 of the SWEL (8151018) and include *data collected in accordance with the monitoring program under condition 4.1 for the previous water accounting year (1 May to 30 April)* and *discuss the measured and modelled impacts of water taken from SWEL (8151018) on the downstream riparian vegetation.*

In accordance with the NT EPA (2022), LDGNT will *notify the NT EPA CEO in writing if GDE monitoring identifies that the total area of GDE loss attributable to the action exceeds 3.6 ha, within seven days of identification of the exceedance.*

The plan will be submitted to the:

- NT Department of Environment, Parks and Water Security (DEPWS) Controller of Water Resources Division as a Condition 4-1 of the SWEL (8151018)
- Chief Executive Officer (CEO) of the DEPWS for review and approval at least 3 months before substantial disturbance at BP33, as per condition 6-2 of the NT EPA BP33 Draft Environmental Approval (NT EPA 2022) as part of the GDE Management Plan.
- NT Department of Industry, Tourism and Trade (DITT) as appendices to BP33 Mine Management Plan (MMP).

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APPENDIX A RIPARIAN VEGETATION ASSESSMENT REPORT

Mangrove and Riparian Vegetation Assessment Grants Lithium Project

Core Lithium

www.ecoz.com.au

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1 INTRODUCTION

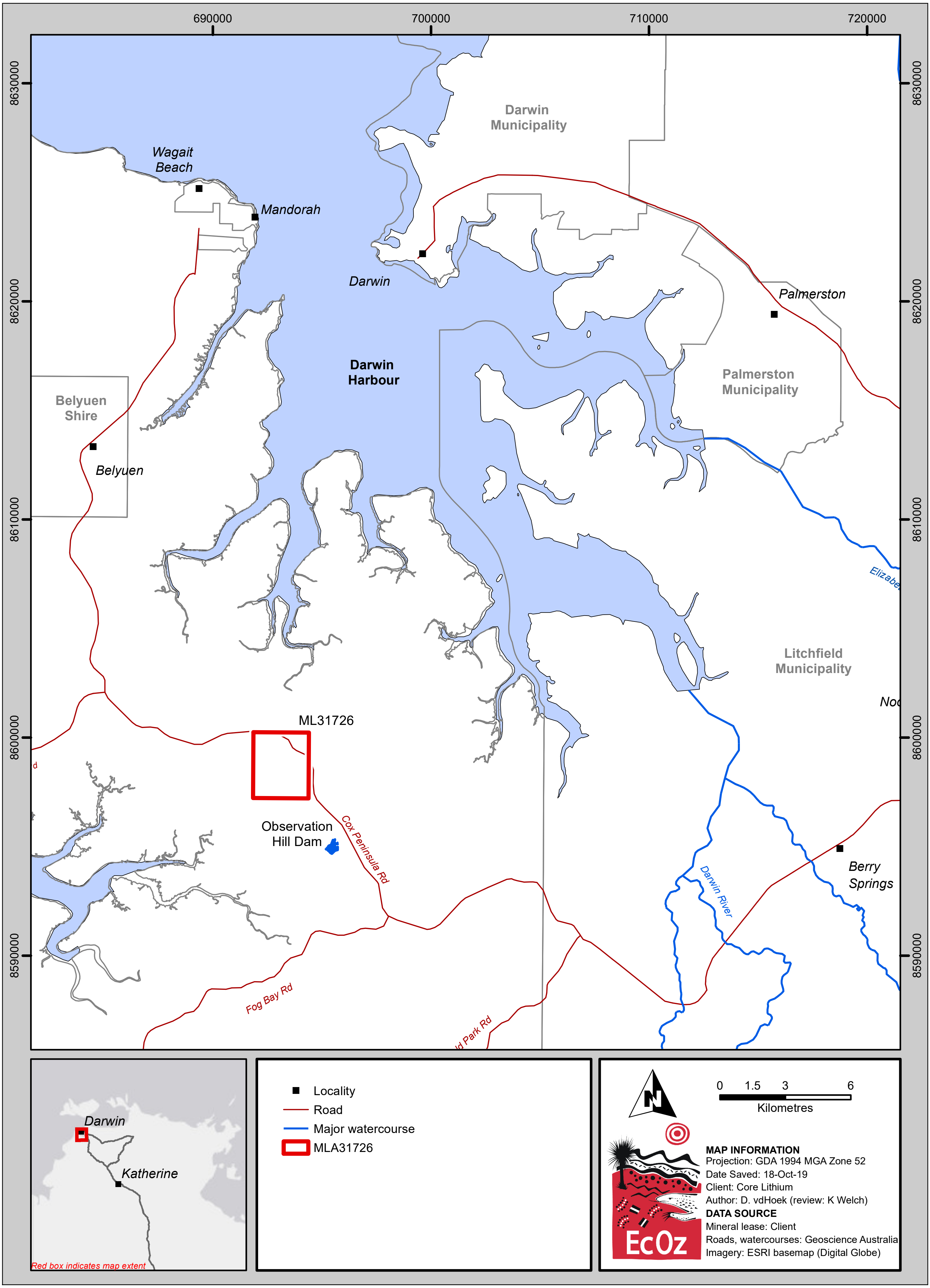
Core Lithium Ltd proposes to develop the Grants Lithium mine on the Cox Peninsula, approximately 90 km by road from Darwin CBD, or 25 km south as the crow flies, Northern Territory (Figure 1). The project area is located south of the Cox Peninsula Road, approximately 36 km west of the township of Berry Springs.

The proposal was assessed under the *Environmental Assessment Act* at the level of an Environmental Impact Statement (EIS). Surveys and assessments undertaken for the EIS process identified riparian mangrove communities downstream of the mine site and closed riparian vegetation communities downstream of the Observation Hill Dam (OHD) water supply that could be susceptible to impacts associated with changes to surface water flows. Both riparian and mangrove communities are considered to be significant vegetation communities as they are spatially restricted and provide habitat to a relatively large number of species (DENR 2019).

To allow for future monitoring of impacts associated with mining activities on Core Lithium mineral leases, EcOz Environmental Consultants (EcOz) was engaged to map mangrove and riparian community boundaries and collect baseline information about community structure and condition prior to development. This report presents the survey methods and findings, including:

- Site selection.
- Methodology used to undertake drone aerial surveys and field surveys.
- Drone captured orthomosaic images (5cm/pixel) of the selected study sites
- Vegetation mapping at 1:500 scale of riparian vegetation boundaries
- Vegetation community descriptions for each mapped vegetation type

The baseline information documented in this report will allow future comparative assessments to detect any major changes in vegetation structure and composition because of project activities.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 1. Map of the project location.mxd

Figure 1. Map of the project location

2 SITE SELECTION

The objective of the baseline assessment was to record vegetation characteristics and condition of the sensitive vegetation communities downstream of the project area. The survey areas were determined with reference to the following spatial datasets:

- Proposed mine site components footprint (Core 2019)
- Digitalglobe aerial imagery (ArcGIS 10.6.1)
- Ground Water Dependant Ecosystem Atlas Dataset (BOM-GDE 2019)
- Land units of the Greater Darwin Area (Fogarty et al. 1984).

Assessment of the above datasets identified two riparian sites downstream of the project area. Mangrove communities associated with the West Arm of Darwin Harbour occur downstream of the proposed mine site. A closed riparian vegetation community occurs downstream of the OHD water supply, which based on community structure, is a potential Groundwater Dependent Ecosystem (GDE). The locations of the two selected study areas are shown in Figure 2.

2.1 Mangrove Ecosystem

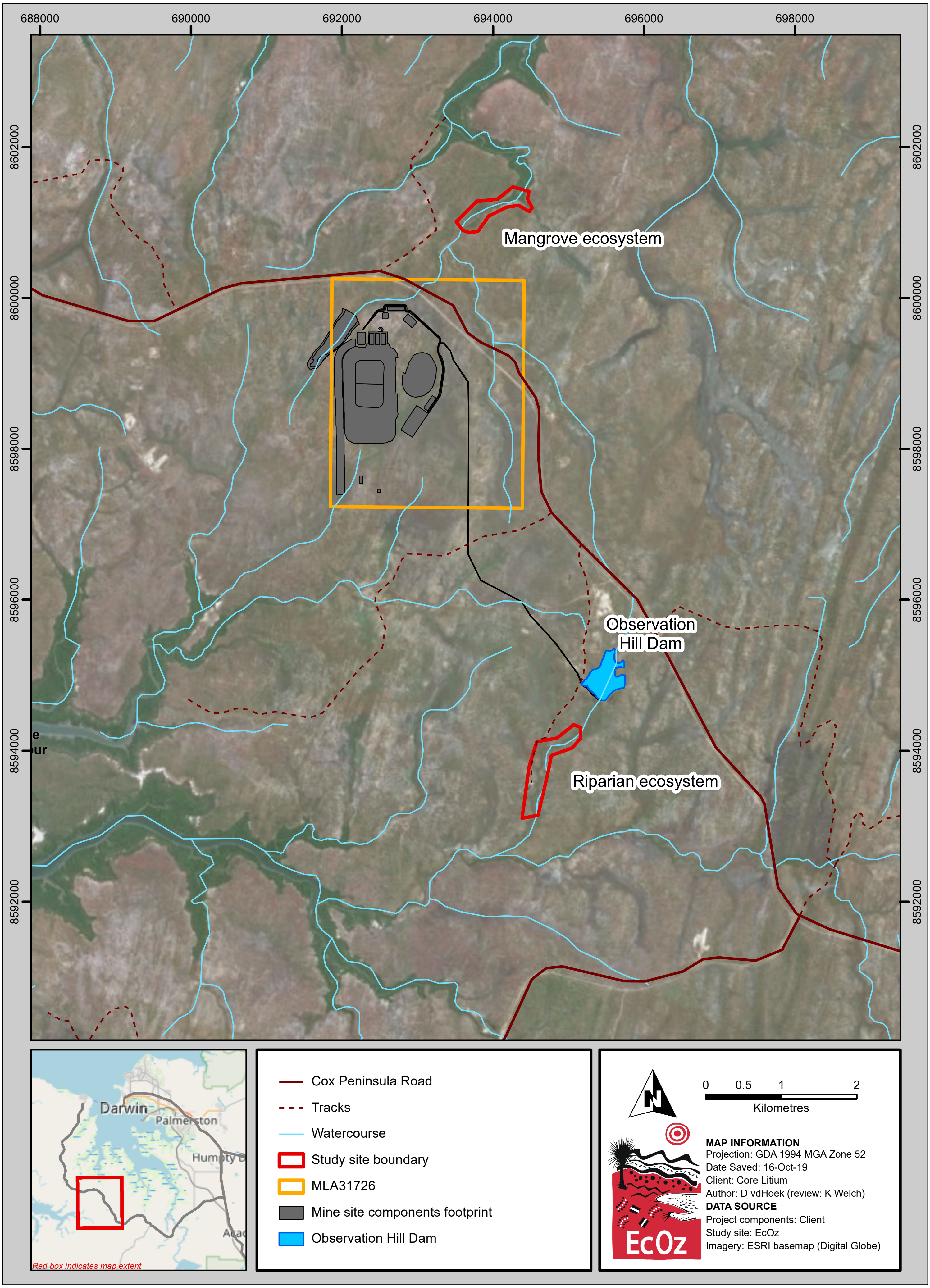
The proposed mine site and dam are located within the catchment of an ephemeral creek that flows into the West Arm of Darwin Harbour approximately 2.6 km to the north. Approximately 1.4 km north-east of the Mineral Lease (ML) boundary, the riparian zone of the creek supports mangrove vegetation. A baseline mangrove study site was established at this location.

Three vegetation survey plots were located within the mangrove study site, representing riparian, swamp and mangrove communities. The study site is located on two land units. The riparian and swamp survey sites are located within land unit 6b – Drainage System, and the mangrove survey site is in land unit 9b – Estuarine Fringes (Fogarty et al. 1984), see Figure 3.

2.2 Riparian Ground Water Dependant Ecosystem

The ephemeral drainage line downstream of OHD supports closed riparian vegetation identified as a potential GDE. The creek flows into the Charlotte River approximately 3 km downstream of the OHD wall, and discharges into Bynoe Harbour. The OHD is an artificial aquatic system that provides year round freshwater seepage into the downstream riparian system. Impacts to either the drainage system or the OHD can potentially result in impacts to downstream riparian vegetation communities.

