

# Preliminary Risk and Discharge Assessment for Lake Roe

Draft Memorandum

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# 1 Introduction

Ramelius Resources Limited (Ramelius) are proposing to develop the Roe Gold Project (the Project) comprising the Bombara deposit, which was first discovered in 2016. The Project is located on the southwestern edge of Lake Roe, 100 km east of Kalgoorlie, in the eastern Goldfields region of Western Australia (**Figure 1**). It comprises six granted tenements across an area of approximately 550 km<sup>2</sup>. Gold mineralisation typically occurs as a sulphide-impregnated lode along a north-south strike.

The Project includes the planned development of three open pits and an underground mine, approximately 2.5 km in length, which will be mined to approximately 200 m in depth. Supporting infrastructure will include a processing plant, waste rock landform (WRL), tailings storage facility (TSF), run of mine pad (ROM), laydown area, topsoil stockpiles, workshop, office and village, as well as linear infrastructure including access roads. To facilitate mining, dewatering of hypersaline groundwater from the pit will be required, with Ramelius considering Lake Roe as a potential environmental discharge option.

Lake Roe is an endorheic salt lake situated within the Roe Palaeoriver System and is fringed by numerous claypans, ephemeral wetlands and drainage features. The lake is approximately 90 km<sup>2</sup> and comprises multiple constrained and convoluted pans divided by a complex series of islands. These pans have been broadly delineated into Pans 1 to 3 and Pans A (key pans) to E by Ramelius (**Figure 2**), with several key pans considered as potential sites to receive discharge.

In May 2019, Stantec was commissioned by Ramelius to undertake a Baseline Aquatic Ecology Study (the 2019 Study) investigating the ecological values of Lake Roe and its peripheral wetlands (Stantec 2020), with several potentially new and/or restricted invertebrate taxa recorded. To investigate the distribution of these taxa, Stantec undertook an additional study of Lake Roe and surrounding regional lakes and wetlands, including Lake Yindalgooda and Lake Yindana in 2025 (the 2025 Study) (Stantec 2025).

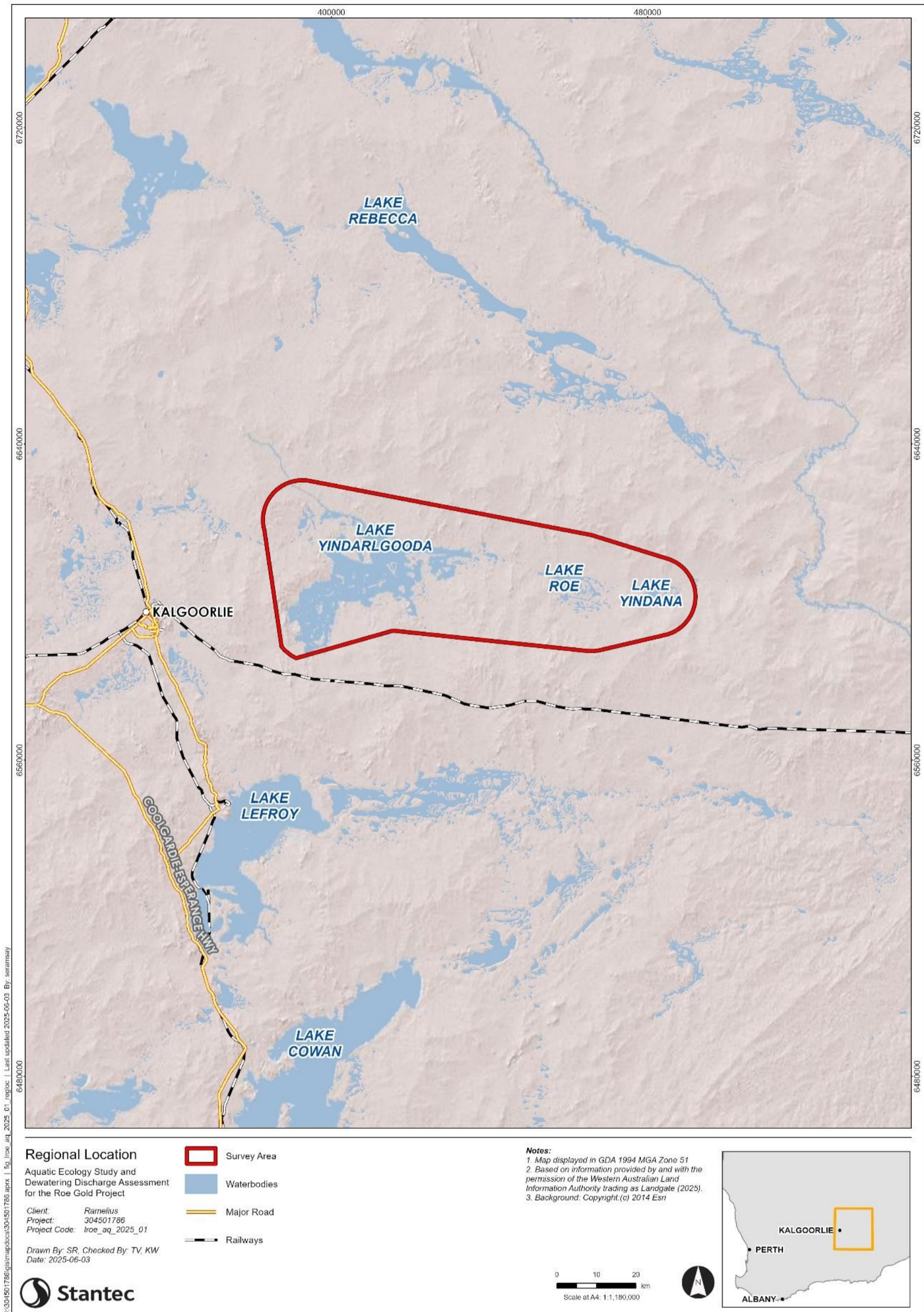
To accompany the 2025 Study, Stantec have prepared this memorandum, which presents the results of a preliminary environmental risk and discharge assessment for Lake Roe (the Assessment). This memorandum will support the referral of the Project to the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act* 1986 (EP Act).

## 2 Objectives and Scope

The objective of the Assessment was to assess the suitability of key pans within Lake Roe to receive steady-state discharge from dewatering of mining pits for the Project. To address the objective the following tasks were undertaken:

- desktop review, including analysis of historical satellite imagery and available ecological and hydrological studies, to characterise the environmental values of Lake Roe and key pans;
- preliminary risk assessment of key pans, based on the findings of the desktop review; and
- discharge assessment, including inundation extent and salt crust modelling of discharge scenarios on key pans.

This Assessment is based on current and available data and information, however may be subject to change in the future, as the Project progresses.



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**Figure 1: Regional location of the Project in relation to Lake Roe and surrounding lakes and wetlands.**

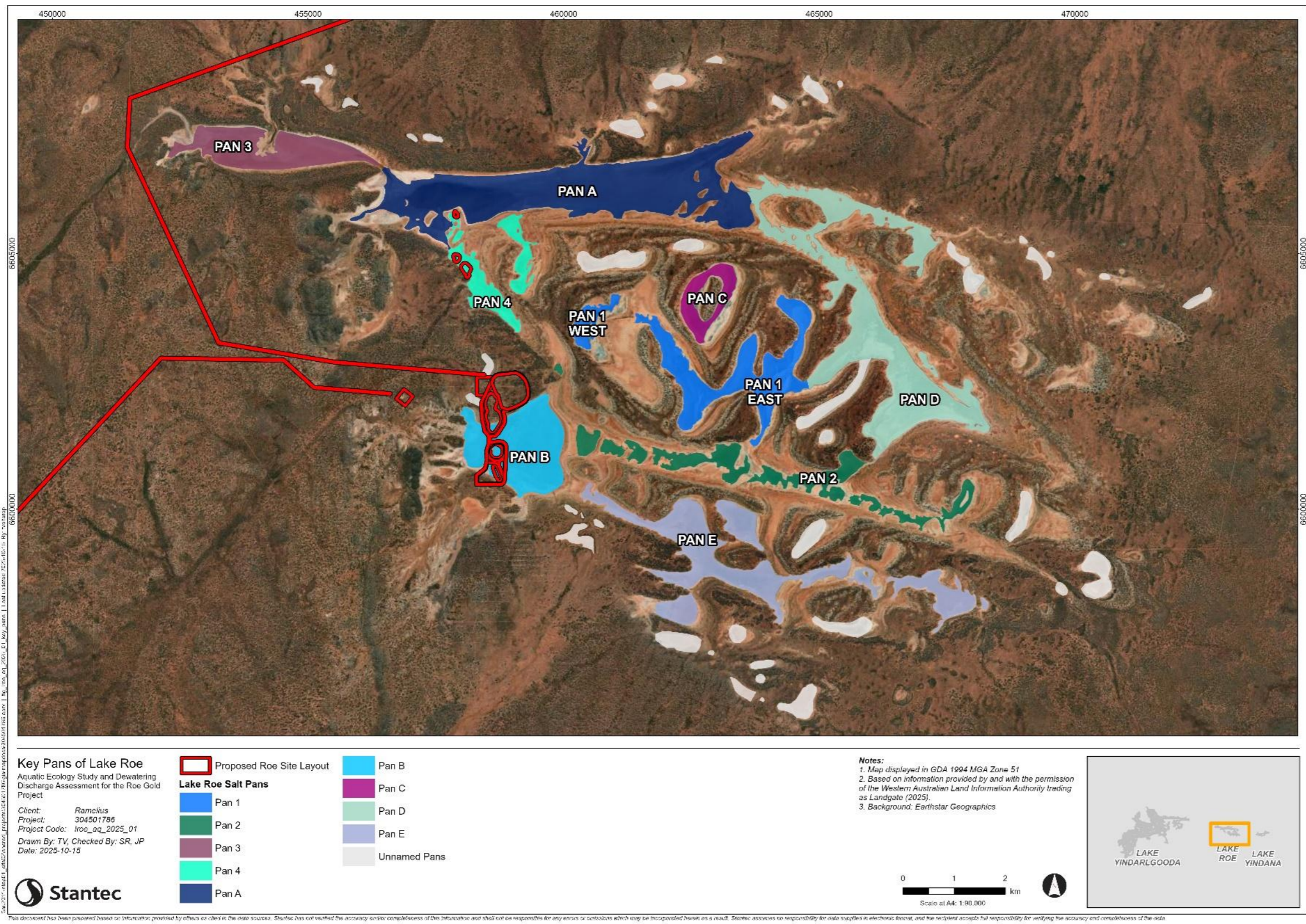


Figure 2: Classification of key pans on Lake Roe in relation to the Project layout.

## 3 Methods

### 3.1 Desktop Review

#### 3.1.1 Satellite Imagery Analysis of Surface Water

Surface water persistence and recurrence on Lake Roe and its peripheral wetlands was derived from Geoscience Australia's Water Observations from Space (WOfS) database (Geoscience Australia 2022). The WOfS database is a multi-temporal remote sensing tool that analyses surface-ground water relationships of aquatic and semi-aquatic systems by classifying water extents from historical satellite imagery. Using legacy and contemporary satellite sensors (Landsat 5 – 9 and Sentinel-2), WOfS can determine inundation extents using all available satellite images of the lake and surrounds. These observed extents (based on the presence or absence of water over time), are summed to generate the frequency (%) in which a pixel is inundated for an entire satellite image.

To investigate the timing and duration of historic inundation events at Lake Roe and peripheral wetlands (1985 to 2025), analysis was carried out using archived satellite data and imagery from the Landsat and Sentinel satellites. Analysis was carried out in the DEA Sandbox Jupyter Lab environment. The specific products used in this analysis were the WOfS Summary Layer, Water Observation Feature Layers (WOfLs), and Sentinel-2 Analysis-Ready Data (ARD). From this data, the timing and duration of inundation events for the lake and key pans on Lake Roe, including the surface area duration curves (SADs) were derived.

#### 3.1.2 Ecological Studies

Previously completed baseline aquatic ecology studies were reviewed as part of the Assessment, comprising:

- Lake Roe Gold Project: Baseline Aquatic Ecology Study (Stantec 2020); and
- Consolidated Aquatic Ecology Study of Lake Roe, Peripheral Wetlands and Regional Lakes (Stantec 2025).

The results of these studies provided an understanding of the ecological values of Lake Roe and the key pans, including significant species and potential environmental receptors. The sites sampled during these studies are presented in **Figure 3** and **Figure 4**. In addition, during the most recent 2025 baseline study regional lakes and wetlands were also assessed (**Figure 3**), to provide regional context for the distribution of potentially new or conservation significant aquatic invertebrates.

Due to the prevailing dry conditions during the 2019 and 2025 baseline studies, rewetting trials were employed to artificially flood sediment samples in the laboratory. These trials aim to simulate flooded conditions required for the emergence of aquatic biota, which were subsequently identified. Detailed interpretation of these results is provided in the baseline aquatic ecology reports.