One vegetation survey plot was located on the receiving channel of each surface water inflow to the riparian vegetation community allow future assessments to determine the potential upstream source of impact. A third survey plot was located downstream of both potential upstream inputs. The riparian study site is situated on land unit 5b1 – Drainage System. A neighbouring land unit 5a – Alluvial Plains is the source of surface water inflows into the study area (Fogarty et al. 1984), see Figure 4.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 2. The location of the riparian study sites.mxd

Figure 2. The location of riparian study sites in relation to the project infrastructure

3 METHODS

Assessment of the riparian vegetation was undertaken in two stages. Stage 1 involved an aerial drone survey to record an up to date orthomosaic photo of riparian vegetation boundaries. Stage 2 involved a ground field survey to assess vegetation structure and composition. A riparian vegetation map was created with reference to the drone orthomosaic image and mapped vegetation types were described with reference to the field vegetation assessments. The methods used for survey and mapping of the study sites are outlined in the sections below.

3.1 Drone survey

A drone survey was undertaken on the 13th of March, towards the end of the annual wet season. The timing of the survey was selected to record maximum vegetation growth within the survey area. Surveys were flown at both the Mangrove and Ri[arian Ground Water Dependant Ecosystem study sites. The drone survey was conducted by EcOz Chief Remote Pilot, David van den Hoek, according to the EcOz Remotely Piloted Aircraft Operations Manual. A DJI Phantom 4pro drone was used to capture images at a height of 75m (75% front overlap and 65% side overlap) using the DroneDeploy app. Images were then uploaded to the DroneDeploy website for processing and orthomosaic images were exported. Two 5cm pixel images were exported for each survey site, a colour orthomosaic and a plant health image, displayed in red, green and blue.

3.2 Vegetation mapping

Vegetation boundaries were delineated at a scale of 1:500 using the 5cm pixel orthomosaic aerial images captured during the drone survey. Individual trees, vegetation cover and soil colour was identified from the imagery to inform the mapping of vegetation boundaries. The following riparian vegetation types were mapped within each of the study sites:

Mangrove Ecosystem (downstream of mine site)

- Mangrove
- Riparian
- Swamp

Groundwater Dependant Ecosystem (downstream of OHD)

- Riparian

3.3 Field survey

Vegetation survey plots were located within each of the mapped riparian vegetation types. A baseline vegetation assessment was undertaken on the 5th of June 2019 by EcOz staff trained in botanical survey, Stephen Reynolds and Nicole Clark. Vegetation community assessments were undertaken based on the *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst et al. 2007).

Six vegetation survey plots, three in each study site, were surveyed to characterise vegetation types to a standard equivalent to NVIS Level V. Assessments were undertaken with a 20 m x 20 m quadrat and for each stratum (upper, mid and ground), three dominant species were recorded (but an attempt was made to record all species), cover was estimated and height values measured. Photographs were taken at the four cardinal directions for each site and NT declared weeds were recorded if present.

4 RESULTS

Vegetation maps were created to record the baseline boundary locations of riparian vegetation types situated within the study sites. The resulting maps and associated information is presented in the sections below.

4.1 Mangrove Ecosystem

The mangrove ecosystem study site records the ecotone between a freshwater creek and side swamp and a marine influenced mangrove community. The site is approximately 950 m long and 250 m wide, with an area of 23.2 ha. The boundaries of three riparian vegetation communities were delineated within the study site. Vegetation type descriptions and unit areas are provided below in Table 1. The vegetation map is presented in Figure 5. A table showing the results of field data collected at each survey site is present in Appendix A.

Incidental observations recorded during the survey noted that mangrove vegetation communities were generally in good condition. No major weed populations or fire impacts were observed within the mangrove and riparian communities. However, recent impacts were recorded within the landward swamp community where evidence of an off-road race track were observed. A number of weeds were also recorded within the swamp community, including Hyptis (*Hyptis suaveolens*), declared Class B – Spread to be controlled, under the Northern Territory *Weed Management Act* and environmental weeds including Annual mission grass (*Cenchrus pedicellatus*), Calopo (*Calopogonium mucunoides*) and Stinking passionfruit (*Passiflora foetida*).

Table 1. Mangrove Ecosystem - Riparian vegetation descriptions and unit areas

Vegetation Type	Vegetation Description	Survey site	Area (ha)
Mangrove	*Lumnitzera racemosa, Bruguiera exaristata, Avicennia marina* low open forest, over *Fimbristylis* sp. and *Xerochloa imberbis* mid sparse tussock grassland	MVS1	5.18
Riparian	*Melaleuca viridiflora* mid woodland over *Acacia plectocarpa* mid open shrubland over *Germainia grandiflora* mid tussock grassland	RVS2	0.76
Swamp	*Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa* mid woodland over *Lophostemon lactifluus* mid open shrubland over *Sorghum intrans* mid tussock grassland	SVS3	1.5

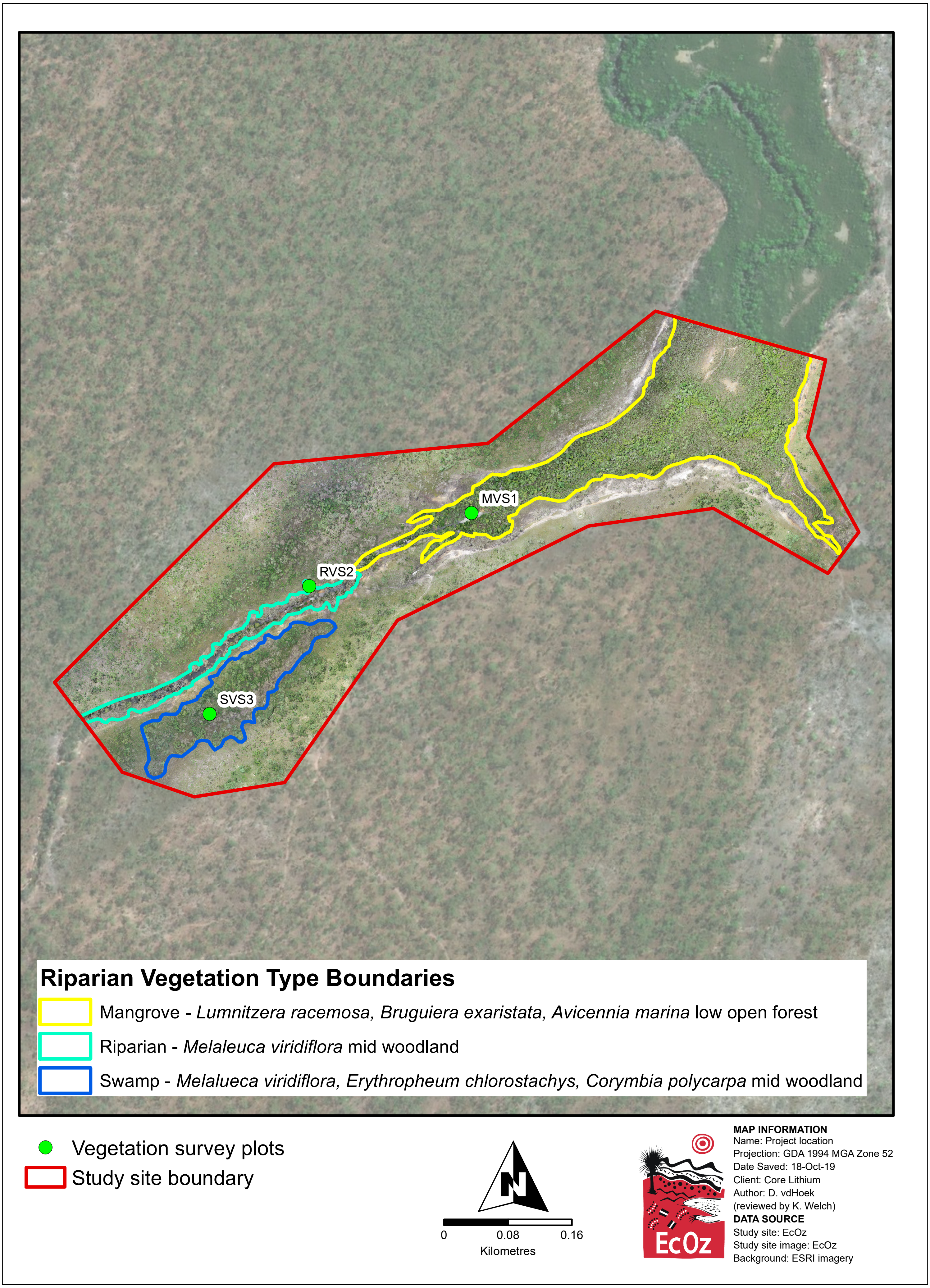
4.2 Riparian Groundwater Dependant Ecosystem

The riparian GDE study site is approximately 1.45 km long and 250 m wide, with an area of 33 ha. The boundary of one riparian vegetation community type was delineated within the study site. Vegetation type descriptions and unit areas are provided below in Table 2. A vegetation map is presented in Figure 6. A table showing the results of field data collected at each survey site is presented in Appendix A.

At the time of survey, riparian vegetation was observed to be in good condition. No major weed populations or fire impacts were recorded.

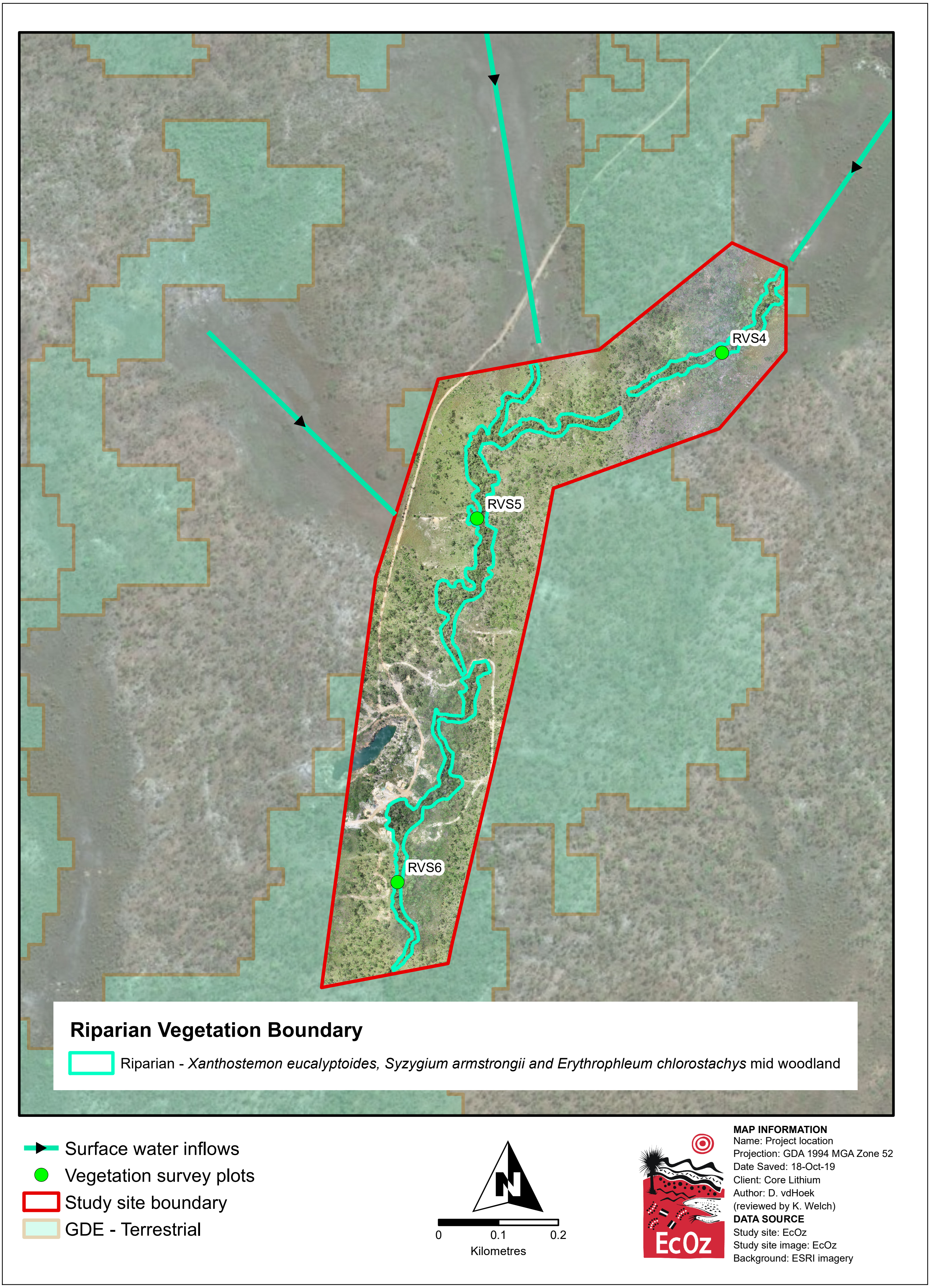
Table 2. Groundwater Dependant Ecosystem – Riparian vegetation descriptions and unit areas

Vegetation Type	Vegetation Description	Survey sites	Area (ha)
Riparian	*Xanthostemon eucalyptoides, Syzygium armstrongii* and *Erythrophleum chlorostachys* mid woodland over *Pandanus spiralis, Helicia australasica* and *Carallia brachiata* mid shrubland over *Eriachne triseta* mid tussock grassland	RVS4, RVS5, RVS6	3.62



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 3. Mangrove ecosystem vegetation boundaries.mxd

Figure 3. Mangrove ecosystem vegetation boundaries



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19042 - Grants Project supplementry ecology 2019\01 Project Files\Riparian veg assessment\Figure 4. GDE vegetation boundaries.mxd

Figure 4. Groundwater dependant ecosystem vegetation boundaries

5 CONCLUSION AND RECOMMENDATIONS

The assessment of vegetation boundaries presented within this report provides a baseline spatial dataset from which to monitor changes in riparian vegetation boundaries within the study sites. The baseline assessment indicates that vegetation communities within the study sites are in good condition, with limited pre-development disturbance. This is with the exception of the swamp community, which occurs downstream of the mine site in the West Arm catchment. Weeds and impacts from off-road racing tracks were observed within this vegetation community.