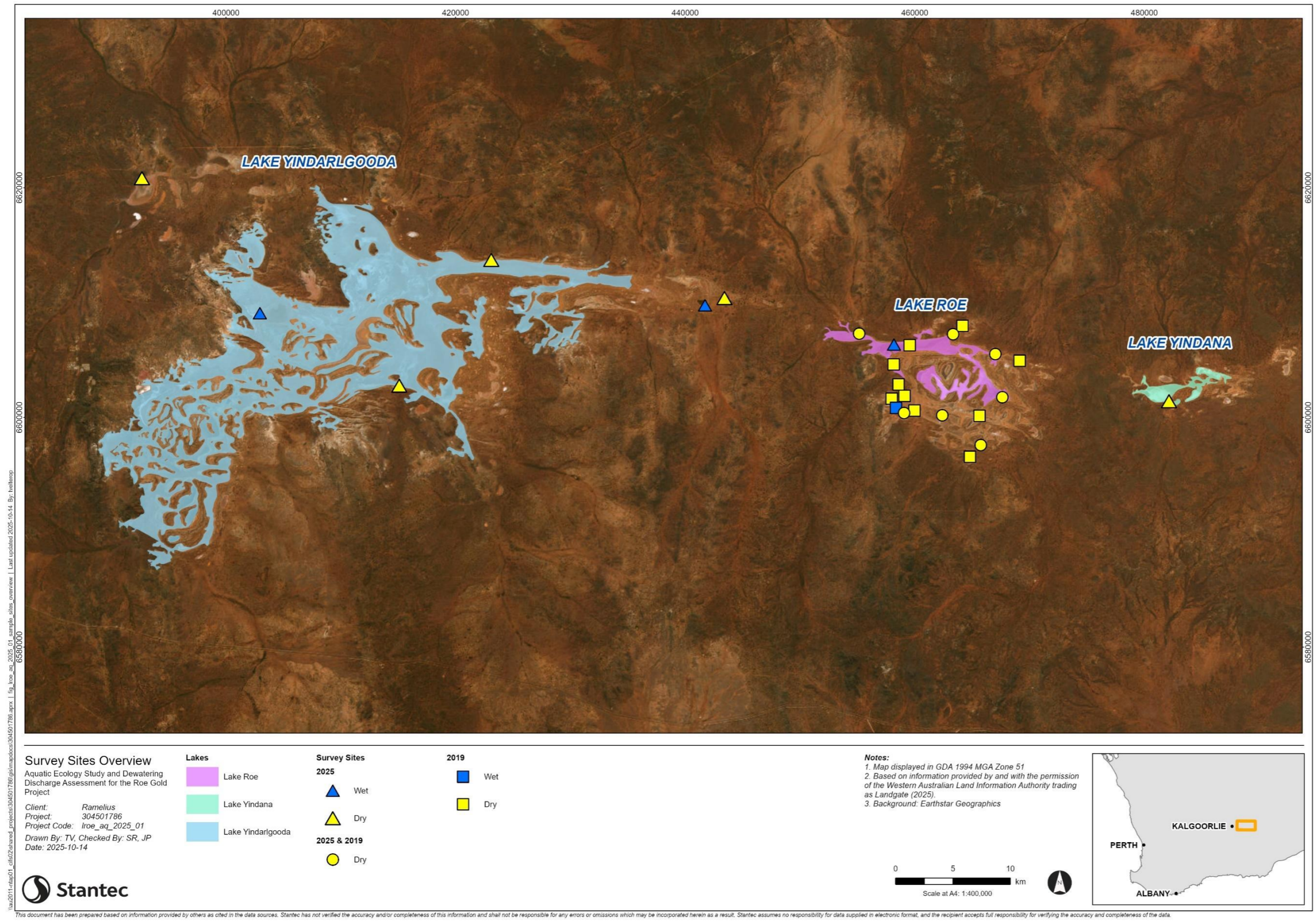


Figure 3: Sites sampled during the 2019 and 2025 baseline studies of Lake Roe and surrounds.

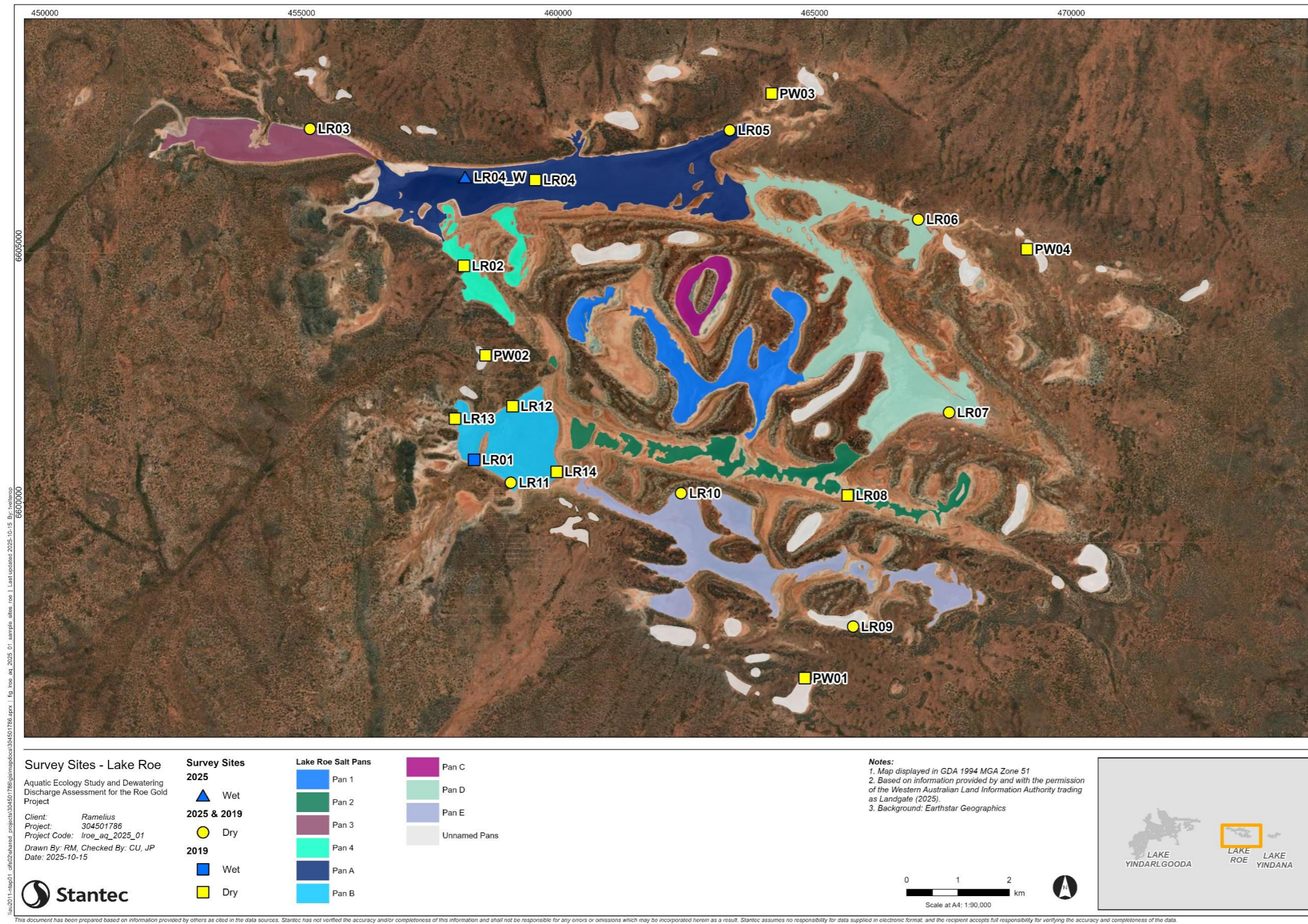


Figure 4: Sites sampled at Lake Roe (indicating key pans), peripheral wetlands and regional waterbodies during the 2019 and 2025 baseline studies.

### 3.1.3 Hydrological and Hydrogeological Studies

The following previous groundwater and surface water modelling assessments were reviewed as part of the Assessment:

- Bombora Project Lake Roe Flood Depth Assessment Rev B (AQ2 2025a); and
- Roe Gold Project Bombora Hydrogeological Dewatering Assessment Rev C (AQ2 2025b).

The flood depth assessment includes modelling results for the 20% Annual Exceedance Probability (AEP) precipitation event, the 1% AEP event, and the Probable Maximum Precipitation (PMP) event. The accompanying hydraulic modelling also includes results for precipitation depths of 25 mm, 37 mm, and 45 mm with and without proposed discharge. The modelled inundation extents correlate with the observed satellite imagery following rainfall events.

## 3.2 Preliminary Risk Assessment

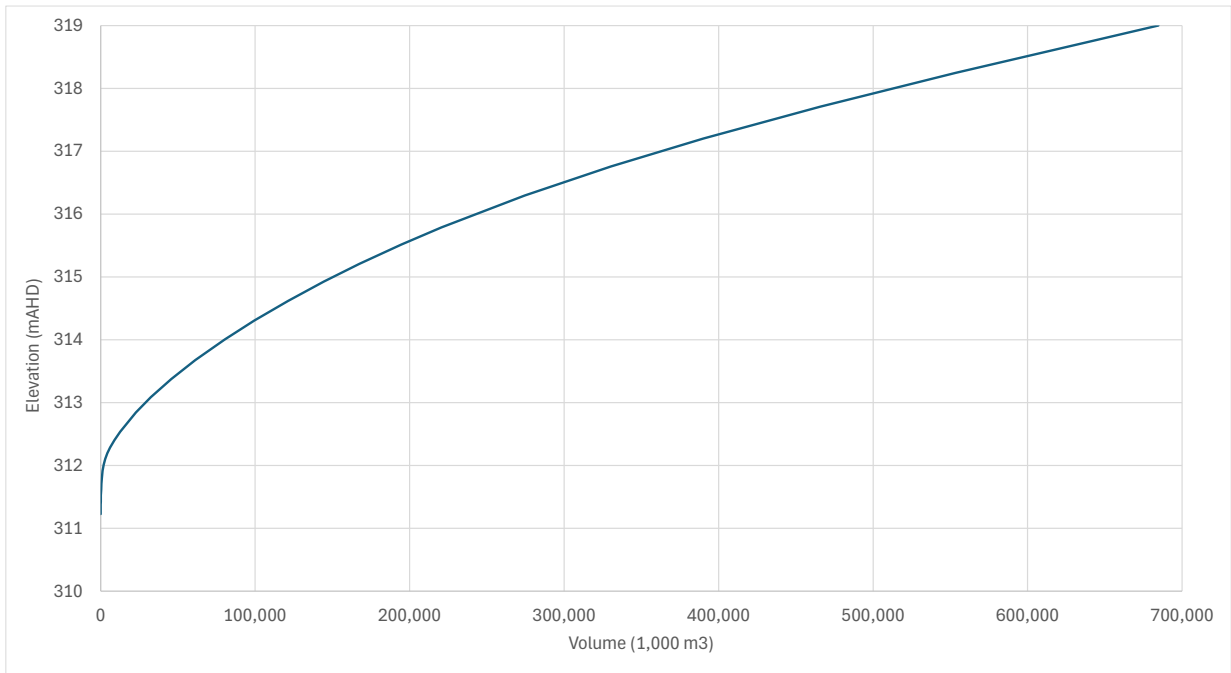
Based on the results of the desktop review, a preliminary risk assessment was completed to understand potential dewatering discharge risks to aquatic ecology, riparian vegetation and the hydrological regime of key pans. The suitability of key pans to receive discharge was assessed and ranked, with supporting justification.

## 3.3 Discharge Assessment

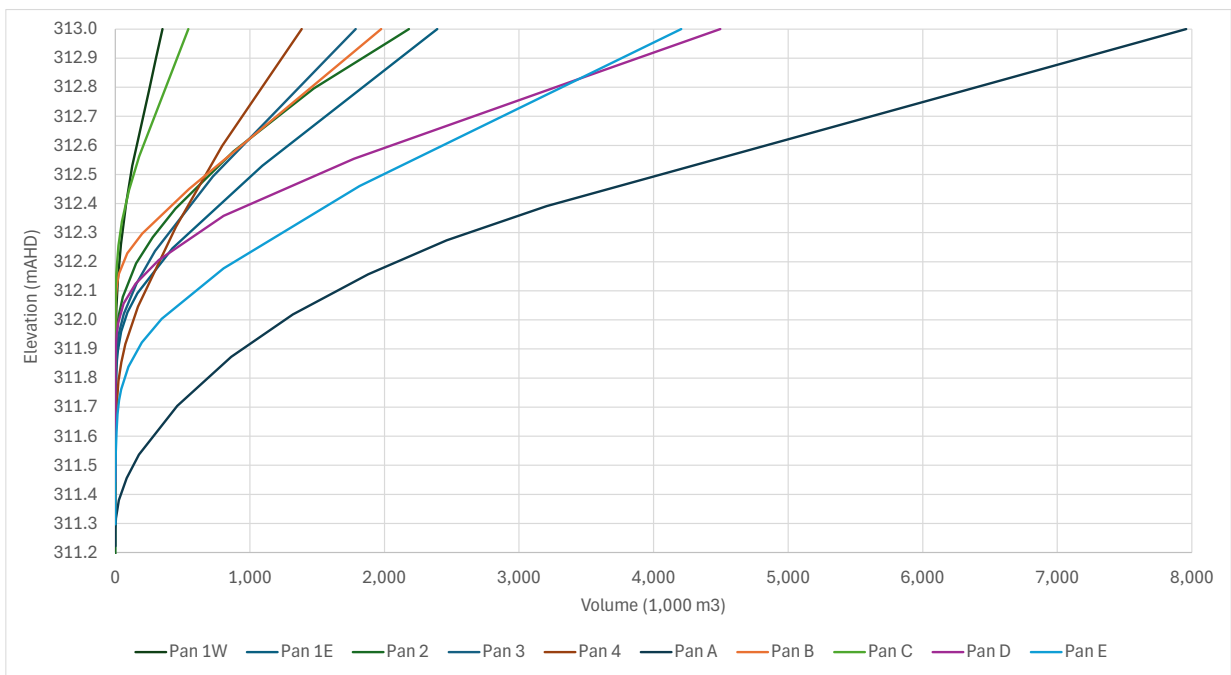
### 3.3.1 Topographic Assessment

A topographic assessment was completed to inform hydraulic modelling. Elevation versus inundation area and elevation versus storage volume relationships were developed for each of the key pans on Lake Roe (**Figure 2**). The values were tabulated based on a detailed 1x1 m resolution raster grid digital elevation model (DEM) of the entire Lake Roe system.

The elevation versus volume relationship for Lake Roe is shown in **Figure 5**. For reference, the maximum elevation of 319 mAHD is approximately equal to the PMP inundation. The 1% AEP flood level is approximately 314.7 mAHD, and the 20% AEP maximum water surface elevation is approximately 313.4 mAHD. In addition, the elevation versus volume relationship for key pans is presented in **Figure 6**. Above the maximum displayed elevation of 313 mAHD, the basins are interconnected during inundation events.



**Figure 5: Elevation versus storage volume for Lake Roe.**

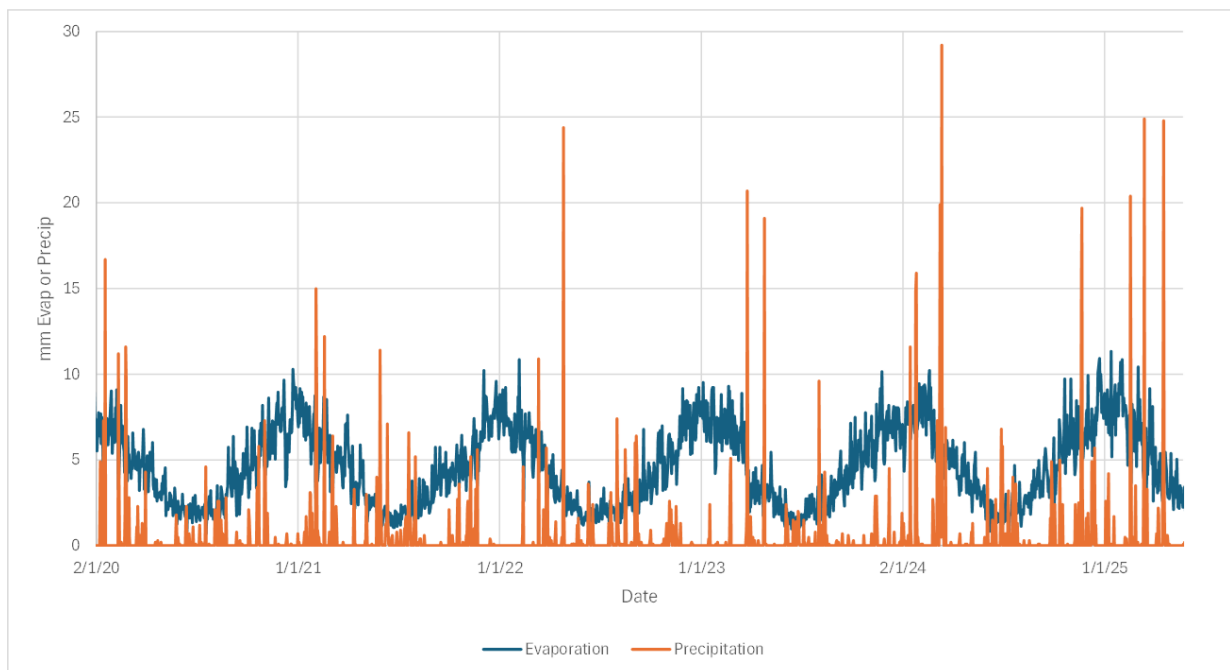


**Figure 6: Elevation versus storage volume for Lake Roe.**

### 3.3.2 Flood Extents and Salinity

Flood extents for a range of precipitation events were modelled with and without discharge, using HEC-RAS Version 6.7. To simulate the maximum extents of hypersaline discharge, a steady state discharge rate of 30 L/s was applied to each pan separately, with initially dry conditions and no direct precipitation or external runoff. The steady state discharge was assumed to occur over a 9-year life of mine (LoM).

Historical evaporation and precipitation data were extracted for the Lake Roe area from the Scientific Information for Land Owners (SILO) database, which compiles Australian climate data from 1889 to present. The database includes interpolated infills for missing data constructed from observational data obtained from the Australian Bureau of Meteorology (BoM). An excerpt of the collated data is presented in **Figure 7**. Pan evaporation values were derived using an assumed lake evaporation pan coefficient of 0.65.



**Figure 7: Evaporation and precipitation for Lake Roe.**

As a worst-case estimate, a minimum winter month evaporation rate of 2 mm/day was assumed. A constant seepage rate of 3 mm/day was applied for inundated areas (AQ2 2025a). Using the assumed discharge, evaporation, and seepage rates over the inundated areas, the maximum inundation extents were delineated and compared to riparian vegetation zones based on aerial photography and satellite imagery.

Based on the surface water assessment (AQ2 2025a) and an analysis of historical satellite imagery, an average period of two years was assumed between events that result in interconnected basins. During this period, the deposited salts from the discharge were assumed to accumulate in the isolated basins, and the stage versus volume relationship was adjusted to account for this. During high runoff events, key pans are assumed to connect, and the deposited salts would be redistributed to other areas.

Salt loads deposited into key pans were calculated, based on the average salinity of the discharge water and discharge volume over the LoM, relative to the available storage volume in each pan. The resulting maximum water surface elevations were compared to the elevations of riparian vegetation, to assess potential impacts.

## 4 Results and Discussion

### 4.1 Satellite Imagery Analysis

Lake Roe comprises a series of convoluted and constrained playas (pans), which are typically flat and subdued, with some separated by low-lying plains or more elevated ridges and hills. Based on the WOfS analysis, the northwestern section of the lake is most frequently inundated; corresponding to the western area of Pan A. Water in this area is detected in approximately 80% of observations, which may be considered semi-permanent, suggesting the potential surface expression of groundwater (**Figure 8**).

The groundwater assessment indicates that local lakes levels and creeks are dominated by surface water runoff during high rainfall events, with minimal contribution from the groundwater (AQ2 2025b). Pooling of surface water is attributed to direct precipitation over the pans and runoff from external catchments rather than surface expression of groundwater. Receding surface water in surrounding claypans results from evaporation and seepage losses; however, groundwater levels were shown to increase close to the surface in low-elevation areas during and following cyclonic rainfall events.

Surface water is also frequently observed in the southeastern sections of the lake; corresponding to the eastern area of Pan D, with water detected in up to 50% of observations, also potentially related to the influence of groundwater (**Figure 8**). Isolated areas throughout the lake including the central basin of Pan B, western and eastern sections of Pan E, the southern section of Pan 4 and the eastern section of Pan 1 have water detected in 20% of observations and are typically dry. The remaining areas throughout the lake are considered mostly dry, with water detected in 5% or less of observations, and likely only hold water intermittently (**Figure 8**), following infrequent, large rainfall events.

Between 1986 and 2025 satellite imagery indicates that the surface area of Lake Roe has been inundated to more than 90% on five occasions, in 1996, 2000, 2005, 2015 and 2017 (**Figure 9**). This corresponds to major flooding events, when the lake completely fills, occurring on average approximately once every five to 10 years, with inundated conditions typically remaining for six to 12 months. These events generally coincide with large ex-tropical cyclone or cyclonic weather systems and storm events that move through the Goldfields in the summer months, followed by top up precipitation, which maintains surface water levels. While major events are rare and infrequent, partial flood events occur more often, usually every three to five years, which may inundate approximately 50% of the surface area of the lake (**Figure 9**).

Lake Roe is only inundated to the maximum 100% extent of its surface area less than 5% of the time (**Figure 10**). Analysis of key pans indicates similar trends, with the exception of a proportion of the surface area of Pan A, which is inundated for a comparatively longer percentage of time (up to 40% in duration) compared to other parts of the lake (**Figure 11**). Similarly, Pan D is inundated for approximately 30% of the time, while the remainder of key pans typically only had a portion of their surface area inundated for less than 20% of the time (**Figure 11**).

The results of the WOfS and satellite imagery analysis indicate that Pan A is the most frequently inundated area of Lake Roe and remains inundated for the longest period, followed by Pan D, with both pans potentially supplemented by groundwater. In comparison, the remaining key pans located throughout the central and southern parts of Lake Roe are mostly dry, only holding water after substantial rainfall events, likely supplemented by additional precipitation received during storms over the course of summer months.

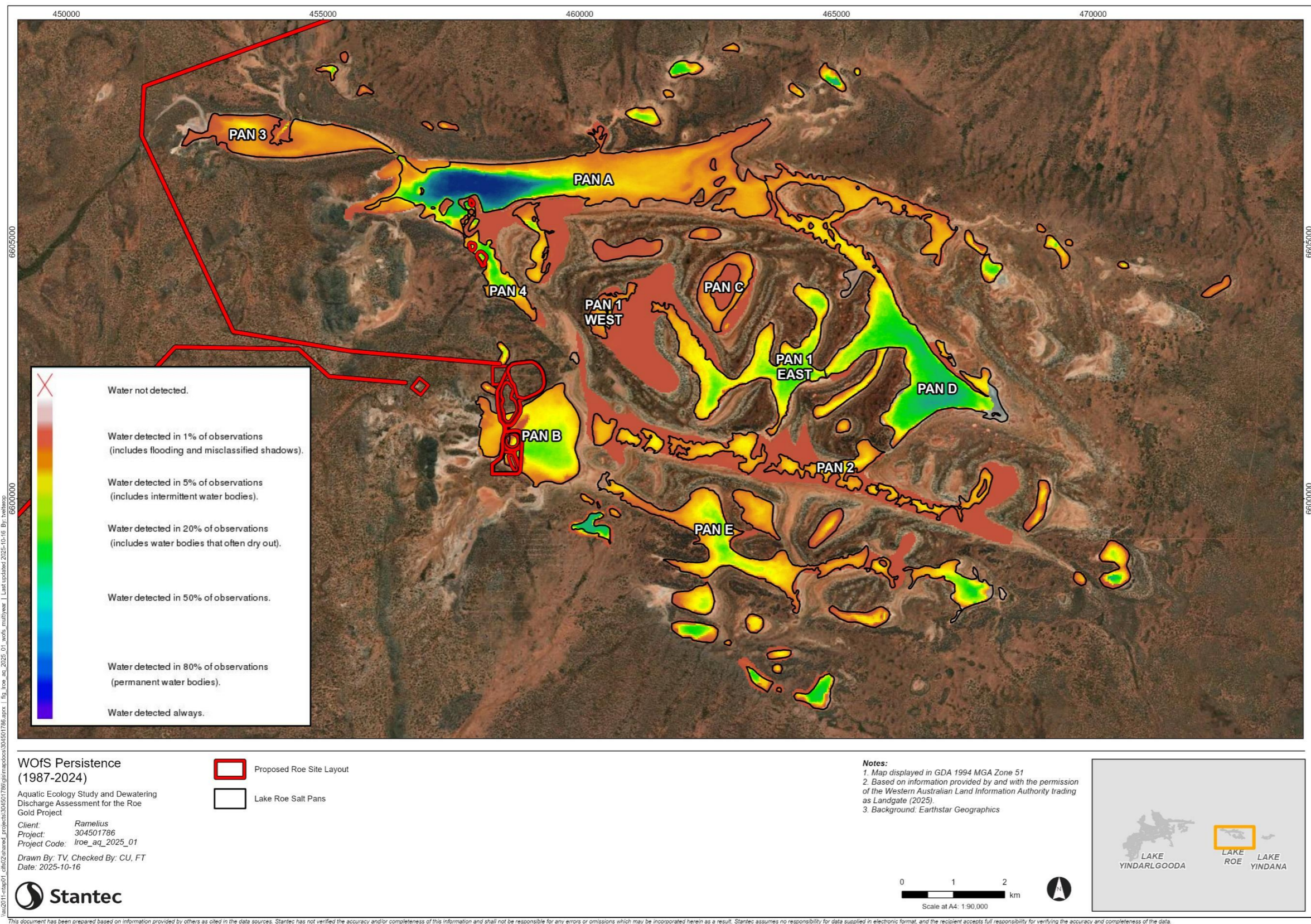


Figure 8: Lake Roe with WofS overlay indicating water detection percentage for key pans.

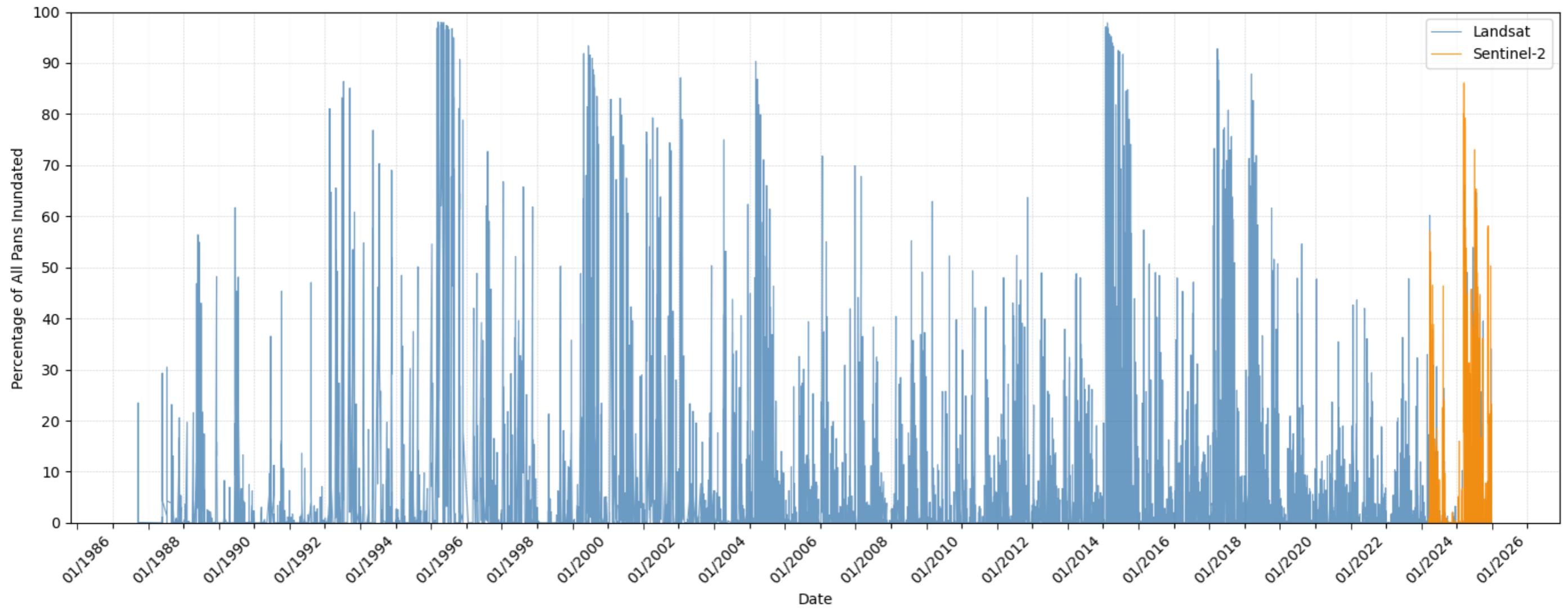


Figure 9: Comparison of percentage inundation values from Landsat and Sentinel imagery at Lake Roe from 1985 to 2025.