Future monitoring should repeat drone and vegetation surveys at the same time of the year that baseline surveys were conducted. This will allow for the capture of vegetation data in a similar seasonal state and enable more accurate analysis and interpretation of results.

When analysing the results of future drone survey against the baseline dataset, any significant retraction in riparian vegetation patch boundaries should trigger further assessment to determine the extent and potential cause of impact i.e. is the change confined to the impacted watercourse or occurring more broadly. This may require re-survey of vegetation plots to determine if there has been a change in vegetation structure and composition in response to vegetation boundary impacts.

Changes in vegetation structure and composition along the landward edge may indicate changes in surface and or groundwater flows entering those communities. However, further contextual assessment will be required as these changes could also occur because of bushfire and weed invasion unrelated to the project activities

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APPENDIX A FIELD VEGETATION PLOT DESCRIPTIONS

Site MVS1 – *Lumnitzera racemosa, Bruguiera exaristata, Avicennia marina* low open forest over *Fimbristylis* sp. and *Xerochloa imberbis* mid sparse tussock grassland

NVIS Code: T6c

Location (GDSA94, z52): 694035E, 8601220N

Upper 1: Mid open forest dominated by *Lumnitzera racemose* and *Avicennia marina*

Mid 1: *Bruguiera exaristata, Avicennia marina* with isolated *Excoecaria ovalis*

Ground 1: Sparse tussock grassland dominated by *Fimbristylis* sp. and *Xerochloa imberbis*



Other species
Upper stratum (U1): -
Mid stratum (M1):
Ground stratum (G1): -

Land unit (Greater Darwin 25K) – 9b Marine

Landform: Mangrove flat near tidal creek

Soils: Brown sandy clay surface soils, some pebbles present ranging in size (2 – 6 cm)

Drainage: Very poorly drained

Fire history: No fire impact

Weeds: Absent

Disturbance: None

Hydrology: tidal, towards upper tide limit. Large pool located adjacent to vegetation assessment site – approximately 4 m wide.

Site RVS2 – *Melaleuca viridiflora* mid woodland over *Acacia plectocarpa* mid open shrubland over *Germainia grandiflora* mid tussock grassland

NVIS Code: T7i

Location (GDA94, z52): 693834E 8601132N

Upper 1: Mid woodland dominated by *Melaleuca viridiflora*

Mid 1: Mid open shrubland dominated by *Acacia plectocarpa, Lumnitzera racemosa* (on the edge of creek) and *Avicennia marina* (in creek channel)

Ground 1: Mid tussock grassland dominated by *Germainia grandiflora, Dapsilanthus* sp. and *Xerochloa imberbis*



Other species

Upper stratum (U1): -

Mid stratum (M1): *Thespesia populneoides*

Ground stratum (G1): - *Asteraceae sp.*, *Wrightia saligna, Flagellaria indica, Acrostichum speciosum, Gymnanthera nitida, Lindernia lobelioides, Diospyros littorea*

Land unit (Greater Darwin 25K) – 6b Drainage system

Landform: Flat, adjacent to creek channel

Soils: Brown clay loam; rocks and pebbles common in channel adjacent to site

Drainage: Poorly drained

Fire history: 2+ years since last fire causing minimal impact

Weeds: None

Disturbance: Motorbike tracks nearby

Hydrology: Some pools nearby, inundated on large high tides and with freshwater during wet season

Site SVS3 – *Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa* mid woodland over *Lophostemon lactifluus* mid open shrubland over *Sorghum intrans* mid tussock grassland
NVIS Code: T7i
Location (GDA94, z52): 693708E, 8600969N
Upper 1: Mid woodland dominated by *Melaleuca viridiflora, Erythrophleum chlorostachys* and *Corymbia polycarpa*
Mid 1: Mid open shrubland dominated by *Lophostemon lactifluus, Clerodendrum floribundum* and *Denhamia obscura*
Ground 1: Mid open tussock grassland dominated by *Sorghum intrans, Aristida* sp. and *Pandanus spiralis*
 
 
Other species **Upper stratum (U1):** - **Mid stratum (M1):** *Alphitonia excelsa, Grevillea decurrens* **Ground stratum (G1):** - *Germainia grandiflora, Acacia difficilis,* Fern sp., *Themeda* sp., *Wrightia saligna, Livistona humilis, Osbeckia australiana, Dianella odorata, Brachychiton megaphyllus, Fern sp.1, Antidesma ghesaembilla*
Land unit (Greater Darwin 25K) – 6b: Drainage system
Landform: Lower slope, flat open depression
Soils: Brown sandy loam. Some quartz present near creek
Drainage: Poorly drained – some wet season inundation
Fire history: Last year (relatively low impact fire)
Weeds: Annual mission grass scattered near site. Patches of *Hyptis suaveolens*, *Calopogonium mucunoides* and *Passiflora foetida* recorded nearby
Disturbance: None
Hydrology: Wet season inundation

Site RVS4 – *Syzygium armstrongii and Xanthostemon eucalyptoides* mid open woodland over *Pandanus spiralis* mid shrubland over *Scleria lingulata* mid open tussock grassland

NVIS Code: T7r

Location (GDA94, z52): 695055E 8594164N

Upper 1: Mid open woodland dominated by *Syzygium armstrongii* and *Xanthostemon eucalyptoides*

Mid 1: Mid shrubland dominated by *Pandanus spiralis, Flagellaria indica* and *Helicia australasica*

Ground 1: Mid open tussock grassland dominated by *Scleria lingulata**,*** *Sorghum intrans* and *Eriachne triseta*



Other species

Upper stratum (U1): *Lophostemon lactifluus*

Mid stratum (M1): *Myrsine benthamiana, Melicope elleryana, Cyclophyllum schultzii, Carallia brachiata, Gmelina australis, Grevillea pluricaulis*

Ground stratum (G1): *Melastoma malabathricum* (*polyanthum*)*, Themeda triandra, Eulalia mackinlayi, Osbeckia australiana, Dianella odorata, Cheilanthes* sp

Land unit (Greater Darwin 25K) – 5b1: Drainage System

Landform: Flat, adjacent to creek channel

Soils: Black clay in channel

Drainage: Poorly drained

Fire history: Very recent adjacent (other side of the creek) but 2+ years since last fire at the site

Weeds: None

Disturbance: Some pig damage

Hydrology: Site situated adjacent to large pool (approximately 8 m x 15 m) 40 cm ~ 1m deep, steep bank (0.5 m).

Site RVS5 – *Xanthostemon eucalyptoides* mid woodland over *Leptospermum madidum* mid open shrubland over *Eriachne triseta* mid tussock grassland

NVIS Code: T6d

Location (GDA94, z52): 694646E 8593887N

Upper 1: Mid woodland dominated by *Xanthostemon eucalyptoides; Syzygium armstrongii;* and *Melaleuca viridiflora*

Mid 1: Mid shrubland dominated by *Leptospermum madidum; Helicia australasica; Carallia brachiata* and *Cyclophyllum schultzii*

Ground 1: Mid tussock grassland dominated by *Eriachne triseta,* , *Fern sp.2* and *Mnesithea rottboellioides*



Other species

Upper stratum (U1): - *Melaleuca viridiflora; Syzygium armstrongii; Corymbia polycarpa*

Mid stratum (M1): - *Pandanus spiralis; Helicia australasica; Acacia 'pellita'; Carallia brachiate; Cyclophyllum schultzii; Carpentaria acuminata,*

Ground stratum (G1): - *Livistona humilis; Grevillea pluricaulis; Osbeckia Australiana; Mnesithea rottboellioides; Dianella odorata; Eulalia mackinlayi; Heteropogon triticeus, Fern sp.2 Cyperus sp., Themeda triandra; Germainia grandiflora; Philydrum lanuginosum*

Land unit (Greater Darwin 25K) – 5b1: Drainage System

Landform: open depression (watercourse/gully)

Soils: Brown loam sand. Clay in channel

Drainage: Poorly-very poorly drained

Fire history: unburnt-fire nearby

Weeds: Absent

Disturbance: Some pig disturbance

Hydrology: Some pools nearby, inundated with freshwater during wet season

Site RVS6 – *Erythrophleum chlorostachys* mid woodland over *Xanthostemon eucalyptoides* mid open shrubland over *Eriachne triseta* mid tussock grassland
NVIS Code: T7i
Location (GDA94, z52): 694513E 8593280N
Upper 1: Mid woodland dominated by *Erythrophleum chlorostachys*
Mid 1: Mid open shrubland dominated by *Xanthostemon eucalyptoides; Melicope elleryana; Carallia brachiate; Lophostemon lactifluus; Pandanus spiralis*
Ground 1: Mid tussock grassland dominated by *Eriachne triseta;* Fern *sp1*; *Xanthostemon eucalyptoides*
 
 
Other species **Upper stratum (U1):** - *Erythrophleum chlorostachys; Xanthostemon eucalyptoides; Corymbia polycarpa* **Mid stratum (M1):** *Xanthostemon eucalyptoides; Melicope elleryana; Carallia brachiate; Lophostemon lactifluus; Pandanus spiralis* **Ground stratum (G1):** - *Asteraceae sp., Wrightia saligna, Flagellaria indica, Acrostichum speciosum, Gymnanthera nitida, Lindernia lobelioides, Diospyros littorea; Mnesithea rottboellioides; Eulalia mackinlayi; Themeda triandra*
Land unit (Greater Darwin 25K) – 5b1: Drainage System
Landform: Lower slope adjacent to creek. Open depression from edge.
Soils: Brown clay loam
Drainage: Moderately well drained. Poorly drained FP. Very poorly drained channel seasonal creek.
Fire history: 2+ years since last fire causing minimal impact
Weeds: None
Disturbance: No visible impact
Hydrology: Seasonal freshwater in the creek during wet season