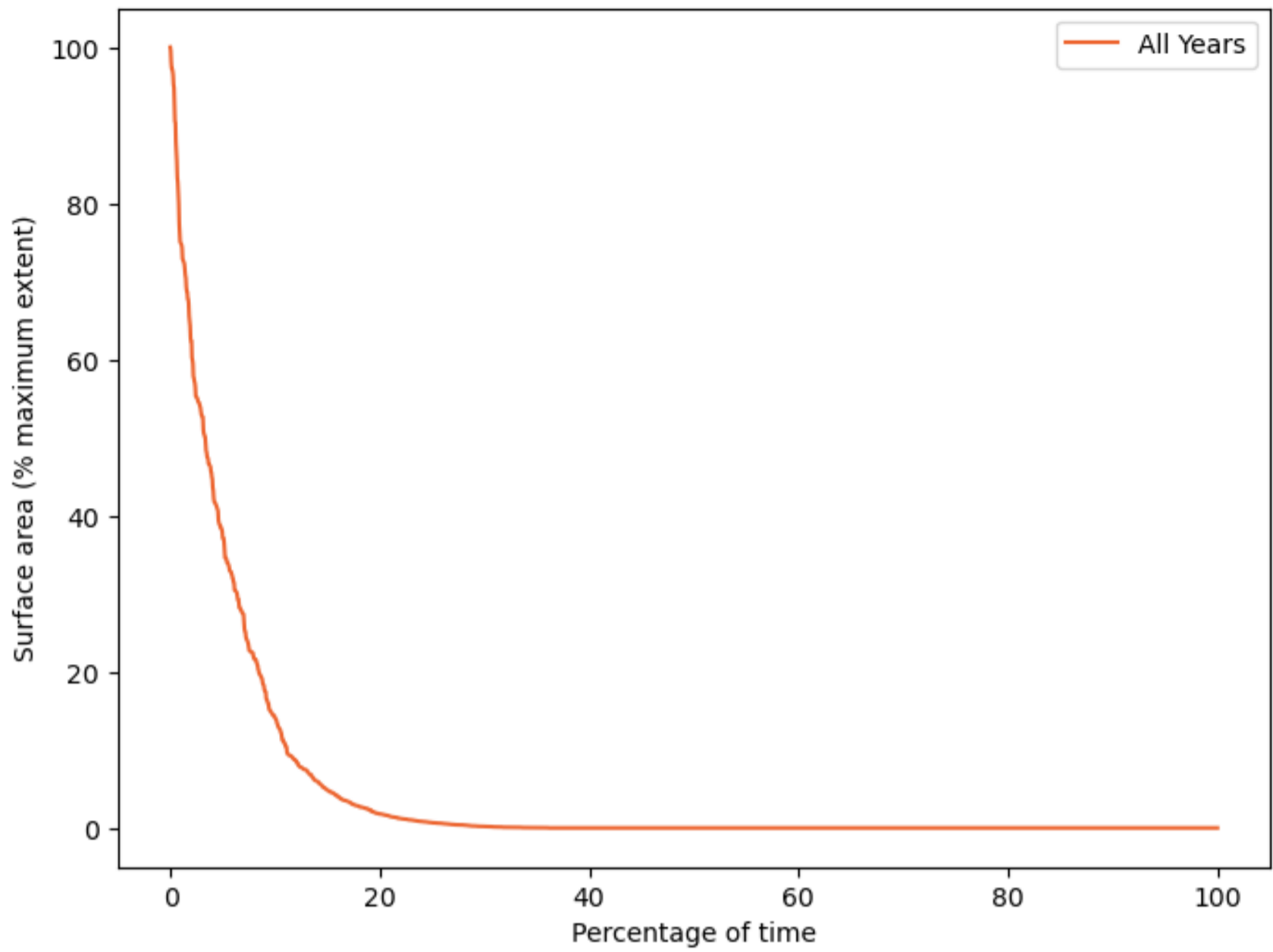


Figure 10: Lake Roe SAD curves for whole of lake for all available data (since 1985).

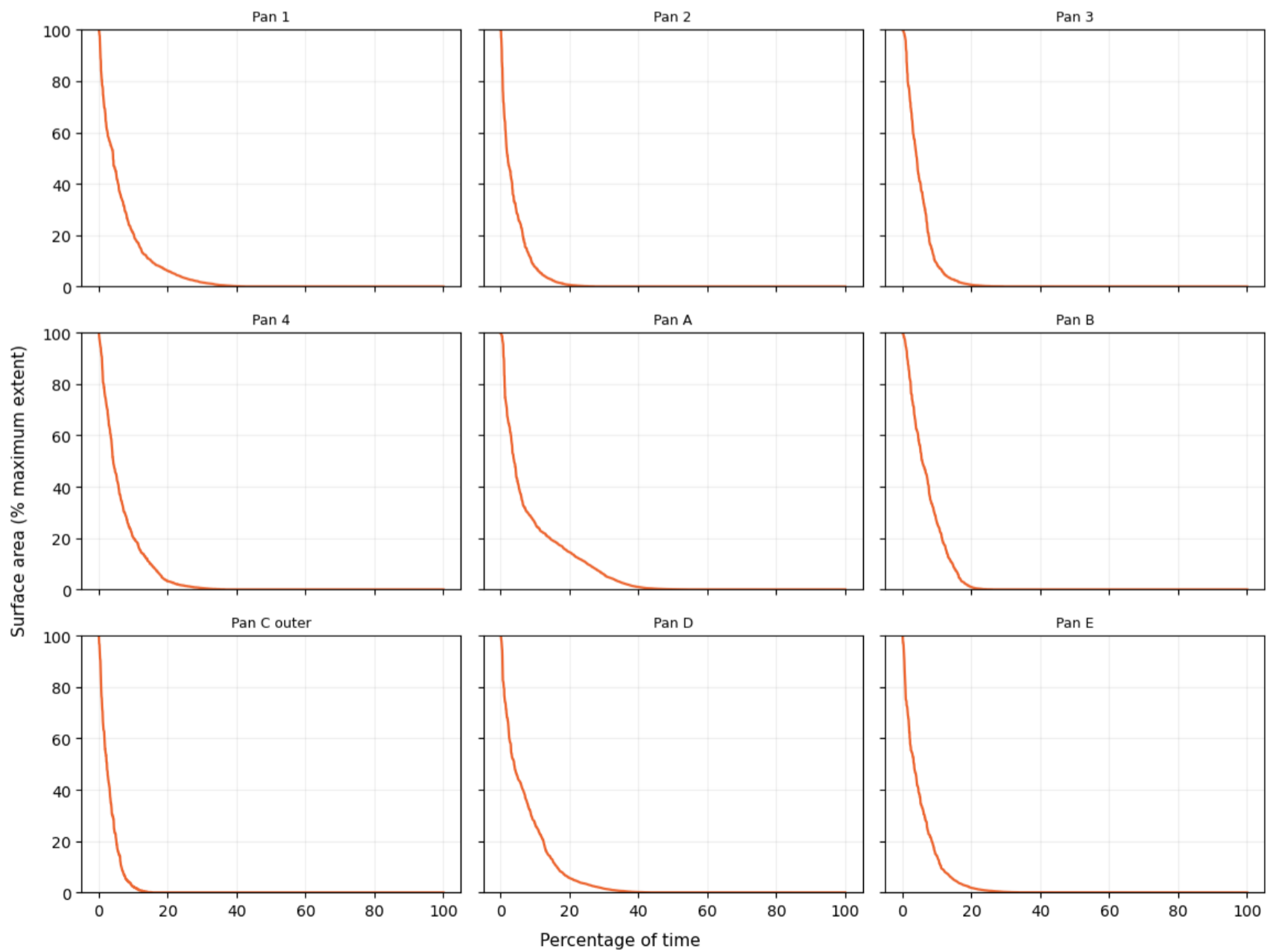


Figure 11: SAD curves for Lake Roe key pans for all available data (since 1985).

## 4.2 Ecological Values

### 4.2.1 Lake Roe

Water quality from rewetting trials indicates that Lake Roe is likely to be alkaline (pH>7.5) and range in salinity from hyposaline to mesosaline (16,000 to 78,000  $\mu\text{S}/\text{cm}$ ), during the initial stages of flooding (**Table 1**). As the hydroperiod progresses it is likely that the surface waters will become hypersaline due to evapoconcentration. In 2025, an isolated pool of surface water in the northwestern part of the lake was classified as alkaline (7.9) and hypersaline (162,000  $\mu\text{S}/\text{cm}$ ). Dissolved metal concentrations were low, and there were no exceedances of the ANZG (2018) default guideline values (DGV) for the protection of 95% of species in marine waters.

Surface sediments in the lake have typically ranged from slightly acidic to moderately alkaline (pH 6.5 to 8.0), with moderate to high salt loads (42,800 to 105,000 mg/kg) (**Table 1**). Total nitrogen and total phosphorous concentrations have also recorded substantial fluctuation (80 to 1,190 mg/kg and 19 to 386 mg/kg, respectively). For metals, chromium and nickel concentrations have consistently exceeded the ANZG (2018) default guideline value (DGV), while nickel also exceeded the GV-High value. This is typical of salt lakes in the Eastern Goldfields, attributed to natural mineralisation within their catchments.

A total diversity of 114 taxa has been recorded from Lake Roe during the 2019 and 2025 studies (**Table 1**). This includes 64 aquatic taxa, including algae (20), macrophytes (two), diatom (25), aquatic invertebrates (13) and waterbirds (four), and 50 riparian vegetation taxa. During the rewetting trials for both studies, the biological assemblage was characterised by common saline genera of algae, including the diatoms *Amphora coffeaeformis*, *Hantzschia* sp. aff. *baltica* and *Navicula* sp. aff. *incertata*, and the cyanophytes *Microcoleus*, *Planktolyngbya* and *Planktothrix*. Macrophytes, including the angiosperm *Ruppia tuberosa* and charophyte *Chara* sp. also occurred widely throughout the lake.

Aquatic invertebrates hatching from the rewetting trials were characterised by resident salt tolerant crustacean fauna, such as the ostracods *Diacypriis phoxe* and *Patcypris outback* and the brine shrimp *Parartemia serventyi* and *Parartemia veronicae* (**Table 1**). In addition, in 2025, the ostracod *Diacypriis whitei* as well as *Parartemia serventyi* were recorded in high abundance from residual surface waters in the northwest of the lake. Waterbird taxa considered typical of Australian inland waters, including *Anas gracilis* (Grey teal), *Recurvirostra novaehollandiae* (Red-necked avocet), *Tadorna tadornoides* (Australian shelduck) and *Thinornis culcullatus* (Hooded plover) were also observed utilising this area of the lake.

Riparian vegetation surrounding the lake was dominated by chenopods including *Tecticornia*, *Frankenia* and *Atriplex* genera, common taxa along the margins of salt lakes. Differences in vegetation community structure occur across the riparian zone, attributed to factors such as distance to groundwater, elevation and geology (including soil properties), which are known to be strongly influential on the riparian vegetation zone (Barrett 2006; Datson 2002).

Several taxa of conservation significance, considered new and/or potentially restricted, have been recorded from Lake Roe (**Table 2**). These include four potentially new aquatic invertebrate taxa; the ostracods *Australocypris* 'BOS1364', *Diacypriis* 'BOS1669', *Reticypriis* 'BOS1088' and *Reticypriis* 'BOS1363' (**Appendix A**). During the 2025 Study, these taxa were also identified from nearby Lake Yindarlgooda during rewetting trials (Stantec 2025). In addition, *Reticypriis* 'BOS1088' and *Reticypriis* 'BOS1363' are known from salinas on the periphery of Lake Roe, with *Reticypriis* 'BOS1363' also identified from the Great Sandy Desert (Stantec 2021). In the riparian zone, two potentially new *Tecticornia* taxa (*Tecticornia* sp. nov. 1 and 2) were recorded during the 2025 Study (**Table 2**). There were also six unidentified *Tecticornia* taxa identified across both studies, which were unable to be resolved due to lack of fruiting or flowing parts (sterile specimens) at the time of collection.

## 4.2.2 Key Pans

### 4.2.2.1 Diversity

Diversity within the key pans of Lake Roe recorded during the 2019 and 2025 studies ranged from 11 (Pan 2) to 72 (Pan B) taxa (**Table 1**). This disparity can be attributed to survey effort, with a higher number of samples collected from the most diverse pans. In addition, although diversity varied, the dominant taxa recorded from the key pans were relatively consistent. The most diverse pans (>50 taxa) included Pan B (72 taxa) and Pan A (54 taxa), comprising 36 aquatic and 36 riparian vegetation taxa and 32 aquatic and 22 riparian vegetation taxa, respectively. Pan A is located approximately 3.5 km from the proposed pit in the northwestern area of the lake, while Pan B is intersected by one of the proposed mining pits.

Key pans with moderate aquatic diversity (<30 taxa) included Pan 3 (15 taxa), Pan D (14 taxa) and Pan E (21 taxa). These pans were located in the north-western (6 km north-west), north-eastern (7km east), southern (1.8km south-east) parts of Lake Roe, respectively, and had moderate to high riparian vegetation diversity (Pan 4: 10 taxa, Pan D: 22 taxa and Pan E: 17 taxa) (**Table 1**). In contrast, Pan 2 and Pan 4, located approximately 1.5 km from the Project in the central-southern and central western area of the lake respectively, low overall diversity (<20), with fewer than 10 aquatic taxa and no more than 10 riparian vegetation taxa (**Table 1**). The ecological values of Pan 1 and Pan C are currently unknown.

### 4.2.2.2 Significant Taxa

Most key pans supported no more than two significant aquatic biota taxa (**Table 2**). Pan A and Pan B were exceptions, with four and three significant aquatic biota taxa recorded, respectively. The aquatic invertebrates *Australocypris* 'BOS1364', *Diacypris* 'BOS1969', *Reticocypris* 'BOS1088' and *Reticocypris* 'BOS1363' were recorded from these pans, although have also been identified from other key pans in Lake Roe, the peripheral wetlands and Lake Yindarlgooda (**Appendix A**). The waterbird *Charadrius cucullatus* (hooded plover; Priority 4 listed under the *Biodiversity and Conservation Act 2016*) was also observed at Pan A in 2025, with this part of the lake also known to hold surface water for longer and more often following rainfall.

The highest number of significant riparian vegetation taxa were recorded from Pan B, Pan D and Pan E (four taxa each) (**Table 2**). This was attributed to a comparatively higher number of sterile *Tecticornia* taxa (sp. 2, 3, 4, 5, 6) identified, with most of these taxa found during the 2019 Study (**Appendix A**). In addition, *Tecticornia* sp. 2 (sterile) and *Tecticornia* sp. 4 (sterile) were only recorded from Pan D, *Tecticornia* sp. 3 (sterile) was only recorded from Pan E, while *Tecticornia* sp. 6 (sterile) was only recorded from Pan B. Two potentially new species have also recorded comprising *Tecticornia* sp. nov. 1, only known from Pan B and *Tecticornia* sp. nov. 2, only known from Pans 3, A, D and E (**Table 2**).

**Table 1: Summary of key ecological characteristics of Lake Roe and number of taxa (whole of lake and key pans) recorded during the 2019 and 2025 studies.**

Ecological Component	Lake Roe		Total Taxa									
	Key Characteristics	Dominant Taxa	Lake Roe	Pan 1	Pan 2	Pan 3	Pan 4	Pan A	Pan B	Pan C	Pan D	Pan E
Water Quality	<ul style="list-style-type: none"> <li>alkaline (&gt;7.5)</li> <li>hyposaline to mesosaline, becoming hypersaline as the hydroperiod progresses</li> </ul>	<ul style="list-style-type: none"> <li>N/A</li> </ul>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sediment Quality	<ul style="list-style-type: none"> <li>acidic to alkaline</li> <li>moderate to high salt loads</li> <li>variable metals, elevated Cr and Ni</li> </ul>	<ul style="list-style-type: none"> <li>N/A</li> </ul>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Algae	<ul style="list-style-type: none"> <li>Composition comprising diatoms, cyanobacteria and chlorophytes</li> <li>Species typical of saline waters</li> <li>Extensive benthic algal mat of <i>Microcoleus</i> (cyanophyte) in northwest</li> </ul>	<ul style="list-style-type: none"> <li><i>Hantzschia</i></li> <li><i>Navicula</i></li> <li><i>Microcoleus</i></li> <li><i>Planktolyngbya</i></li> <li><i>Planktothrix</i></li> </ul>	20	N/S	3	2	1	8	7	N/S	2	7
Macrophytes	<ul style="list-style-type: none"> <li>Patchy distribution of species typical of saline waters</li> </ul>	<ul style="list-style-type: none"> <li><i>Chara</i> sp.</li> <li><i>Ruppia tuberosa</i></li> </ul>	2	N/S	1	Nil	Nil	1	2	N/S	Nil	2
Diatoms	<ul style="list-style-type: none"> <li>Composition typical of saline waters, including <i>Amphora</i>, <i>Hantzschia</i> and <i>Navicula</i></li> </ul>	<ul style="list-style-type: none"> <li><i>Amphora coffeaeformis</i></li> <li><i>Hantzschia</i> sp. aff. <i>baltica</i></li> <li><i>Navicula</i> sp. aff. <i>incertata</i></li> </ul>	25	N/S	3	10	4	11	16	N/S	8	8
Aquatic Invertebrates	<ul style="list-style-type: none"> <li>Composition dominated by crustaceans including ostracods &amp; anostracans</li> <li>Assemblage typical of saline waters</li> </ul>	<ul style="list-style-type: none"> <li><i>Diacypris phoxe</i></li> <li><i>Diacypris whitei</i></li> <li><i>Patcypris outback</i></li> </ul>	13	N/S	2	3	3	7	11	N/S	4	4
Waterbirds	<ul style="list-style-type: none"> <li>Common waterbird taxa observed on the lake</li> <li>Typical assemblage associated with inland salt lakes</li> </ul>	<ul style="list-style-type: none"> <li><i>Anas gracilis</i></li> <li><i>Recurvirostra novaehollandiae</i></li> <li><i>Tadorna tadornoides</i></li> </ul>	4	N/S	Nil	Nil	Nil	4	Nil	N/S	Nil	Nil
Riparian Vegetation	<ul style="list-style-type: none"> <li>Composition dominated by salt tolerant chenopods</li> <li>Taxa recorded typical of salt lake riparian zone</li> <li>No declared rare or priority flora species recorded</li> </ul>	<ul style="list-style-type: none"> <li><i>Tecticornia</i> spp.</li> <li><i>Frankenia</i> sp.</li> <li><i>Atriplex nana</i></li> </ul>	50	NS	2	15	10	22	36	NS	22	17
<b>Total</b>			<b>114</b>	<b>NS</b>	<b>11</b>	<b>30</b>	<b>18</b>	<b>54</b>	<b>72</b>	<b>NS</b>	<b>36</b>	<b>38</b>

Note: N/A indicates not applicable to diversity; N/S indicates not sampled, nil indicates aquatic biota did not emerge during hatching trials or was not observed in the field.

**Table 2: Significant taxa recorded from key individual pans during the 2019 and 2025 assessments.**

Significant Taxa		Pan 1	Pan 2	Pan 3	Pan 4	Pan A	Pan B	Pan C	Pan D	Pan E
Aquatic Invertebrates	<i>Australocypris</i> 'BOS1364'				•	•	•			
	<i>Diacypris</i> 'BOS1969'					•			•	•
	<i>Reticypris</i> 'BOS1088'			•	•	•	•		•	
	<i>Reticypris</i> 'BOS1363'						•			
	<b>Sub Total</b>	<b>N/S</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>N/S</b>	<b>2</b>	<b>1</b>
Waterbirds	<i>Charadrius cucullatus</i> (P4)					•				
	<b>Sub Total</b>	<b>N/S</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>N/S</b>	<b>0</b>	<b>0</b>
Riparian Vegetation	<i>Tecticornia</i> sp. 2 (sterile)								•	
	<i>Tecticornia</i> sp. 3 (sterile) (2019)						•		•	•
	<i>Tecticornia</i> sp. 3 (sterile) (2025)									•
	<i>Tecticornia</i> sp. 4 (sterile)								•	
	<i>Tecticornia</i> sp. 5 (sterile)						•			•
	<i>Tecticornia</i> sp. 6 (sterile)						•			
	<i>Tecticornia</i> sp. nov. 1						•			
	<i>Tecticornia</i> sp. nov. 2			•		•			•	•
<b>Sub Total</b>	<b>N/S</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>4</b>	<b>N/S</b>	<b>4</b>	<b>4</b>	
<b>Total</b>	<b>N/S</b>	<b>0</b>	<b>2</b>	<b>2</b>	<b>5</b>	<b>7</b>	<b>N/S</b>	<b>6</b>	<b>5</b>	
<b>13</b>										

Note: N/S indicates pan has not been sampled.

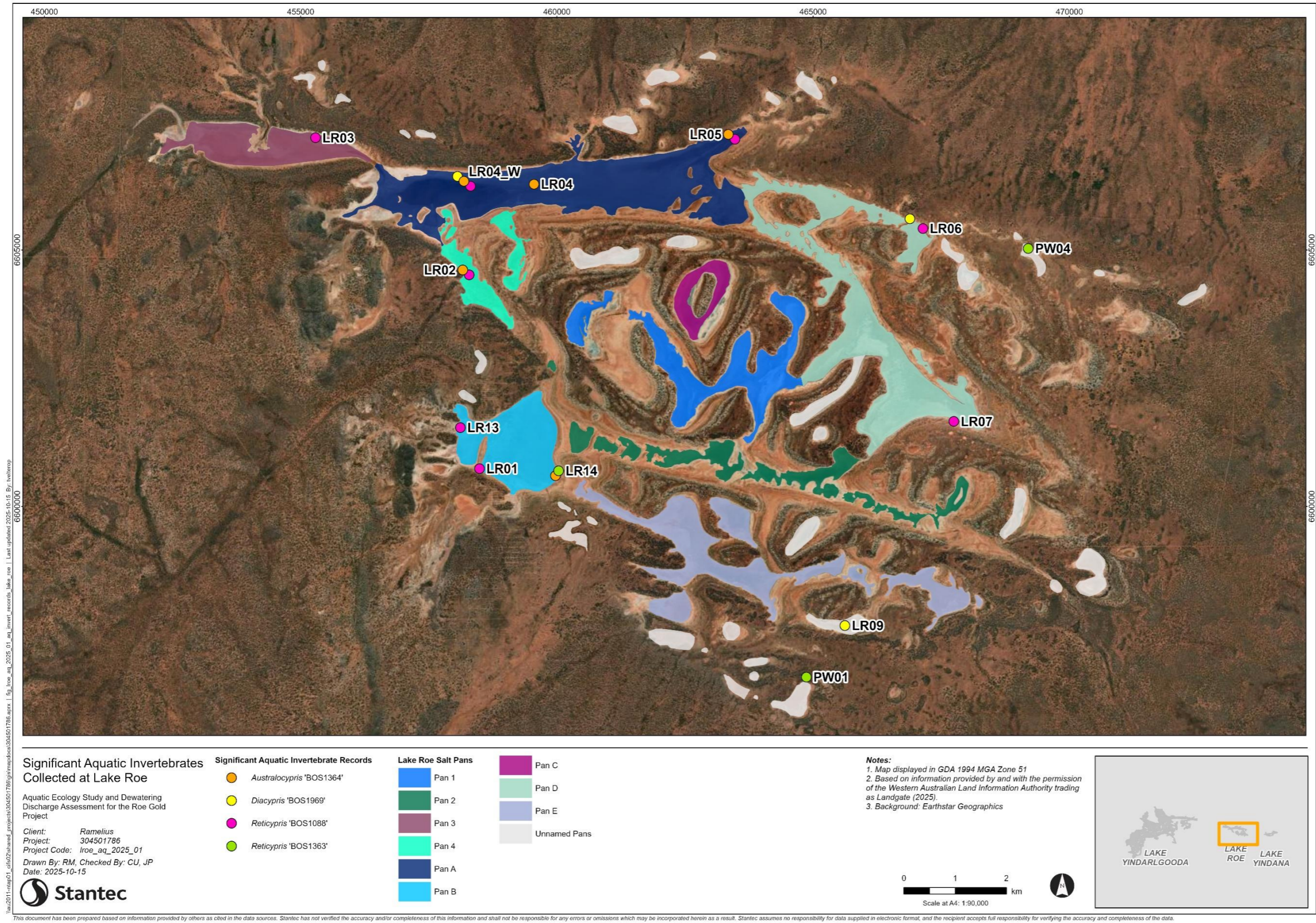


Figure 12: Significant aquatic invertebrate and waterbird taxa recorded from the 2019 and 2025 studies, in relation to the Lake Roe key pans.

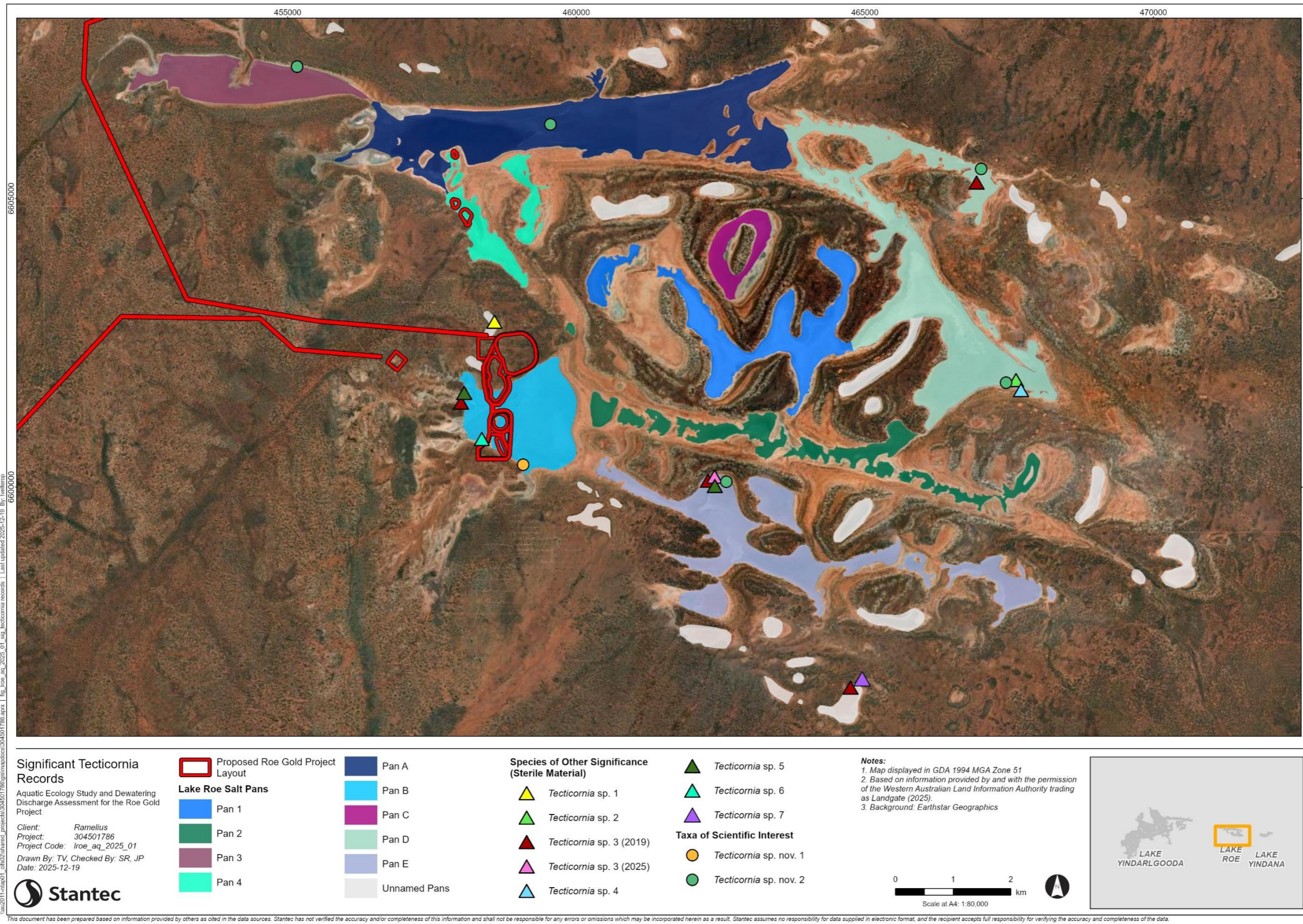


Figure 13: Significant *Tecticornia* taxa recorded from the 2019 and 2025 studies, in relation to Lake Roe key pans.

### 4.3 Preliminary Risk Assessment

Based on the outcomes of the desktop review, a preliminary risk assessment was completed for the key pans of Lake Roe, considering hydrological and geomorphological characteristics, biological values and Project attributes (**Table 3**). The key environmental receptors were identified for each pan, in relation to proposed discharge, including:

- water and sediment;
- aquatic biota (including algae, macrophytes, aquatic invertebrates and waterbirds); and
- riparian vegetation.

Several key environmental risks were identified from proposed discharge for the Project, which have the potential to affect these receptors, including the potential for:

- salt and metal toxicity effects on aquatic biota in less frequently inundated parts of the lake;
- salt and metal toxicity effects on aquatic biota in more frequently inundated parts of the lake;
- inundation and salt toxicity of riparian vegetation (including significant *Tecticornia* taxa) in the riparian zone and within basin with hypersaline discharge water; and
- loss of key waterbird foraging habitat (including for listed species).

The risk rankings for most of the key pans (Pans 2, 3, 4, A, C and D) were 'High' to 'Extreme' (**Table 3**). Based on these rankings these pans were considered unsuitable to receive discharge, due to several factors, unique to each pan, including:

- Insufficient storage capacity and limited pathways for salt removal and dispersal;
- Unknown or poorly understood biological values;
- Higher frequency of inundation, and comparatively higher biological productivity and number of significant taxa;
- Potential for mobilisation and movement of salts to an adjacent area of high productivity; and/or
- Greater distance from the pit and increased cost and complexity (for environmental approvals) of infrastructure development.