APPENDIX B POST WET-SEASON SURVEY TREE DATA

Site name	Species	Strata	Height (m)	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
Reference	*Lophostemon lactifluus*	U	8-10	5	1	0	0	0
Reference	*Melaleuca argentea*	U	16-18	15	1	0	0	0
Reference	*Syzygium armstrongii*	U	14-16	15	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	U	10-12	5	1	0	0	0
Reference	*Carallia brachiata*	M	4-6	5	1	0	1	0
Reference	*Cyclophyllum schultzii f. schultzii*	M	3-6	1	1	0	0	1
Reference	*Melicope elleryana*	M	8-10	5	1	0	0	1
Reference	*Myrsine benthamiana*	M	3-6	5	1	0	0	1
Reference	*Pandanus aquaticus*	M	3-6	10	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	M	3-8	5	1	0	0	0
Reference	*Barringtonia acutangula subsp. acutangula*	R	<3	10-15	1	0	0	0
Reference	*Carallia brachiata*	R	<3	10-15	1	0	0	0
Reference	*Carpentaria acuminata*	R	<3	10-15	1	0	0	0
Reference	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	0
Reference	*Helicia australasica*	R	<3	10-15	1	0	0	0
Reference	*Melicope elleryana*	R	<3	10-15	1	0	0	0
Reference	*Myrsine benthamiana*	R	<3	10-15	1	0	0	0
Reference	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
Reference	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS1	*Melaleuca argentea*	U	12-14	15	1	1	1	0
RVS1	*Syzygium armstrongii*	U	10-12	5	1	0	0	0
RVS1	*Xanthostemon eucalyptoides*	U	12-14	15-20	1	0	0	0
RVS1	*Acacia holosericea*	M	4	2	1	0	0	0
RVS1	*Barringtonia acutangula subsp. acutangula*	M	3-4	5	1	0	0	0
RVS1	*Carallia brachiata*	M	3-5	2	1	0	0	0
RVS1	*Cyclophyllum schultzii f. schultzii*	M	3-4	1	1	0	0	1
RVS1	*Leptospermum madidum subsp. sativum*	M	4-8	20	1	0	0	0
RVS1	*Myrsine benthamiana*	M	3-5	<1	1	1	1	1
RVS1	*Barringtonia acutangula subsp. acutangula*	M	3-4	5	1	0	0	0
RVS1	*Barringtonia acutangula subsp. acutangula*	R	<3	15	1	0	0	0
RVS1	*Carallia brachiata*	R	<3	15	1	0	0	0
RVS1	*Cyclophyllum schultzii f. schultzii*	R	<3	15	1	0	0	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS1	*Fagraea racemosa*	R	<3	15	1	0	0	0
RVS1	*Myrsine benthamiana*	R	<3	15	1	0	0	1
RVS2	*Eucalyptus miniata*	U	10-12	3-5	1	0	0	0
RVS2	*Lophostemon lactifluus*	U	10	3-5	1	0	0	0
RVS2	*Melaleuca viridiflora*	U	10-12	5-10	1	0	1	0
RVS2	*Melicope elleryana*	U	-	-	1	0	0	1
RVS2	*Syzygium armstrongii*	U	10	5-10	1	0	0	0
RVS2	*Acacia holosericea*	M	3-4	3-5	1	0	1	0
RVS2	*Carpentaria acuminata*	M	6	>1	1	1	0	0
RVS2	*Helicia australasica*	M	3-5	1-3	1	0	0	1
RVS2	*Leptospermum madidum subsp. Sativum*	M	4-8	10-15	1	0	0	0
RVS2	*Pandanus spiralis*	M	3-5	1-3	1	0	1	0
RVS2	*Syzygium armstrongii*	M	3-6	1	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	M	6-8	10-15	1	0	0	0
RVS2	*Acacia holosericea*	R	<3	40	1	0	0	0
RVS2	*Alphitonia excelsa*	R	<3	40	1	0	0	0
RVS2	*Breynia cernua*	R	<3	40	1	0	0	0
RVS2	*Carpentaria acuminata*	R	<3	40	1	0	0	0
RVS2	*Cyclophyllum schultzii f. schultzii*	R	<3	40	1	0	0	1
RVS2	*Erythrophleum chlorostachys*	R	<3	40	1	0	0	0
RVS2	*Exocarpos latifolius*	R	<3	40	1	0	0	0
RVS2	*Helicia australasica*	R	<3	5	1	0	0	1
RVS2	*Leptospermum madidum subsp. sativum*	R	<3	40	1	0	0	0
RVS2	*Pandanus spiralis*	R	<3	40	1	0	0	0
RVS2	*Syzygium armstrongii*	R	<3	40	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	R	<3	40	1	0	0	0
RVS2	*Carpentaria acuminata*	Other species	-	-	1	0	0	0
RVS2	*Diospyros sp*	Other species	-	-	1	0	0	0
RVS3	*Erythrophleum chlorostachys*	U	12-14	<5	1	0	0	0
RVS3	*Lophostemon lactifluus*	U	12-14	5-10	1	0	0	0
RVS3	*Melaleuca viridiflora*	U	12-14	5	1	0	1	0
RVS3	*Syzygium armstrongii*	U	12-14	5	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	U	12-14	5-10	1	0	0	0
RVS3	*Acacia auriculiformis*	M	8-10	5	1	0	1	0
RVS3	*Acacia holosericea*	M	3-5	10-15	1	0	1	0
RVS3	*Alphitonia excelsa*	M	4-5	15	1	0	0	0
RVS3	*Carallia brachiata*	M	4-6	15	1	1	1	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS3	*Cyclophyllum schultzii f. schultzii*	M	2-5	15	1	0	0	1
RVS3	*Denhamia obscura*	M	6-8	15	1	0	0	0
RVS3	*Erythrophleum chlorostachys*	M	3	15	1	0	0	0
RVS3	*Leptospermum madidum subsp. sativum*	M	5-7	5	1	0	0	0
RVS3	*Livistona humilis*	M	3-4	15	1	0	0	0
RVS3	*Melaleuca viridiflora*	M	4-5	15	1	0	0	0
RVS3	*Pandanus aquaticus*	M	3	15	1	0	0	0
RVS3	*Pandanus spiralis*	M	4	15	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	M	3-8	5-10	1	0	0	0
RVS3	*Acacia holosericea*	R	<3	10-15	1	0	0	0
RVS3	*Alphitonia excelsa*	R	<3	10-15	1	0	0	0
RVS3	*Breynia cernua*	R	<3	10-15	1	0	0	0
RVS3	*Carallia brachiata*	R	<3	10-15	1	0	0	0
RVS3	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
RVS3	*Erythrophleum chlorostachys*	R	<3	10-15	1	0	0	0
RVS3	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS3	*Livistona humilis*	R	<3	10-15	1	0	0	0
RVS3	*Melaleuca viridiflora*	R	<3	10-15	1	0	0	0
RVS3	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS3	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS4	*Corymbia polycarpa*	U	10-12	5	1	0	0	0
RVS4	*Syzygium armstrongii*	U	14-16	20	1	0	0	0
RVS4	*Xanthostemon eucalyptoides*	U	12-14	15	1	0	0	0
RVS4	*Acacia holosericea*	M	2-4	15-20	1	0	0	0
RVS4	*Carallia brachiata*	M	2-4	15-20	1	0	0	0
RVS4	*Cyclophyllum schultzii f. schultzii*	M	2-5	15-20	1	1	1	1
RVS4	*Flagellaria indica*	M	6	15-20	1	0	0	0
RVS4	*Gmelina shirleyi*	M	6-8	15-20	1	0	0	0
RVS4	*Melaleuca viridiflora*	M	2-4	15-20	1	0	0	1
RVS4	*Myrsine benthamiana*	M	3-6	15-20	1	0	0	0
RVS4	*Pandanus spiralis*	M	4-6	15-20	1	0	0	0
RVS4	*Syzygium angophoroides*	M	6-8	15-20	1	0	0	0
RVS4	*Syzygium armstrongii*	M	6-8	10	1	0	0	0
RVS4	*Xanthostemon eucalyptoides*	M	4-8	25-30	1	0	0	0
RVS4	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead 0 Live 1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS4	*Helicia australasica*	R	<3	10-15	1	0	0	0
RVS4	*Melicope elleryana*	R	<3	10-15	1	0	0	0
RVS4	*Myrsine benthamiana*	R	<3	10-15	1	0	0	0
RVS4	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS4	*Syzygium angophoroides*	R	<3	10-15	1	0	0	0
RVS4	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS5	*Lophostemon lactifluus*	U	8-10	5	1	0	0	0
RVS5	*Melaleuca viridiflora*	U	8-10	15	1	0	0	0
RVS5	*Syzygium armstrongii*	U	10-12	15	1	0	0	0
RVS5	*Xanthostemon eucalyptoides*	U	12-14	10	1	0	0	0
RVS5	*Acacia holosericea*	M	3-5	3	1	0	0	0
RVS5	*Carallia brachiata*	M	6-8	5	1	0	0	0
RVS5	*Cyclophyllum schultzii f. schultzii*	M	5-6	<1	1	0	0	1
RVS5	*Helicia australasica*	M	3-6	10	1	0	0	1
RVS5	*Leptospermum madidum subsp. sativum*	M	4-6	10	1	0	0	0
RVS5	*Lophostemon lactifluus*	M	4-6	5	1	0	0	0
RVS5	*Pandanus spiralis*	M	3-5	2	1	0	0	0
RVS5	*Syzygium armstrongii*	M	6-8	15	1	0	0	0
RVS5	*Xanthostemon eucalyptoides*	M	4-8	15	1	0	0	0
RVS5	*Acacia holosericea*	R	<3	5-10	1	0	0	0
RVS5	*Carallia brachiata*	R	<3	5-10	1	0	0	0
RVS5	*Cyclophyllum schultzii f. schultzii*	R	<3	5-10	1	0	0	0
RVS5	*Erythrophleum chlorostachys*	R	<3	5-10	1	0	0	0
RVS5	*Helicia australasica*	R	<3	5-10	1	0	0	0
RVS5	*Leptospermum madidum subsp. sativum*	R	<3	5-10	1	0	0	0
RVS5	*Lophostemon lactifluus*	R	<3	5-10	1	0	0	0
RVS5	*Melicope elleryana*	R	<3	5-10	1	0	0	0
RVS5	*Myrsine benthamiana*	R	<3	5-10	1	0	0	0
RVS5	*Pandanus spiralis*	R	<3	5-10	1	0	0	0
RVS5	*Syzygium armstrongii*	R	<3	5-10	1	0	0	0
RVS5	*Xanthostemon eucalyptoides*	R	<3	5-10	1	0	0	0