The risk rankings for remaining key pans (Pans 1, B and E) were 'Moderate'. These pans do not flood as frequently as Pans A and D and have comparatively lower productivity and biological values. They also have a greater storage capacity to prevent the overtopping of hypersaline discharge water into the riparian vegetation zone, and were located closer to the proposed mining pit, which is advantageous for infrastructure development. However, some of these pans have not yet been studied, meaning there is potential for salt loading from the proposed discharge to cause environmental harm.

The discharge of hypersaline water to Lake Roe will increase salt loads on the lake surface, forming a salt crust that extends beyond the wetting footprint, which will continue to build up over time. Following rainfall events, salts will partially or completely dissolve into surface waters, which will increase the salinity of surface waters adversely affecting aquatic biota, and in substantial events may also impact on riparian vegetation during overtopping events (SIGMC 2018).

Over time salt loading can potentially reach a tipping point, where during flooding, salinity increases, and a pan may no longer support a low salinity phase. This phase is critical, and is required for the emergence of many groups of aquatic biota or for mature biota, can exceed the tolerance limits of some species (Taukulis 2016). If aquatic biota fail to emerge and mature during flooding, or complete their lifecycles, this can limit the release of propagules and eggs (collectively known as resting stages) into the lake sediments. Over time this depletes the bank of resting stages limiting productivity and the environmental values of the lake (Stantec 2018). In addition, the flooding of the riparian zone with hypersaline water for an extended period, can cause the death of plants along the shoreline (SIGMC 2018).

To address these concerns, additional hydraulic modelling of the proposed discharge to key pans ranked as moderate was undertaken. This part of the assessment, detailed in the subsequent sections, included inundation extent and salinity modelling, to assess potential impacts and risks to aquatic biota and riparian vegetation.

Table 3: Preliminary risk assessment of potential dewatering discharge to key pans of Lake Roe.

Lake Roe Area	Pan	Distance from Proposed Pits	Hydrological & Geomorphological Assessment	Biological Values	Project Considerations	Preliminary Risk Assessment				Suitability of Option
						Receptors	Key Risks	Risk Ranking	Justification	
Central	Pan 1 (West)	2 km to north east	<ul style="list-style-type: none"> <li>Comparatively smaller size &amp; disconnected.</li> <li>Low inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>Unknown</li> </ul>	<ul style="list-style-type: none"> <li>Close proximity (&lt;5 km) to proposed pit.</li> <li>Likely lower cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity effects on aquatic biota in a less frequently inundated part of the lake.</li> <li>Inundation &amp; salt toxicity of <i>Tecticornia</i> in riparian zone &amp; within basin with hypersaline discharge water.</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Biological values are unknown.</li> <li>Rarely holds water.</li> <li>Likely lower biological productivity.</li> <li>Insufficient storage capacity &amp; limited playa, increasing salt build up &amp; inundation of riparian zone with hypersaline water.</li> <li>Limited pathways for salt removal &amp; dispersal.</li> <li>Provided additional riparian vegetation surveys are conducted &amp; no significant taxa are found.</li> </ul>	✓
Central	Pan 1 (East)	3.5 km to east	<ul style="list-style-type: none"> <li>Comparatively smaller &amp; narrower, minor connectivity to adjacent pans.</li> <li>Moderate inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>Unknown</li> </ul>	<ul style="list-style-type: none"> <li>Close proximity (&lt;5 km) to proposed pit.</li> <li>Likely lower cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity effects on aquatic biota in a more frequently inundated part of the lake.</li> <li>Inundation &amp; salt toxicity of <i>Tecticornia</i> in riparian zone &amp; within basin with hypersaline discharge water.</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Biological values are unknown.</li> <li>Occasionally holds water.</li> <li>Likely higher biological productivity.</li> <li>Potentially adequate storage capacity.</li> <li>Limited pathways for salt removal &amp; dispersal.</li> <li>Provided additional riparian vegetation surveys are conducted &amp; no significant taxa are found.</li> </ul>	✓
Central-south	Pan 2	1.5 km to east	<ul style="list-style-type: none"> <li>Series of disconnected &amp; comparatively smaller sized pans.</li> <li>Low inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>None recorded.</li> </ul>	<ul style="list-style-type: none"> <li>Close proximity (&lt;5 km) to proposed pit.</li> <li>Likely lower cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity on aquatic biota in a less frequently inundated part of the lake.</li> <li>Inundation &amp; salt toxicity of <i>Tecticornia</i> in riparian zone &amp; within basin with hypersaline discharge water.</li> </ul>	High	<ul style="list-style-type: none"> <li>Biological values poorly understood.</li> <li>Rarely holds water.</li> <li>Likely lower biological productivity.</li> <li>Insufficient storage capacity, increasing salt build up &amp; potential for inundation of riparian zone with hypersaline water.</li> <li>Limited pathways for salt removal &amp; dispersal.</li> </ul>	✘
North-west	Pan 3	6 km to northwest	<ul style="list-style-type: none"> <li>Comparatively larger size, partially intersected by a substantial drainage inflow, moderate connectivity to adjacent pans.</li> <li>Low inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>One new aquatic invertebrate, distributed broadly throughout Lake Roe &amp; peripheral salinas and Lake Yindarlgooda.</li> <li>One potentially novel <i>Tecticornia</i> species distributed broadly throughout Lake Roe.</li> </ul>	<ul style="list-style-type: none"> <li>Distance from pit (&gt;5 km) likely to be prohibitive.</li> <li>Likely prohibitive cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity on aquatic biota in a less frequently inundated part of the lake.</li> <li>Inundation &amp; salt toxicity of <i>Tecticornia</i> in riparian zone and within basin with hypersaline discharge water.</li> </ul>	High	<ul style="list-style-type: none"> <li>Lower number of significant taxa.</li> <li>Rarely holds water.</li> <li>Likely lower biological productivity.</li> <li>Potential for backflow of hypersaline discharge water into adjacent substantial drainage lines.</li> <li>Potential for mobilisation &amp; movement of salts to adjacent area of high productivity.</li> <li>Greater distance from the pit &amp; increased cost and complexity (for environmental approvals) of infrastructure development.</li> </ul>	✘

Lake Roe Area	Pan	Distance from Proposed Pits	Hydrological & Geomorphological Assessment	Biological Values	Project Considerations	Preliminary Risk Assessment				Suitability of Option
						Receptors	Key Risks	Risk Ranking	Justification	
Central-west	Pan 4	1.6 km to north	<ul style="list-style-type: none"> <li>Comparatively smaller and narrower, minor connectivity to adjacent pans.</li> <li>Moderate inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>One new aquatic invertebrate, distributed broadly throughout Lake Roe &amp; Lake Yindarlgooda.</li> <li>One new aquatic invertebrate, distributed broadly throughout Lake Roe &amp; peripheral salinas and Lake Yindarlgooda.</li> </ul>	<ul style="list-style-type: none"> <li>Close proximity (&lt;5 km) to proposed pit.</li> <li>Likely lower cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity effects on aquatic biota in a more frequently inundated part of the lake.</li> <li>Inundation &amp; salt toxicity of <i>Tecticornia</i> in riparian zone &amp; within basin with hypersaline discharge water.</li> </ul>	High	<ul style="list-style-type: none"> <li>Lower number of significant taxa.</li> <li>Occasionally holds water</li> <li>Potentially higher biological productivity.</li> <li>Reduced storage capacity, increasing salt build up &amp; potential for inundation of riparian zone with hypersaline water.</li> <li>Limited pathways for salt removal &amp; dispersal.</li> <li>Potential for mobilisation &amp; movement of salts to adjacent area of high productivity.</li> </ul>	✘
North	Pan A	3.5 km to north	<ul style="list-style-type: none"> <li>Comparatively large and wide, moderate connectivity to adjacent pans.</li> <li>Low (east) to High (west) inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>Extensive benthic algal mat (<i>Microcoleus</i> sp.).</li> <li>Two new aquatic invertebrates, distributed broadly throughout Lake Roe &amp; Lake Yindarlgooda.</li> <li>One new aquatic invertebrate, distributed broadly throughout Lake Roe and peripheral salinas and Lake Yindarlgooda.</li> <li>One BC-listed waterbird.</li> <li>One potentially novel <i>Tecticornia</i> species distributed broadly throughout Lake Roe.</li> </ul>	<ul style="list-style-type: none"> <li>Close proximity (&lt;5 km) to proposed pit.</li> <li>Likely lower cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> <li>Waterbirds</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity effects on aquatic biota in a productive &amp; frequently inundated part of the lake.</li> <li>Loss of key waterbird feeding habitat.</li> </ul>	Extreme	<ul style="list-style-type: none"> <li>Comparatively higher number of significant taxa, including an BC-listed waterbird.</li> <li>Frequently holds water.</li> <li>Higher biological productivity.</li> <li>Adequate storage capacity.</li> <li>Greater distance from the pit &amp; increased cost and complexity (for environmental approvals) of infrastructure development.</li> </ul>	✘
South-west	Pan B	<1 km to east	<ul style="list-style-type: none"> <li>Comparatively larger size &amp; more open, disconnected.</li> <li>Moderate inundation frequency.</li> <li>Adjacent to substantial drainage inflows.</li> </ul>	<ul style="list-style-type: none"> <li>One new aquatic invertebrate, distributed broadly throughout Lake Roe &amp; Lake Yindarlgooda.</li> <li>Two new aquatic invertebrates, distributed broadly throughout Lake Roe &amp; peripheral salinas and Lake Yindarlgooda.</li> <li>Two <i>Tecticornia</i> taxa of other significance (sterile material) distributed broadly throughout Lake Roe &amp; peripheral salinas.</li> <li>One <i>Tecticornia</i> taxa of other significance (sterile material), currently only known from Pan B.</li> <li>One potentially novel <i>Tecticornia</i> species currently only known from Pan B.</li> </ul>	<ul style="list-style-type: none"> <li>Immediate proximity to proposed pit.</li> <li>Likely lower cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity effects on aquatic biota in a more frequently inundated part of the lake.</li> <li>Inundation and salt toxicity of <i>Tecticornia</i> (including significant taxa) in riparian zone &amp; within basin with hypersaline discharge water.</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Comparatively higher number of significant taxa.</li> <li>Occasionally holds water.</li> <li>Likely adequate holding capacity.</li> <li>Limited pathways for salt removal and dispersal.</li> <li>Potential for backflow of hypersaline discharge water into adjacent areas of drainage.</li> <li>Comparatively higher number of significant <i>Tecticornia</i> taxa.</li> </ul>	✓
Central	Pan C	4 km to northeast	<ul style="list-style-type: none"> <li>Comparatively smaller &amp; narrower, disconnected.</li> <li>Low inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>Unknown</li> </ul>	<ul style="list-style-type: none"> <li>Close proximity (&lt;5 km) to proposed pit.</li> <li>Likely lower cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity on aquatic biota in a less frequently inundated part of the lake.</li> <li>Inundation &amp; salt toxicity of <i>Tecticornia</i> in riparian zone &amp; within basin with hypersaline discharge water.</li> </ul>	High	<ul style="list-style-type: none"> <li>Insufficient storage capacity, increasing salt build up &amp; potential to inundate riparian zone with hypersaline water.</li> <li>No pathways for salt removal.</li> <li>Biological values are unknown.</li> <li>Rarely holds water.</li> <li>Lower biological productivity likely.</li> <li>Greater distance from the pit &amp; increased cost and complexity (for environmental approvals) of infrastructure development.</li> </ul>	✘

Lake Roe Area	Pan	Distance from Proposed Pits	Hydrological & Geomorphological Assessment	Biological Values	Project Considerations	Preliminary Risk Assessment				Suitability of Option
						Receptors	Key Risks	Risk Ranking	Justification	
North-eastern	Pan D	7 km to east	<ul style="list-style-type: none"> <li>Comparatively larger size, moderate connectivity to adjacent pans.</li> <li>Moderate to High inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>One new aquatic invertebrate, distributed broadly throughout Lake Roe &amp; Lake Yindarlgooda.</li> <li>One new aquatic invertebrate, distributed broadly throughout Lake Roe &amp; peripheral salinas and Lake Yindarlgooda.</li> <li>One <i>Tecticornia</i> taxa of other significance (sterile material) distributed broadly throughout Lake Roe &amp; peripheral salinas.</li> <li>Two <i>Tecticornia</i> taxa of other significance (sterile material), currently only known from Pan D.</li> <li>One potentially novel <i>Tecticornia</i> species distributed broadly throughout Lake Roe.</li> </ul>	<ul style="list-style-type: none"> <li>Distance from pit (&gt;5 km) likely to be prohibitive.</li> <li>Likely prohibitive cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> <li>Waterbirds</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity on aquatic biota in a less frequently inundated part of the lake.</li> <li>Inundation &amp; salt toxicity of <i>Tecticornia</i> (including significant taxa) in riparian zone &amp; within basin with hypersaline discharge water.</li> </ul>	High	<ul style="list-style-type: none"> <li>Often holds water.</li> <li>Potentially higher biological productivity.</li> <li>Likely adequate holding capacity.</li> <li>Comparatively higher number of significant <i>Tecticornia</i> taxa.</li> <li>Greater distance from the pit &amp; increased cost and complexity (for environmental approvals) of infrastructure development.</li> </ul>	✘
Southern	Pan E	4 km to southeast	<ul style="list-style-type: none"> <li>Comparatively smaller &amp; narrower, disconnected.</li> <li>Moderate inundation frequency.</li> </ul>	<ul style="list-style-type: none"> <li>One new aquatic invertebrate, distributed broadly throughout Lake Roe &amp; Lake Yindarlgooda.</li> <li>Two <i>Tecticornia</i> taxa of other significance (sterile material) distributed broadly throughout Lake Roe &amp; peripheral salinas.</li> <li>One potentially novel <i>Tecticornia</i> species distributed broadly throughout Lake Roe.</li> <li>One <i>Tecticornia</i> of other significance (sterile material), currently only known from Pan E.</li> </ul>	<ul style="list-style-type: none"> <li>Close proximity (&lt;5 km) to proposed pit.</li> <li>Likely lower cost associated with infrastructure (pipeline development).</li> </ul>	<ul style="list-style-type: none"> <li>Water &amp; sediment</li> <li>Aquatic biota</li> <li>Riparian vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Salt &amp; metal toxicity effects on aquatic biota in a more frequently inundated part of the lake.</li> <li>Inundation of <i>Tecticornia</i> (including significant taxa) in riparian zone with hypersaline discharge water.</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Occasionally holds water.</li> <li>Likely adequate holding capacity.</li> <li>Comparatively higher number of significant <i>Tecticornia</i> taxa.</li> <li>Limited pathways for salt removal &amp; dispersal.</li> </ul>	✔