APPENDIX C POST DRY-SEASON SURVEY TREE DATA

Site name	Species	Strata	Height (m)	Cover (%)	Dead-0 Live-1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
Reference	*Lophostemon lactifluus*	U	8-10	5	1	0	0	0
Reference	*Melaleuca viridiflora*	U	16-18	15	1	0	0	0
Reference	*Syzygium armstrongii*	U	14-16	15	0	1	0	0
Reference	*Xanthostemon eucalyptoides*	U	10-12	5-10	1	0	0	0
Reference	*Carallia brachiata*	M	4-6	5	1	0	0	0
Reference	*Corymbia polycarpa*	M	4	<1	1	0	0	0
Reference	*Cyclophyllum schultzii f. schultzii*	M	3-6	1	1	1	0	1
Reference	*Fagraea racemosa*	M	6	<5	1	1	0	1
Reference	*Melicope elleryana*	M	8-10	5	1	0	0	1
Reference	*Myrsine benthamiana*	M	3-6	5	1	0	1	1
Reference	*Pandanus aquaticus*	M	3-6	5-10	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	M	3-8	5-10	1	0	0	0
Reference	*Barringtonia acutangula subsp. acutangula*	R	<3	10-15	1	0	0	0
Reference	*Carpentaria acuminata*	R	<3	10-15	1	0	0	0
Reference	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
Reference	*Helicia australasica*	R	<3	10-15	1	0	0	1
Reference	*Melicope elleryana*	R	<3	10-15	1	0	0	1
Reference	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
Reference	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
Reference	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
Reference	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS1	*Melaleuca argentea*	U	12-14	15	1	0	0	0
RVS1	*Syzygium armstrongii*	U	10-12	5-10	1	0	0	0
RVS1	*Xanthostemon eucalyptoides*	U	12-14	15-20	1	0	0	0
RVS1	*Acacia holosericea*	M	3-4	1-5	1	0	1	0
RVS1	*Barringtonia acutangula subsp. acutangula*	M	3-5	5-10	1	1	1	0
RVS1	*Carallia brachiata*	M	3-5	2-5	1	0	0	0
RVS1	*Cyclophyllum schultzii f. schultzii*	M	3-4	1	1	1	0	1
RVS1	*Leptospermum madidum subsp. sativum*	M	4-8	15-20	1	0	0	0
RVS1	*Myrsine benthamiana*	M	4	<1	1	0	0	1
RVS1	*Pandanus spiralis*	M	3-6	5-10	1	0	0	0
RVS1	*Xanthostemon eucalyptoides*	M	5-8	10-15	1	0	0	0
RVS1	*Barringtonia acutangula subsp. acutangula*	R	<3	10-15	1	0	0	0
RVS1	*Carallia brachiata*	R	<3	10-15	1	0	0	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead-0 Live-1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS1	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	0	0	1
RVS1	*Fagraea racemosa*	R	<3	10-15	1	0	0	1
RVS1	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS1	*Leptospermum madidum subsp. Sativum*	R	<3	10-15	1	0	0	0
RVS1	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
RVS1	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS1	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS2	*Eucalyptus miniata*	U	10-12	3-5	1	0	0	0
RVS2	*Lophostemon lactifluus*	U	10	5	1	0	0	0
RVS2	*Melaleuca viridiflora*	U	10-12	5	1	0	1	0
RVS2	*Syzygium armstrongii*	U	10	5-10	1	0	0	0
RVS2	*Acacia holosericea*	M	3-5	3-5	1	0	1	0
RVS2	*Carpentaria acuminata*	M	6	1	1	0	1	0
RVS2	*Cyclophyllum schultzii f. schultzii*	M	3-4	<1	1	1	1	1
RVS2	*Exocarpos latifolius*	M	3-4	<1	1	0	0	0
RVS2	*Helicia australasica*	M	3-5	<3	1	0	0	1
RVS2	*Leptospermum madidum subsp. sativum*	M	4-8	10-15	1	0	0	0
RVS2	*Pandanus spiralis*	M	3-6	1-3	1	0	0	0
RVS2	*Syzygium armstrongii*	M	3-6	1-2	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	M	4-8	10-15	1	0	0	0
RVS2	*Acacia holosericea*	R	<3	30-40	1	0	0	0
RVS2	*Alphitonia excelsa*	R	<3	30-40	1	0	0	0
RVS2	*Breynia cernua*	R	<3	30-40	1	0	0	0
RVS2	*Carpentaria acuminata*	R	<3	30-40	1	0	0	0
RVS2	*Cyclophyllum schultzii f. schultzii*	R	<3	30-40	1	1	0	1
RVS2	*Exocarpos latifolius*	R	<3	30-40	1	0	0	0
RVS2	*Helicia australasica*	R	<3	30-40	1	0	0	1
RVS2	*Leptospermum madidum subsp. sativum*	R	<3	30-40	1	0	0	0
RVS2	*Pandanus spiralis*	R	<3	30-40	1	0	0	0
RVS2	*Syzygium armstrongii*	R	<3	30-40	1	0	0	0
RVS2	*Xanthostemon eucalyptoides*	R	<3	30-40	1	0	0	0
RVS3	*Erythrophleum chlorostachys*	U	12-14	5-10	1	1	0	0
RVS3	*Leptospermum madidum subsp. sativum*	U	10-12	<5	1	0	0	0
RVS3	*Melaleuca viridiflora*	U	12-15	5-10	1	1	0	0
RVS3	*Syzygium armstrongii*	U	12-15	5	1	1	1	0
RVS3	*Xanthostemon eucalyptoides*	U	10-14	5	1	0	0	0
RVS3	*Acacia auriculiformis*	M	8-10	1-5	1	0	0	0
RVS3	*Acacia holosericea*	M	3-5	5	1	1	1	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead-0 Live-1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS3	*Alphitonia excelsa*	M	4-5	<1	1	0	0	0
RVS3	*Carallia brachiata*	M	3-4	<1	1	1	0	0
RVS3	*Cyclophyllum schultzii f. schultzii*	M	3-4	1	1	1	1	1
RVS3	*Dead stump - unknown tree*	M	10	<1	0	0	0	0
RVS3	*Denhamia obscura*	M	6-8	1-3	1	0	0	1
RVS3	*Erythrophleum chlorostachys*	M	3-5	<1	1	0	0	0
RVS3	*Leptospermum madidum subsp. sativum*	M	5-8	5-10	1	0	0	0
RVS3	*Livistona humilis*	M	3-4	1	1	0	0	0
RVS3	*Melaleuca viridiflora*	M	4-6	<1	1	1	0	0
RVS3	*Pandanus aquaticus*	M	1-4	2-5	1	0	0	0
RVS3	*Pandanus spiralis*	M	1-4	1	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	M	3-10	10-15	1	0	0	0
RVS3	*Acacia holosericea*	R	<3	10-15	1	0	0	0
RVS3	*Alphitonia excelsa*	R	<3	10-15	1	0	0	0
RVS3	*Breynia cernua*	R	<3	10-15	1	0	0	0
RVS3	*Carallia brachiata*	R	<3	10-15	1	0	0	0
RVS3	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	1	0	1
RVS3	*Erythrophleum chlorostachys*	R	<3	10-15	1	0	0	0
RVS3	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS3	*Livistona humilis*	R	<3	10-15	1	0	0	0
RVS3	*Melaleuca viridiflora*	R	<3	10-15	1	0	0	0
RVS3	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS3	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS3	*Xanthostemon eucalyptoides*	R	<3	10-15	1	0	0	0
RVS4	*Corymbia polycarpa*	U	10-12	5	1	0	0	0
RVS4	*Syzygium angophoroides*	U	8-10	5	1	1	0	0
RVS4	*Syzygium armstrongii*	U	14-16	20	1	1	0	0
RVS4	*Xanthostemon eucalyptoides*	U	12-14	15	1	0	0	0
RVS4	*Acacia holosericea*	M	4-5	15	1	0	0	0
RVS4	*Carallia brachiata*	M	3-5	15	1	0	0	0
RVS4	*Cyclophyllum schultzii f. schultzii*	M	3-5	15	1	1	0	1
RVS4	*Flagellaria indica*	M	8-10	15	1	0	0	0
RVS4	*Gmelina shirleyi*	M	5-8	15	1	0	1	0
RVS4	*Ilex arnhemensis*	M	6-8	15	1	1	0	1
RVS4	*Melaleuca viridiflora*	M	8-10	15	1	0	0	0
RVS4	*Myrsine benthamiana*	M	3-6	10	1	0	0	1
RVS4	*Pandanus spiralis*	M	4-6	15	1	0	0	0
RVS4	*Syzygium armstrongii*	M	6-8	10	1	1	1	0

Site name	Species	Strata	Height (m)	Cover (%)	Dead-0 Live-1	Flower No-0 Yes-1	Fruit No-0 Yes-1	Riparian sensitive sp. No-0 Yes-1
RVS4	*Xanthostemon eucalyptoides*	M	4-8	25	1	0	1	0
RVS4	*Acacia holosericea*	R	<3	10-15	1	0	0	0
RVS4	*Cyclophyllum schultzii f. schultzii*	R	<3	10-15	1	1	1	1
RVS4	*Helicia australasica*	R	<3	10-15	1	0	0	1
RVS4	*Melicope elleryana*	R	<3	10-15	1	0	0	1
RVS4	*Myrsine benthamiana*	R	<3	10-15	1	0	0	1
RVS4	*Pandanus spiralis*	R	<3	10-15	1	0	0	0
RVS4	*Syzygium angophoroides*	R	<3	10-15	1	0	0	0
RVS4	*Syzygium armstrongii*	R	<3	10-15	1	0	0	0
RVS5	*Lophostemon lactifluus*	U	8-10	5-10	1	0	0	0
RVS5	*Melaleuca viridiflora*	U	10-12	10-15	1	0	0	0
RVS5	*Syzygium armstrongii*	U	10-12	10-15	1	1	0	0
RVS5	*Xanthostemon eucalyptoides*	U	12-14	15	1	0	0	0
RVS5	*Acacia holosericea*	M	3-5	1-3	1	0	1	0
RVS5	*Carallia brachiata*	M	6-8	5	1	0	1	0
RVS5	*Cyclophyllum schultzii f. schultzii*	M	3-6	1-2	1	1	0	0
RVS5	*Helicia australasica*	M	3-6	10-15	1	1	0	1
RVS5	*Leptospermum madidum subsp. sativum*	M	4-6	5-10	1	0	0	0
RVS5	*Lophostemon lactifluus*	M	6-7	<5	1	0	0	0
RVS5	*Melaleuca viridiflora*	M	6	<1	0	0	0	0
RVS5	*Myrsine benthamiana*	M	3-4	<1	1	0	0	1
RVS5	*Pandanus spiralis*	M	4-5	1-2	1	0	0	0
RVS5	*Syzygium armstrongii*	M	6-8	5	1	1	0	0
RVS5	*Xanthostemon eucalyptoides*	M	4-10	15	1	0	0	0
RVS5	*Acacia holosericea*	R	<3	5-10	1	0	0	0
RVS5	*Carallia brachiata*	R	<3	5-10	1	0	0	0
RVS5	*Cyclophyllum schultzii f. schultzii*	R	<3	5-10	1	0	0	1
RVS5	*Helicia australasica*	R	<3	5-10	1	0	0	1
RVS5	*Leptospermum madidum subsp. Sativum*	R	<3	5-10	1	0	0	0
RVS5	*Livistona humilis*	R	<3	5-10	1	0	0	0
RVS5	*Melaleuca viridiflora*	R	<3	5-10	1	0	0	0
RVS5	*Melicope elleryana*	R	<3	5-10	1	0	0	1
RVS5	*Myrsine benthamiana*	R	<3	5-10	1	0	0	1
RVS5	*Pandanus spiralis*	R	<3	5-10	1	0	0	0
RVS5	*Syzygium armstrongii*	R	<3	5-10	1	0	0	0
RVS5	*Xanthostemon eucalyptoides*	R	<3	5-10	1	0	0	0

APPENDIX D GROUND COVER POST WET-SEASON SURVEY

Site name	Ground cover type	% cover	Vegetation type	% cover
RVS1	Vegetation	70	Grass	10
RVS1	Soil	5	Ferns	10
RVS1	Rock	0	Sedges	40
RVS1	Litter	25	Herbs	5
RVS1	Other	0	Other vegetation	5
RVS2	Vegetation	65	Grass	35
RVS2	Soil	10	Ferns	15
RVS2	Rock	0	Sedges	0
RVS2	Litter	15	Herbs	5
RVS2	Other (water)	10	Other vegetation	0
RVS3	Vegetation	70	Grass	50
RVS3	Soil	2	Ferns	5-10
RVS3	Rock	0	Sedges	5
RVS3	Litter	18	Herbs	5
RVS3	Other (water)	10	Other vegetation	0
RVS4	Vegetation	55	Grass	40
RVS4	Soil	10	Ferns	5
RVS4	Rock	0	Sedges	5
RVS4	Litter	15	Herbs	5
RVS4	Other	20	Other vegetation	0
RVS5	Vegetation	40	Grass	25
RVS5	Soil	25	Ferns	5
RVS5	Rock	5	Sedges	5
RVS5	Litter	25	Herbs	5
RVS5	Other	5	Other vegetation	0
Reference	Vegetation	40	Grasses	25
Reference	Soil	5	Ferns	0
Reference	Rock	0	Sedges	10
Reference	Litter	15	Herbs	<1
Reference	Other (water)	40	Other vegetation	0

APPENDIX E GROUND COVER POST DRY-SEASON SURVEY

Site name	Ground cover type	% cover	Vegetation type	% cover
RVS1	Vegetation	60	Grass	5
RVS1	Soil	10	Ferns	<1
RVS1	Rock	0	Sedges	40
RVS1	Litter	30	Herbs	<1
RVS1	Other	0	Other vegetation	0
RVS2	Vegetation	55	Grass	30
RVS2	Soil	15	Ferns	10
RVS2	Rock	<1	Sedges	5
RVS2	Litter	30	Herbs	<1
RVS2	Other	0	Other vegetation	10
RVS3	Vegetation	70	Grass	55
RVS3	Soil	5	Ferns	2-5
RVS3	Rock	0	Sedges	5-10
RVS3	Litter	20	Herbs	<1
RVS3	Other	5	Other vegetation	0
RVS4	Vegetation	50	Grass	40
RVS4	Soil	5	Ferns	0
RVS4	Rock	0	Sedges	5-10
RVS4	Litter	25	Herbs	<1
RVS4	Other	20	Other vegetation	0
RVS5	Vegetation	35	Grass	25
RVS5	Soil	15	Ferns	5
RVS5	Rock	5	Sedges	1
RVS5	Litter	50	Herbs	0
RVS5	Other	<1	Other vegetation	0
Reference	Vegetation	40	Grass	30
Reference	Soil	5	Ferns	<1
Reference	Rock	0	Sedges	10-15
Reference	Litter	15	Herbs	<1
Reference	Other	40	Other vegetation	0

APPENDIX F GENERAL OBSERVATIONS POST WET-SEASON AND POST-DRY SEASON SURVEY

Site name	Survey date	Fire	Weeds	Erosion	Surface water flows	Aquatic life flora/fauna	Sedimentation (present/absent)	Climatic conditions	Contamination	Additional notes
RVS1	May	<1 year	None	Absent	Trickling	Present	Absent	Sunny, slightly hazy	Bio-film/sheen	Eriocaulon sp, Nymphaea sp alive in stream
RVS2	May	<1 year	None	Absent	Trickling	Present	Absent	Humid, partly cloudy	Nil	Eriocaulon sp, Nymphaea sp alive in stream
RVS3	May	>3 year, part of, site <1 yr for remaining	Mission grass patch adjacent to site	Absent	Trickling	Present	Absent	Humid, partly cloudy	Nil	Eriocaulon sp, Nymphaea sp alive in stream
RVS4	May	<1 year	None	Absent	Tricking	Present	Absent, slight red tinge to water	Humid, partly cloudy	Nil	Eriocaulon sp, Nymphaea sp alive in stream.
RVS5	May	<1 year	None	Absent	Slow trickle	Present	Absent, red algal present	Humid, partly cloudy	Bio-film/sheen	Eriocaulon sp, Nymphaea sp, Fimbristylis sp. all alive in stream; snake spotted, fish and insect also present
Reference	May	>3 year	None	Absent	Slow trickle	Present	Absent	Sunny	Natural biofilm present on surface water	Eriocaulon sp, Nymphaea sp all alive in stream, 8m wide bank side sloping bank 3-5% slope towards the water. 1-2m deep from the bank
RVS1	October	<1 year	None	Absent	Stagnant no flow	Present	Absent	Partly cloudy	Bio-film/sheen and red algae present	Nil
RVS2	October	<1 year (moderate severity)	None	Absent	No standing water present	None	None	Partly cloudy	Nil	Nil
RVS3	October	<1 year	None	Absent	Stagnant no flow, x1 small pool	None	Absent	Sunny	Nil	Some pig damage x1 large Syzygium 6-cm DBH recorded on GPS next to water
RVS4	October	<1 year (moderate severity)	None	Absent	Stagnant, no flow	None	Absent	Sunny, partial cloud cover	Bio-film/sheen, some plant matter on surface brown stagnant water	Nil
RVS5	October	<1 year	None	Absent	No standing water present	None	Absent	Sunny	Nil	Nil
Reference	October	Nil	None	Absent	Not flowing, water stagnant	Present	Absent	Sunny	Nil	Eriocaulon sp, Nymphaea sp all alive in stream

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APPENDIX F WEEKLY SURVEYED OHD WATER LEVELS

Date	AHD level	Comments	Date	AHD level	Comments
8/7/2022	28.809	Manual WL by Survey Team	11/11/2022	27.09	Logger
13/7/2022	28.743	Manual WL by Survey Team	12/11/2022	27.09	Logger
20/07/2022	28.712	Manual WL by Survey Team	13/11/2022	27.09	Logger
27/07/2022	28.627	Manual WL by Survey Team	14/11/2022	27.08	Logger
1/8/2022	28.547	Manual WL by Survey Team	15/11/2022	27.08	Logger
10/8/2022	28.45	Manual WL by Survey Team	16/11/2022	27.08	Logger
14/08/2022	28.38	Manual WL by Survey Team	17/11/2022	27.08	Logger
24/08/2022	28.222	Manual WL by Survey Team	18/11/2022	27.08	Logger
29/8/2022	28.112	Manual WL by Survey Team	19/11/2022	27.08	Logger
5/9/2022	28.019	Manual WL by Survey Team	20/11/2022	27.08	Logger
9/9/2022	27.944	Manual WL by Survey Team	21/11/2022	27.08	Logger
13/9/2022	27.872	Manual WL by Survey Team	22/11/2022	27.08	Logger
20/9/2022	27.729	Manual WL by Survey Team	23/11/2022	26.43	Logger
28/9/2022	27.597	Manual WL by Survey Team	24/11/2022	26.43	Logger
4/10/2022	26.43	Logger	25/11/2022	26.43	Logger
5/10/2022	26.43	Logger	26/11/2022	26.43	Logger
6/10/2022	26.43	Logger	27/11/2022	26.43	Logger
7/10/2022	26.43	Logger	28/11/2022	26.43	Logger
8/10/2022	26.43	Logger	29/11/2022	26.43	Logger
9/10/2022	26.43	Logger	30/11/2022	26.43	Logger
10/10/2022	26.43	Logger	1/12/2022	27.287	Logger
11/10/2022	26.43	Logger	2/12/2022	27.287	Logger
12/10/2022	26.43	Logger	3/12/2022	27.28	Logger
13/10/2022	26.43	Logger	4/12/2022	27.273	Logger
14/10/2022	26.43	Logger	5/12/2022	27.262	Logger
15/10/2022	26.43	Logger	6/12/2022	27.252	Logger
16/10/2022	26.43	Logger	7/12/2022	27.238	Logger
17/10/2022	26.43	Logger	8/12/2022	27.226	Logger
18/10/2022	26.43	Logger	9/12/2022	27.214	Logger
19/10/2022	26.43	Logger	10/12/2022	27.2	Logger
20/10/2022	26.43	Logger	11/12/2022	27.207	Logger
21/10/2022	26.43	Logger	12/12/2022		Logger Error
22/10/2022	26.43	Logger	16/12/2022	27.147	Manual WL by Survey Team
23/10/2022	26.43	Logger	19/12/2022	27.169	Manual WL by Survey Team
24/10/2022	26.43	Logger	21/12/2022	27.184	Manual WL by Survey Team
25/10/2022	26.43	Logger	28/12/2022	27.679	Manual WL by Survey Team
26/10/2022	26.43	Logger	30/12/2022	28.167	Manual WL by Survey Team
27/10/2022	26.43	Logger	1/1/2022	28.672	Manual WL by Survey Team
28/10/2022	26.43	Logger	4/1/2023	28.973	Manual WL by Survey Team
29/10/2022	26.43	Logger	11/1/2023	29.178	Manual WL by Survey Team
30/10/2022	26.43	Logger	14/01/2023	29.15	Manual WL by Survey Team
31/10/2022	26.43	Logger	16/01/2023	29.123	Manual WL by Survey Team
1/11/2022	26.43	Logger	17/01/2023	29.103	Manual WL by Survey Team
2/11/2022	27.24	Logger	26/01/2023	29.088	Manual WL by Survey Team
3/11/2022	27.22	Logger	31/01/2023	29.173	Manual WL by Survey Team
4/11/2022	27.2	Logger	12/2/2023	29.475	Manual WL by Survey Team
5/11/2022	27.2	Logger	14/2/2023	29.482	Manual WL by Survey Team
6/11/2022	27.18	Logger	23/02/2023	29.516	Manual WL by Survey Team
7/11/2022	27.15	Logger	25/3/2023	29.49	Manual WL by Survey Team
8/11/2022	27.14	Logger	4/4/2023	29.49	Manual WL by Survey Team
9/11/2022	27.12	Logger	11/4/2023	29.5	Manual WL by Survey Team
10/11/2022	27.12	Logger	21/4/2023	29.57	Manual WL by Survey Team

APPENDIX G CALIBRATTION OF THE OHD WATER BALANCE MODEL (MEMO)

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MEMORANDUM

Date	14 July 2023
Attention	Paul McHugh
Company	Lithium Developments Pty Ltd
WRM ref.	1727-18-C
Subject	Calibration of the Observation Hill Dam (OHD) Water balance model

1 INTRODUCTION

1.1 OVERVIEW

WRM Water & Environment Pty Ltd (WRM) was requested by Lithium Developments Pty Ltd (LD) to calibrate the Observation Hill Dam (OHD) runoff parameters using the Finniss Lithium Project water balance model based on the recorded data during the period of 1st May 2022 to 30th April 2023 (the reporting period). This assessment was undertaken to address special condition 4.2 (viii) of Core Lithium Ltd's (Core's) surface water extraction licence (SWEL) 8151018.

The location of the key features relating to the OHD catchment are shown in Figure 1.1.

1.2 SWEL SPECIAL CONDITION 4.2 (VIII)

Special condition 4.2 (viii) of the Core SWEL states that the monitoring report must 'include a summary of the outputs from updated surface water modelling using the most recent monitoring data'.

1.3 SIMULATION METHODOLOGY

The Finniss Lithium Project Goldsim model (combined Grants OC and BP33 UG system) was used to calibrate the OHD runoff parameters to the recorded OHD dam water level, OHD spillway flow and flow through surface monitoring location BPDS SW2 during the reporting period.

The development and configuration of the Finniss Lithium Project Goldsim model is presented in the Grants Lithium Water Balance Model Assessment (WRM, 2023a) and BP33 Underground Mine Water Balance Water Balance Model Assessment (WRM, 2023b).

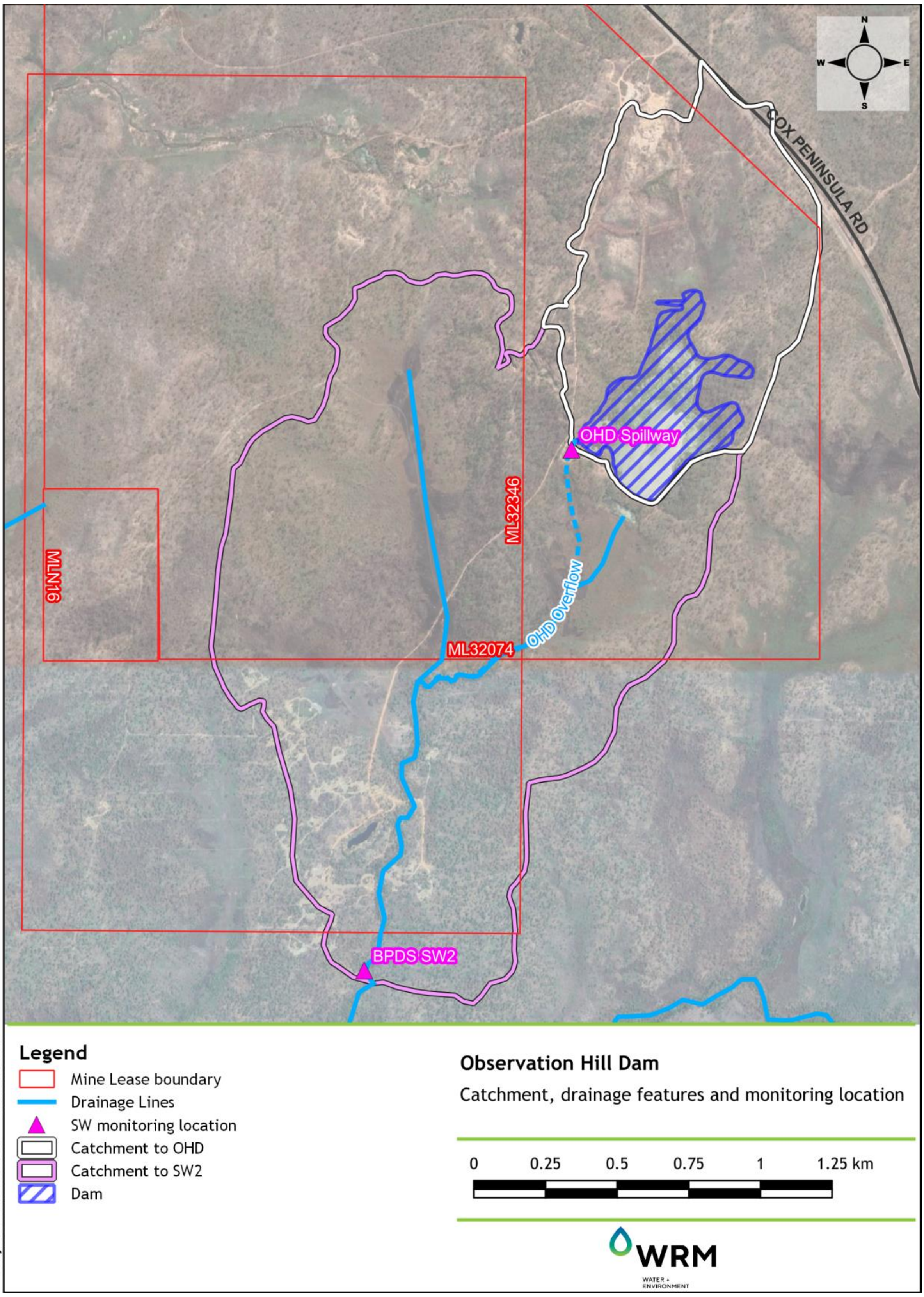

Figure 1.1 Observation Hill Dam catchment and features

2 AVAILABLE DATA

The following data was available for this assessment during the reporting period:

- Rainfall data recorded at:
  - Grants between 14 November 2022 and 30 April 2023; and
  - Territory Wildlife Park (Bureau of Meteorology (the Bureau) station number 14264) between 1 May 2022 and 19 April 2023;
- Recorded water extraction volumes from OHD to Grants;
- OHD bathymetric survey provided by Core personnel that was captured on 7 May 2023;
- Recorded water levels in OHD between 8 July 2022 and 30 April 2023 the OHD spillway between 30 September 2022 and 30 April 2023; and
- Recorded water levels and flows at surface water monitoring point BPDS SW2 between 10 November 2022 and 30 April 2023.

2.1 RAINFALL AND EVAPORATION DATA

Figure 2.1 shows the cumulative rainfall at for the Territory Wildlife Park (14264) and Grants for the reporting period. There is a significant difference between the total rainfall between site (1453 mm) and the Territory wildlife park gauge (2022 mm) during the reporting period. For calibration purposes, the Territory Wildlife Park rainfall data was adopted as it had a more complete record during the reporting period and was found to better represent the behaviour of recorded data at OHD and BPDS SW2.

SILO gridded data (DES, 2022) was used to estimate evaporation, Morton's lake evaporation and evapotranspiration for the OHD catchment and lake surface for the reporting period.

2.2 WATER EXTRACTION VOLUMES

OHD surface water has been extracted for various mine water uses during the reporting period. Figure 2.2 shows the water extraction from OHD for the given period. A total of 434 ML was extracted during the reporting period.

2.3 OHD STAGE STORAGE CURVE

Figure 2.3 shows the stage storage curve of OHD and adopted spillway level based on bathymetric survey provided by Core (see attachment A). Based on available information the OHD spillway level is approximately 29.5 mAHD at a full supply volume of 375 ML.