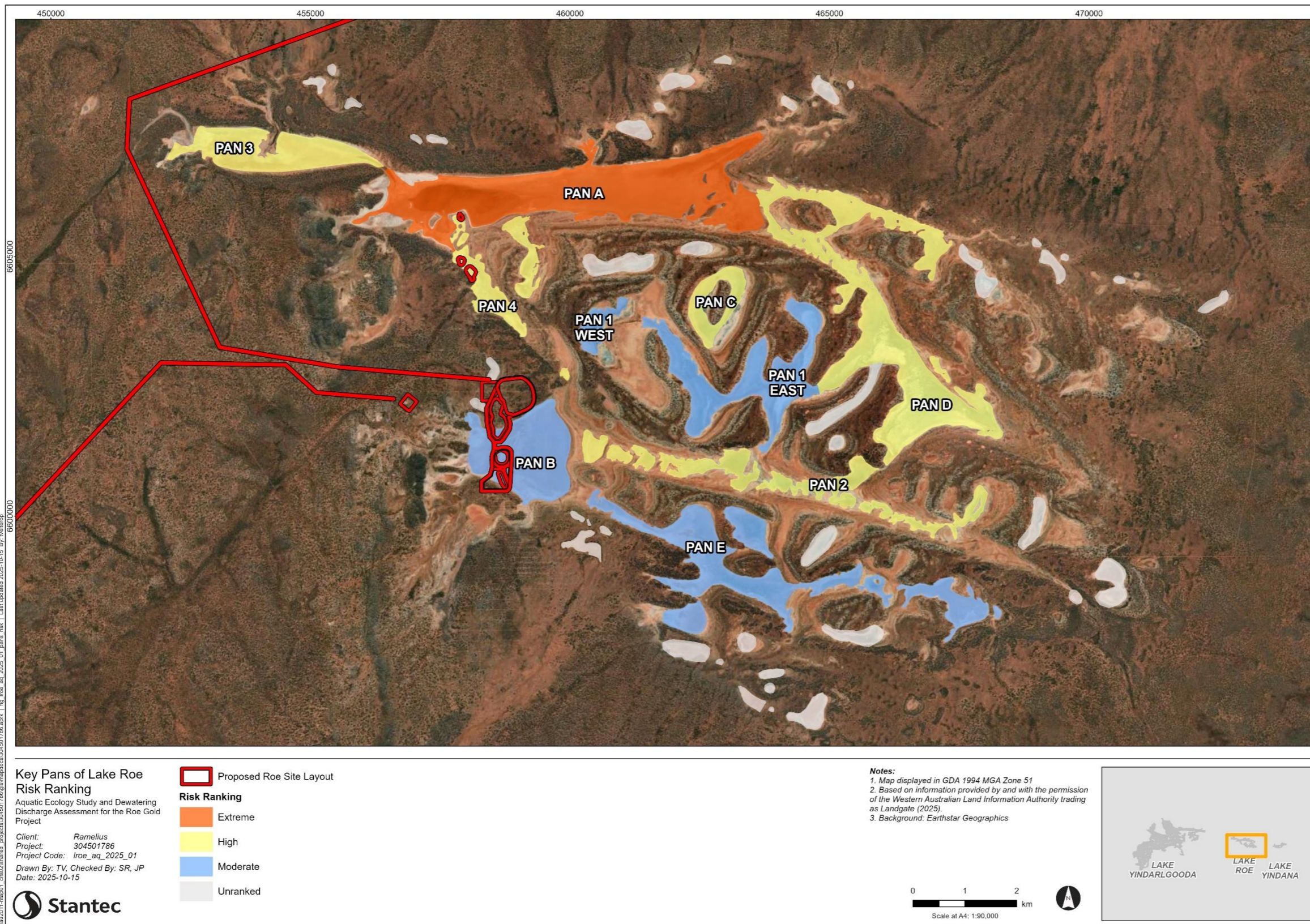


Figure 14: Risk ranking of Lake Roe key pans following the preliminary risk assessment.

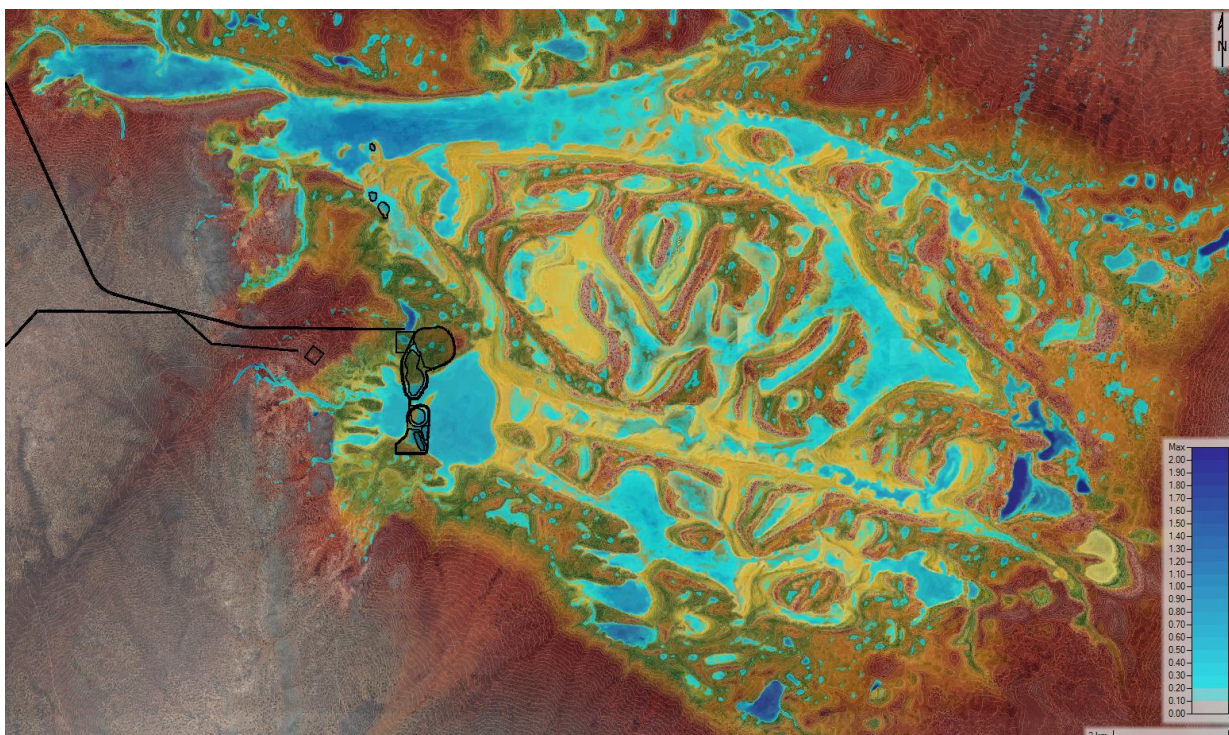
## 4.4 Discharge Assessment

All key pans on Lake Roe were modelled, however only those pans allocated a 'Moderate' preliminary risk ranking were considered further in the discharge assessment. Additional modelling results are shown in **Appendix B**, which were excluded from the assessment and are considered the worse-case scenario, prior to overtopping adjacent pans.

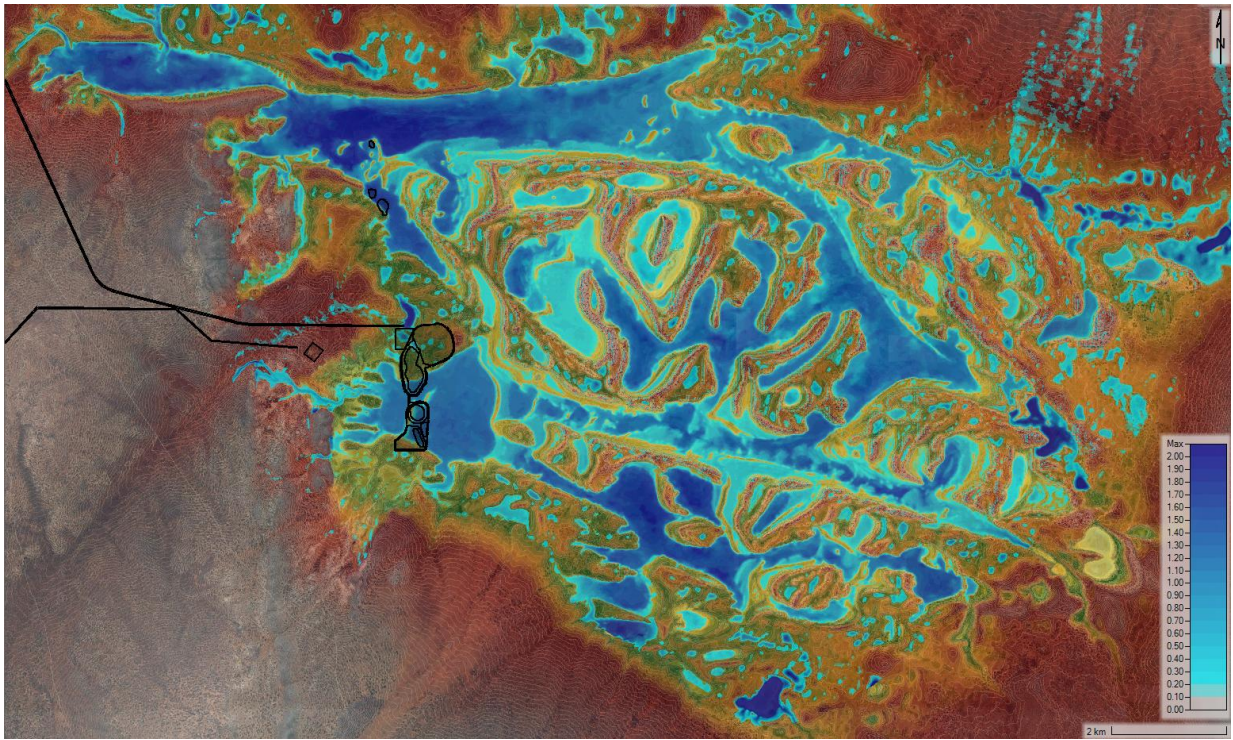
### 4.4.1 Flood Extents

Flood extents for a range of precipitation events were modelled with and without dewatering discharge. Infiltration loss rates for external catchments were adjusted based on recommendations in the Lake Roe flood depth assessment (AQ2 2025b). Due to evaporation and seepage losses, the proposed steady discharge rates of up to 30 L/s do not have an appreciable effect on flood inundation extents.

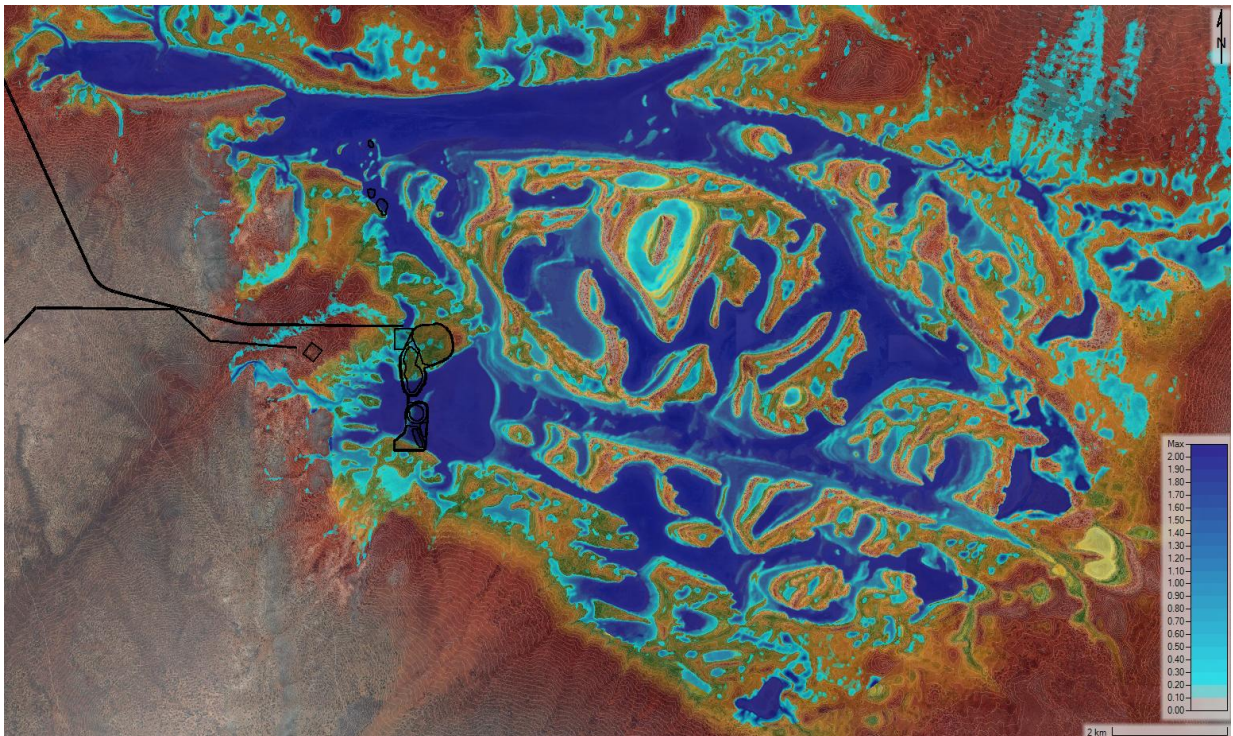
The maximum inundation depths associated with an excess precipitation depth of 25 mm is shown in **Figure 15**. This corresponds to rainfall events with an average recurrence interval (ARI) of between two years and five years (corresponding to an AEP between 20% and 40%). In this scenario, pans are generally isolated. The maximum inundation depths associated with a 20% AEP event are presented in **Figure 16**. In this scenario, connections form between the largest pans, with some pans remaining isolated. The 1% AEP event maximum inundation extents, with connections formed between most pans is shown in **Figure 17**. Smaller ponds remain isolated; Pan C is the largest pan that remains isolated in this event.