2.4 RECORDED WATER LEVELS AND FLOWS

Figure 2.4 shows the recorded OHD water level and spillway levels provided by Core. Note that spillway flows were derived assuming a flow cutoff depth of 100 mm and a spillway width of 5 m.

Figure 2.5 and Figure 2.6 shows the recorded flow and water level at BPDS SW2 respectively..

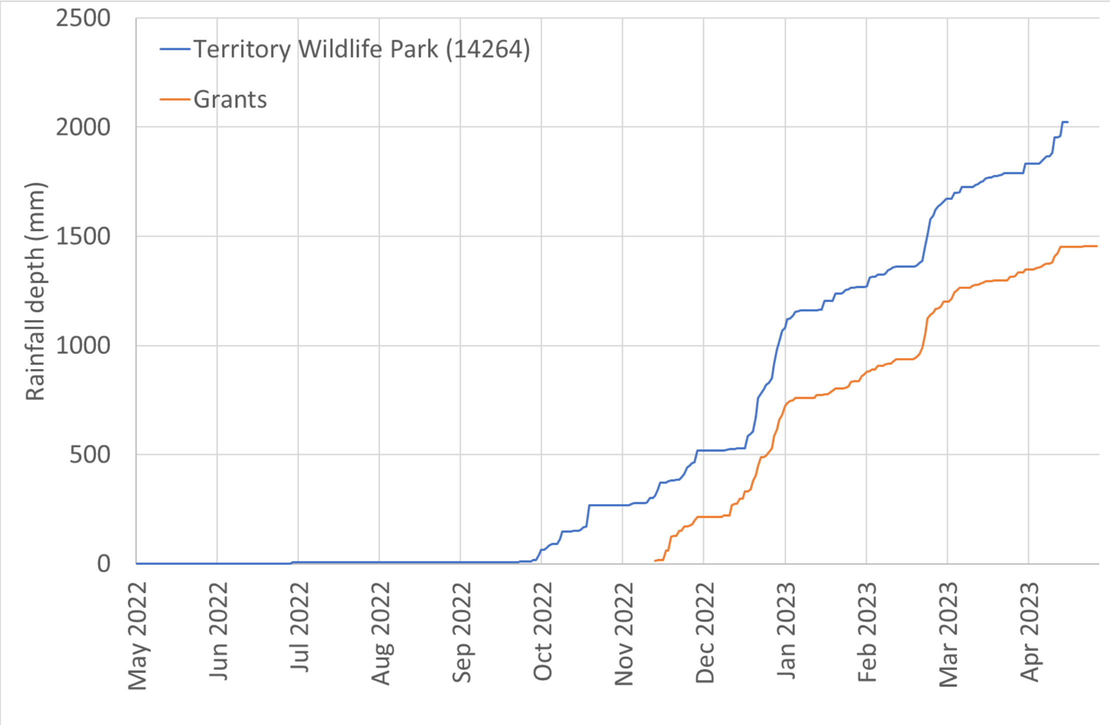

Figure 2.1 Cumulative rainfall data from Grants at site and BoM station 14264

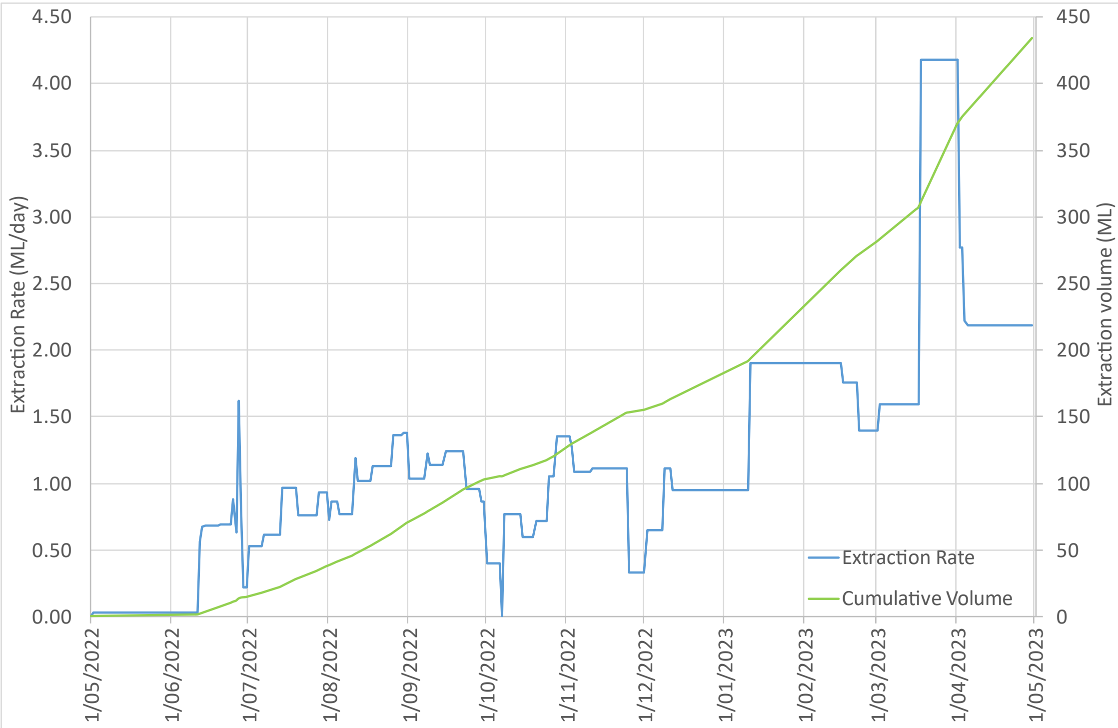

Figure 2.2 OHD Water Extraction during the reporting period

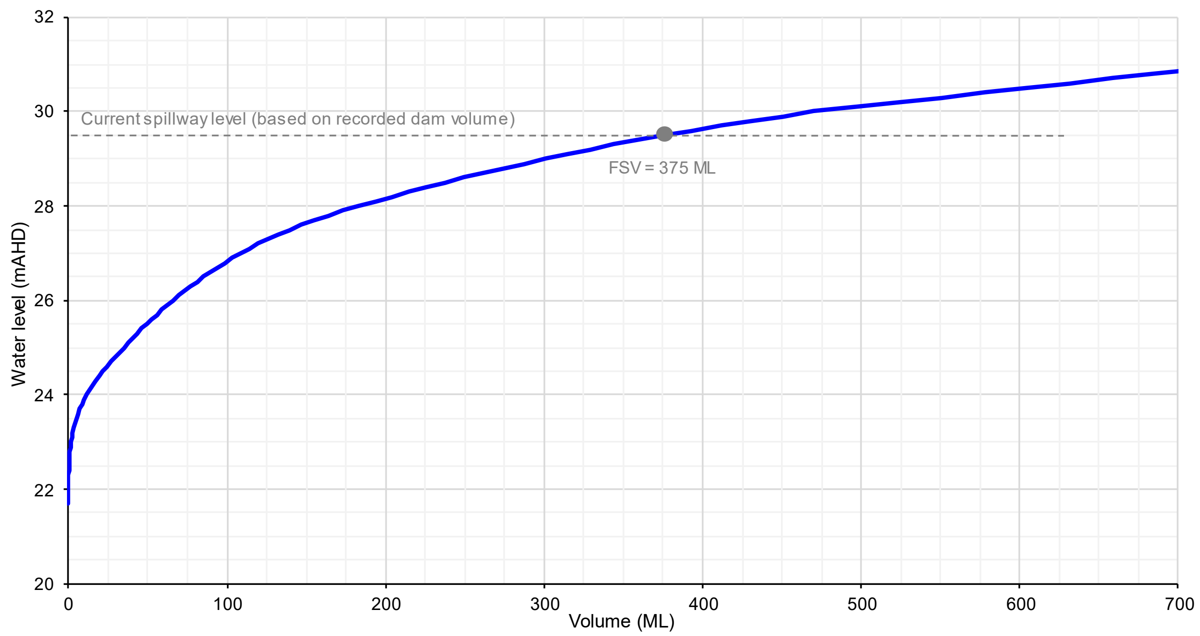

Figure 2.3 Adopted OHD Stage Storage Curve

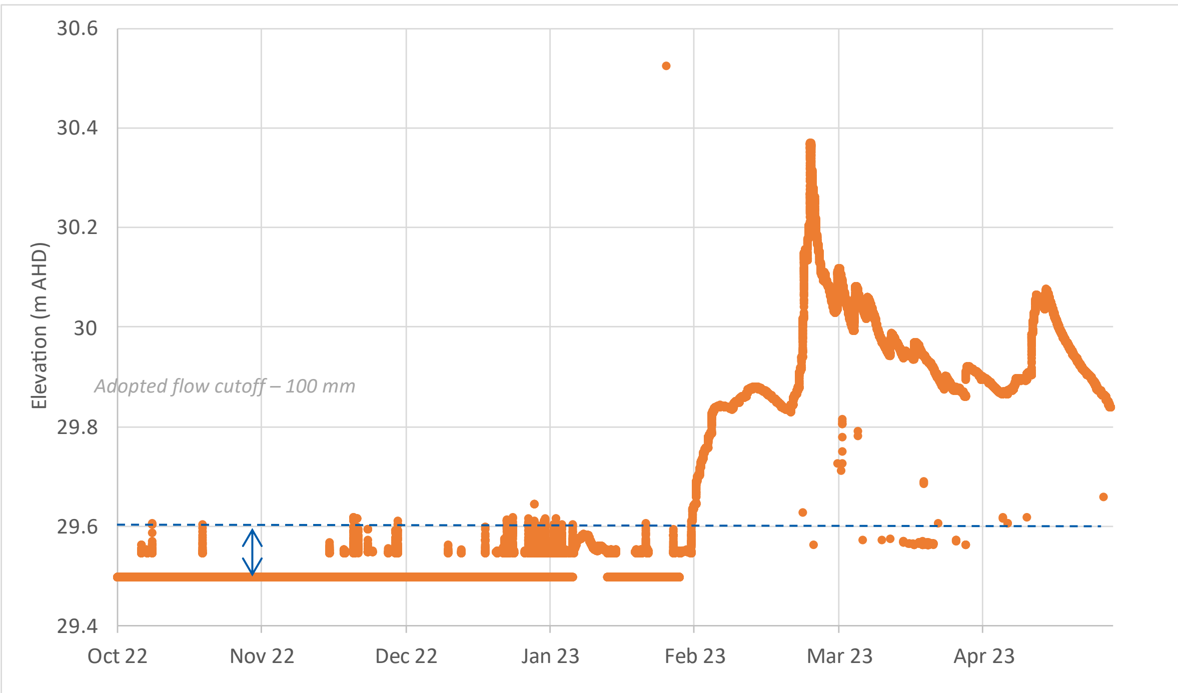

Figure 2.4 OHD recorded water levels during the reporting period

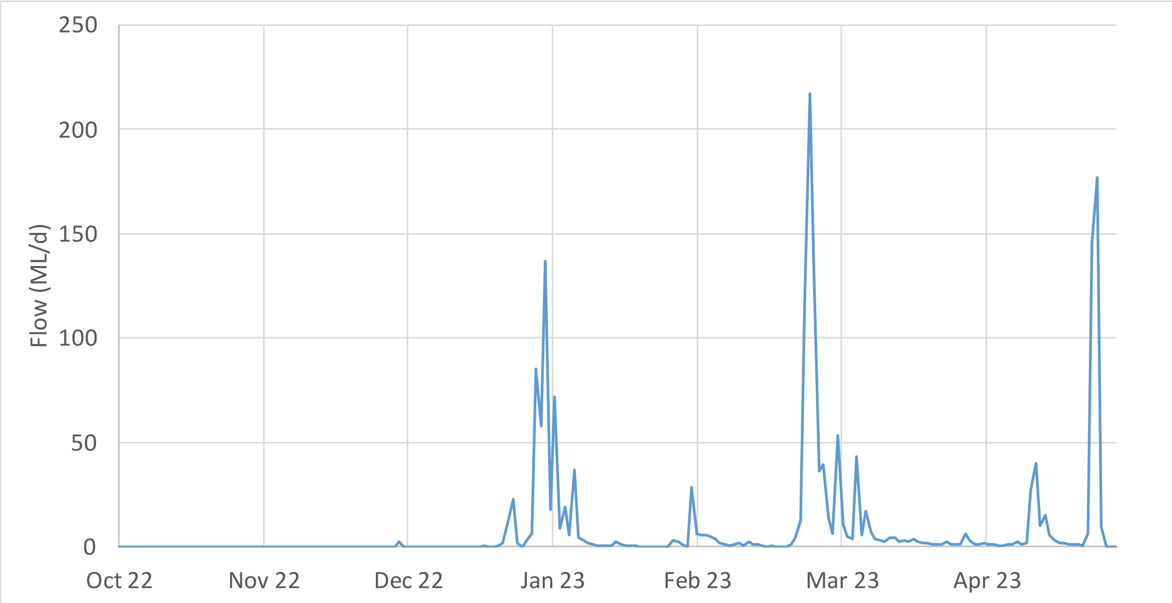

Figure 2.5 BPDS SW2 recorded flow during the reporting period

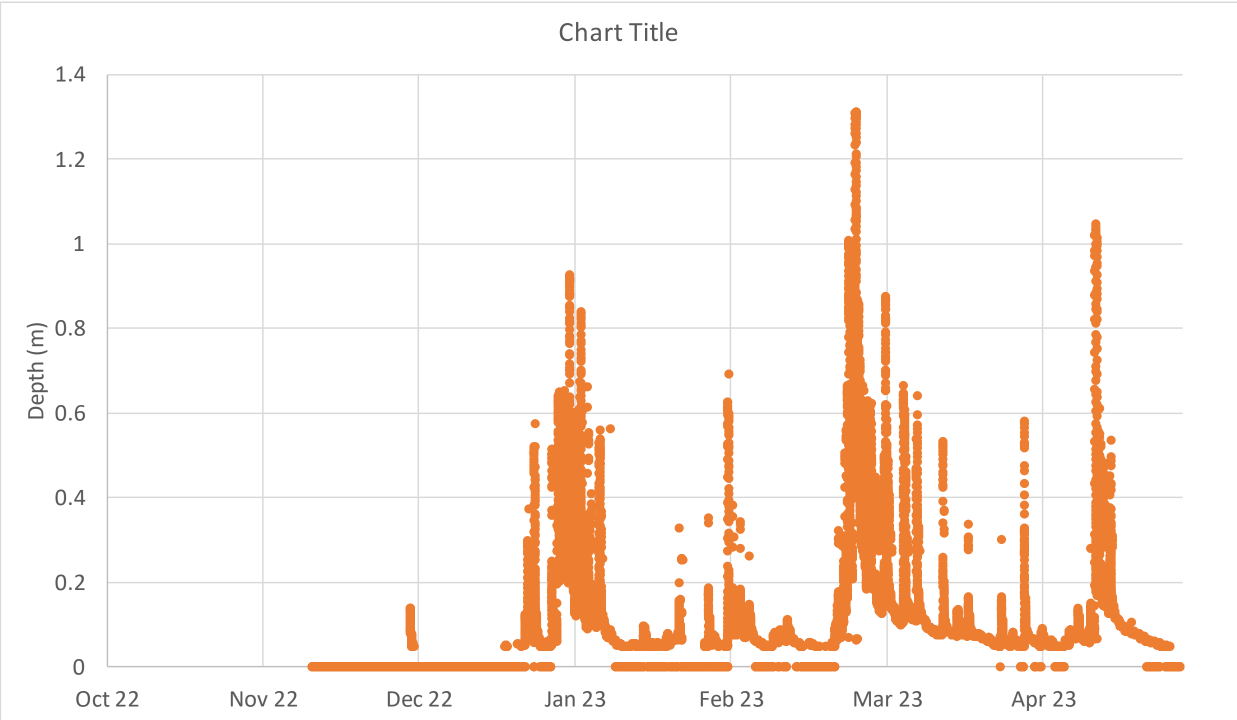

Figure 2.6 BPDS SW2 recorded water level during the reporting period

3 WATER BALANCE RESULTS

3.1 AWBM CALIBRATION PARAMETERS

Catchment runoff for OHD and BP SW2 was modelled using the Australian Water Balance Model (AWBM). The AWBM parameters for OHD and BP SW2 were reviewed as part of this assessment. The following is of note:

- The updated calibration of the AWBM parameters is considered preliminary only. This is due to the significant distance between the recorded rainfall data and OHD as well as the uncertainty in historical mining in the OHD catchment.
- The original AWBM parameters used for BPDS SW2 were found to be appropriate.
- The original AWBM parameters used for OHD did not match recorded water levels and overflows in OHD. It was found that recorded runoff into OHD was significantly attenuated when compared to the original AWBM parameters. The reasons for this unknown, however it may be due to the historical tin mining operations in the OHD catchment and/or flood attenuation within the OHD. Hence, the OHD AWBM parameters were updated for this assessment.
- The volumetric runoff coefficient for the original and updated parameter sets is the same. Hence, there is no material change in the catchment yield when compared with previous studies.
- Table 3.1 shows the original and updated AWBM parameters for OHD. The updated AWBM parameters provided a significantly better fit to recorded data (as discussed in the following sections).

Table 3.1 OHD AWBM parameters

Model parameters	ID	Original	Updated
Soil Store Depths (mm)	C1	10	10
	C2	20	20
	C3	120	120
Partial Areas	A1	0.5	0.5
	A2	0.3	0.3
Base Flow Index	BFI	0	0.65
Base flow recession constant	Kbase	0	0.99
Surface flow recession constant	Ksurf	0	0
Reporting Period volumetric runoff coefficient	Rv	58%	58%

3.2 WATER LEVELS AND FLOWS

Figure 3.1 shows the modelled and recorded water level in OHD during the reporting period.

Figure 3.2 shows the modelled and recorded OHD spillway flow during the reporting period.

Figure 3.3 shows the modelled and recorded flows at BPDS SW2 during the reporting period.

In general, the calibration results indicate that the adopted AWBM parameters for the OHD and BPDS SW2 catchments provide a reasonable fit to recorded data, when taking into account the rainfall and landuse uncertainty in the OHD catchment.

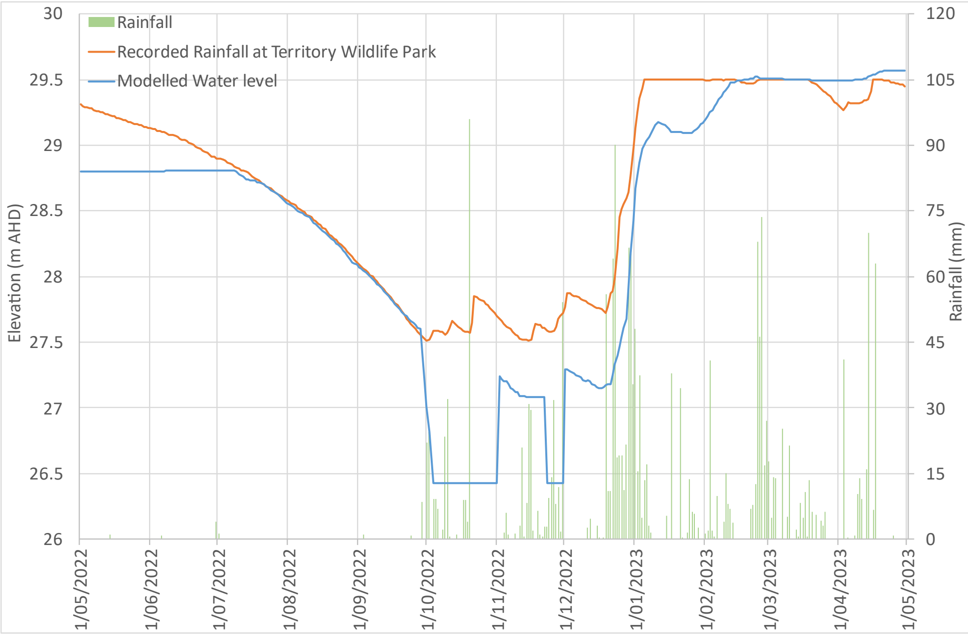

Figure 3.1 Calibrated model water level vs recorded water level at OHD

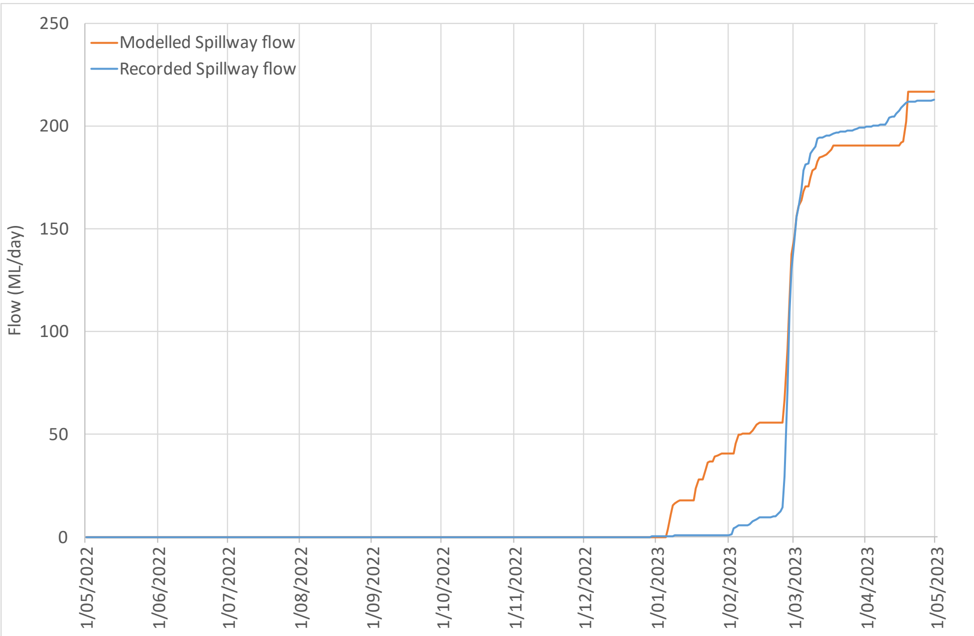

Figure 3.2 Calibrated model water level vs recorded spillway flow at OHD

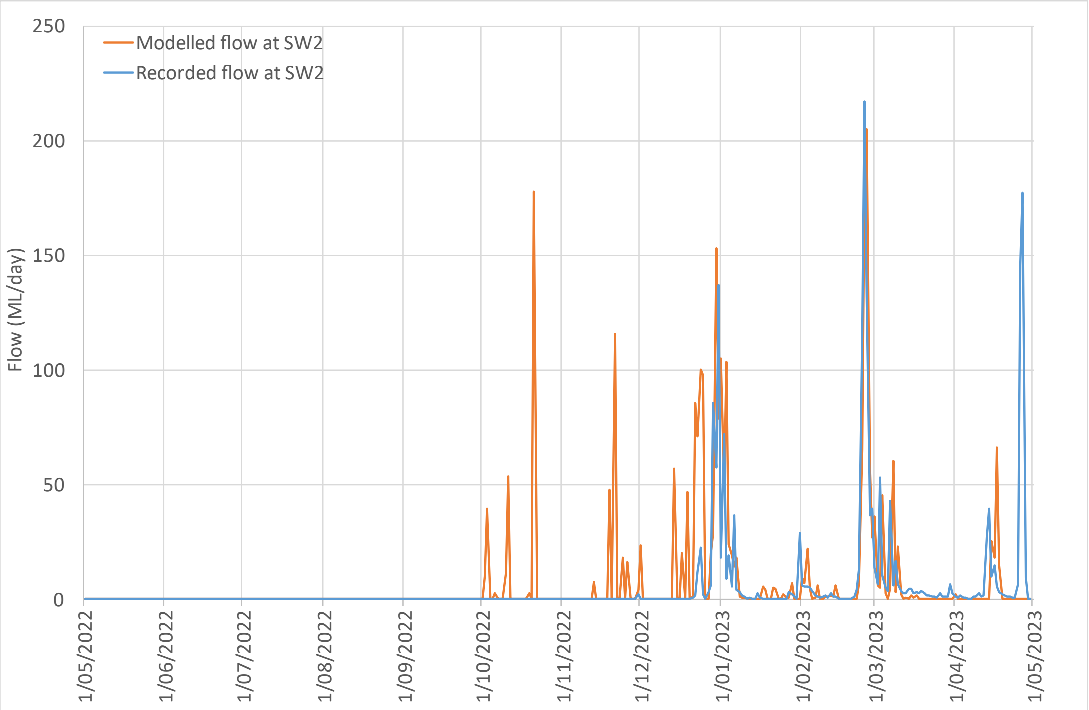

Figure 3.3 Calibrated model water level vs recorded flow at SW2

I trust this preliminary advice is of assistance. Please feel free to contact use if you have any queries or require any clarifications.

Regards,

Julian Orth
Principal Engineer

REFERENCES

DES, 2020	Department of Environment and Science, SILO Climate Database. Point darta requested at -12.65,130.75, Queensland Government
WRM, 2023	*'Grants Lithium - Water Balance Modelling Report'*, WRM, May 2023
WRM, 2023b	*'BP33 Underground Mine – Water Balance Modelling Report'*, WRM, June 2023