**Figure 15: Maximum inundation depths for 25 mm of excess rainfall on Lake Roe, in relation to Project infrastructure (black outline).**



**Figure 16: Maximum 20% AEP inundation depths on Lake Roe, in relation to Project infrastructure (black outline).**

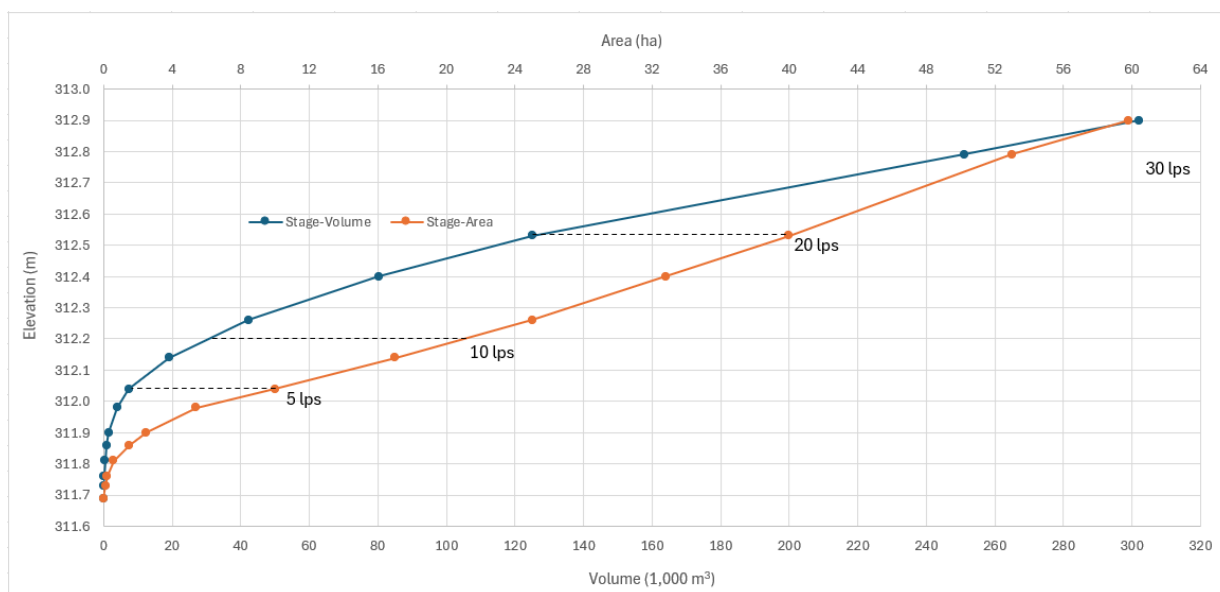


**Figure 17: Maximum 1% AEP inundation depths on Lake Roe, in relation to Project infrastructure (black outline).**

## 4.4.2 Discharge Inundation Extents

Following the completion of the desktop review and preliminary risk assessment, all pans were screened based on respective risk rankings and proximity to proposed mining infrastructure. Pan A (and other key pans in the north) were not considered for any assessment due to their 'High' or 'Extreme' risk rankings.

An example of the inundation areas and storage volumes corresponding to a range of discharge rates in Pan 1W is shown in **Figure 18**. For reference, riparian vegetation occurs between elevations of 312.5 mAHD and 313 mAHD.



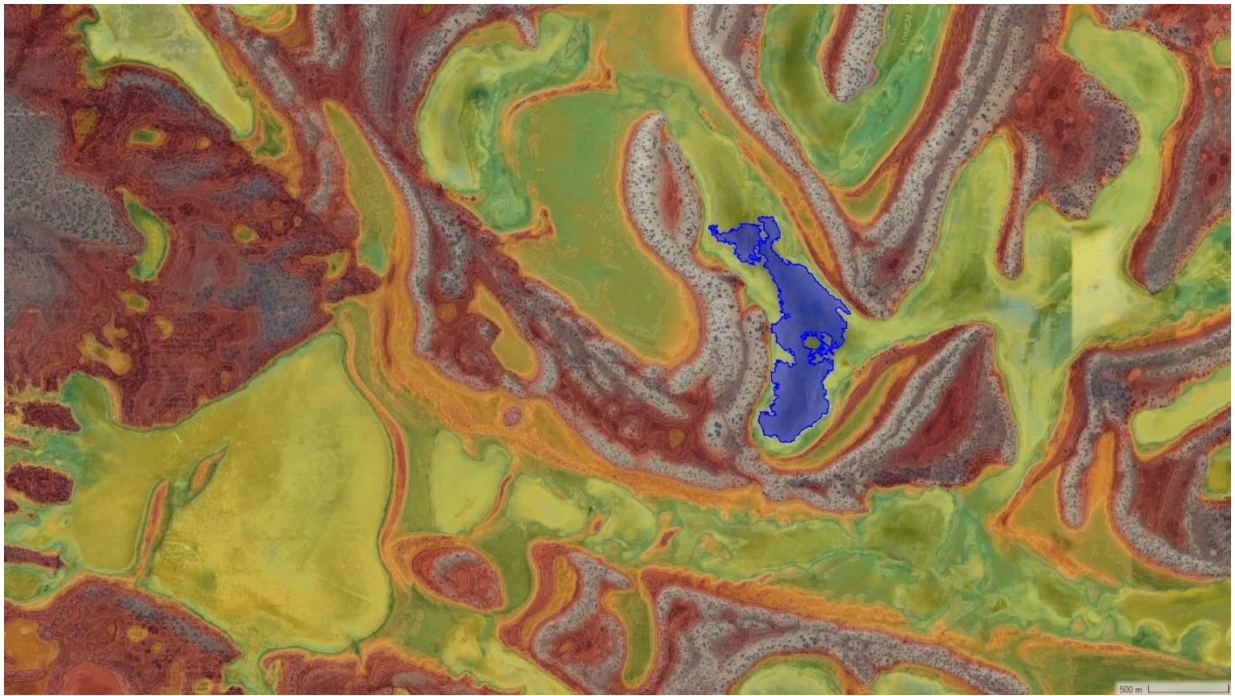
**Figure 18: Elevation versus discharge, inundation area, and storage volume for Pan 1W.**

The inundation levels (**Figure 18**) are shown without adjustment for deposited salts. Over a two-year period, the deposited salts have the potential to fill the entire western pan to its overflow point within Pan 1E. This would raise the elevation of any hypersaline discharge, including reduced rates of 5 L/s or lower, resulting the interaction with riparian vegetation.

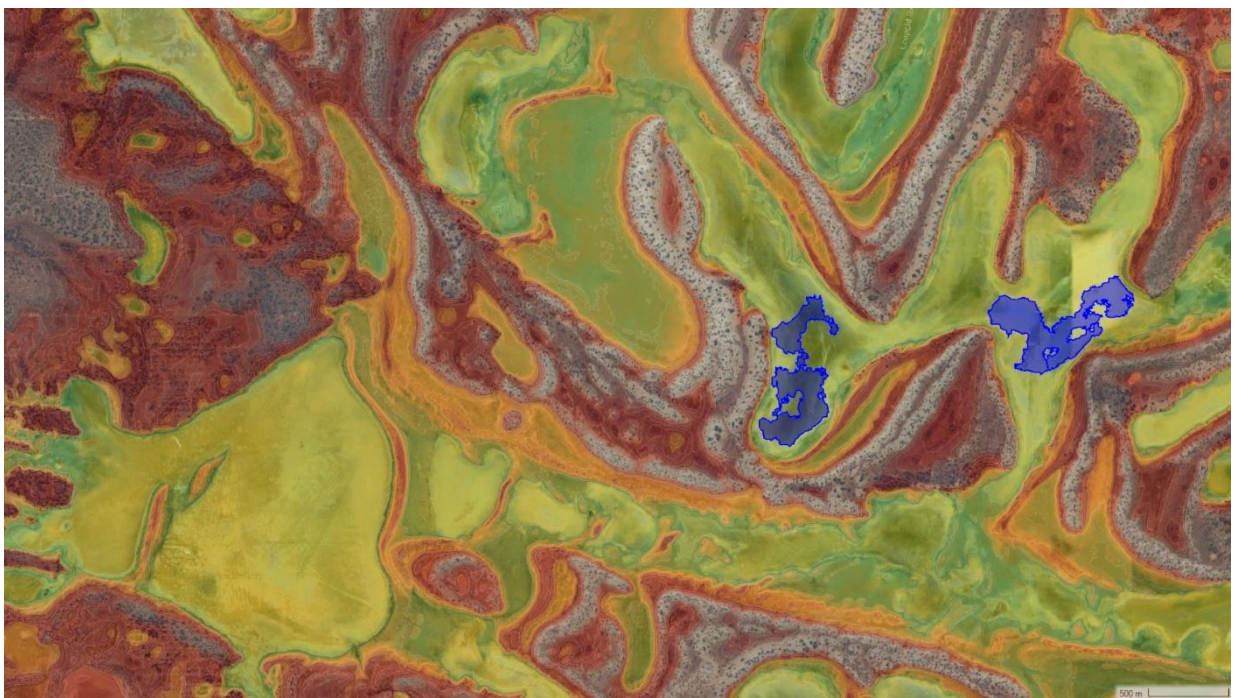
Several pans, including Pan C, would remain isolated even in cyclonic runoff events. Discharge to these pans would be completely contained without affecting the remainder of the lake, but the riparian vegetation within these pans would be affected by potential flooding with hypersaline water in all scenarios over a 9-year LoM. Therefore, these options were subsequently discounted following discussions with Ramelius.

Additional pans with 'High' risk rankings were also dismissed following further review and discussion, and three options with 'Moderate' risk rankings were carried forward for more detailed assessment, based on reduced discharge rates of 20 L/s that avoids impacts to riparian vegetation.

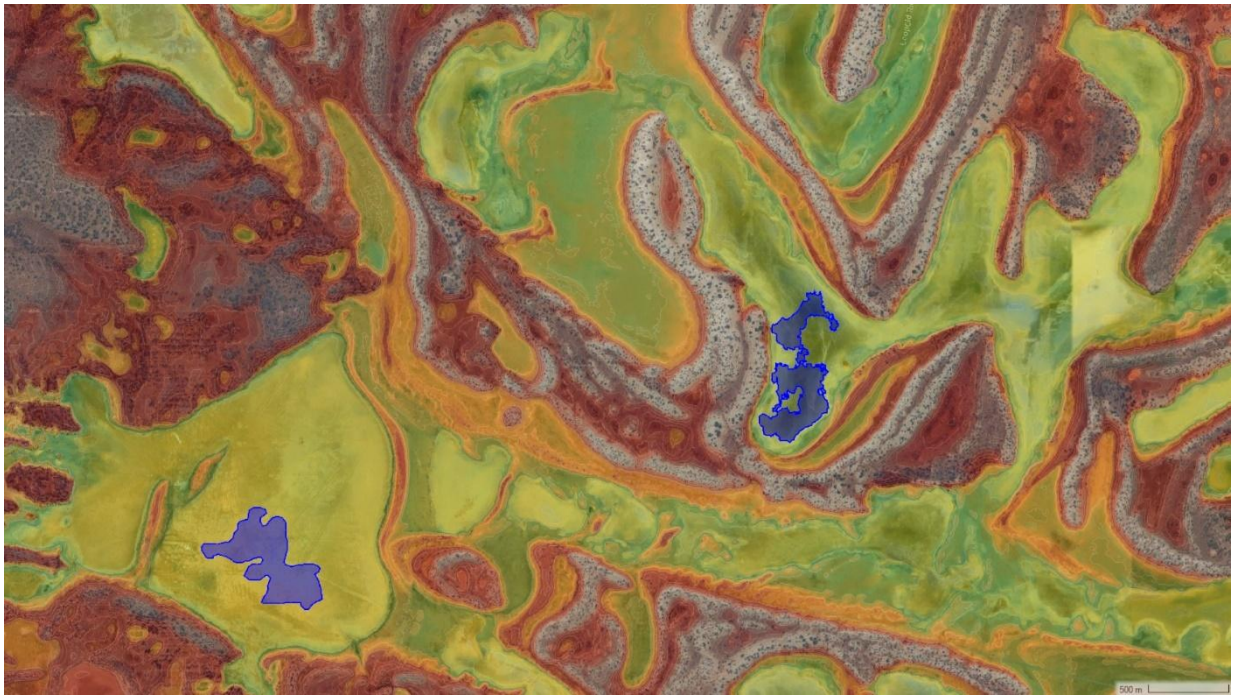
The maximum hypersaline inundation extents associated with a 20 L/s discharge to a single outfall location in Pan 1E are presented in **Figure 19**, while **Figure 20** shows the 20 L/s total discharge, split between two locations in Pan 1E. The inundation extents associated with a 10 L/s discharge in Pan B and 10 L/s in Pan 1E are presented in **Figure 21**. The results show that these discharge locations could accommodate a total discharge rate of 20 L/s without inundating adjacent riparian vegetation, while higher discharge rates would result in interaction. While local rainfall and runoff would dilute salts from the discharge following significant precipitation events, overtopping and interaction with riparian vegetation may still occur with higher salinity surface waters than background levels.



**Figure 19: Extent of 20 L/s discharge scenario to single outfall in Pan 1E on Lake Roe.**



**Figure 20: Extent of 10 L/s discharge scenario to each of two outfalls in Pan 1E on Lake Roe.**



**Figure 21: Extent of 10 L/s discharge scenario to Pan B and 10 L/s discharge to Pan 1E on Lake Roe.**

#### **4.4.3 Salinity**

The inundation extents based on the hydraulic modelling results represent inundation with the most hypersaline discharge during the lowest monthly evaporation periods. Salinity would decrease through dilution with any external runoff events that are contained within the pans, and salinities would further decrease with any runoff events that result in interconnected pans. The dissolution rates of deposited salts depend on inundation periods and depths.

On Lake Lefroy, located in the south-eastern Goldfields for example, discharge to the lake has occurred since the 1980s from the St Ives Gold Mine. The lake currently receives discharge from multiple outfalls with a licensed limit of 30,000,000 tonnes per annum (equivalent to 30 giganlitres; GL, per annum). This has led to substantial salt deposition on the lakebed, with residual salts remaining following inundation events that contribute to hypersaline surface water conditions (>150,000 mg/L), which adversely impacting ecology (SIGMC 2018).

The total estimated mass of deposited salts over the 9-year LoM for this Project, based on the proposed 30L/s discharge scenario, is approximately 2,100,000 tonnes (assumed average salinity of 250,000 mg/L). Relative to the 120 GL storage volume associated with the 1% AEP inundation event (**Figure 5**), this represents an average salinity increase of approximately 18,000 mg/L in surface waters. The relative increase in salinity would likely be higher due to the pans that remain isolated in the 1% AEP event; however, this increase may be offset by undissolved discharge salts on the lake surface. Relative to the 450 GL storage volume associated with the 20% AEP inundation event, the salinity increase in surface waters would be approximately 44,000 mg/L, assuming uniform mixing and dilution.

Background salinity levels in Lake Roe vary over time, including seasonal fluctuations. No salinity thresholds for impacts to riparian vegetation have been established, and no baseline inflow testing has been conducted to establish background salinity levels for surface water inflows. Regardless of the background levels, the magnitude of hypersaline discharge will increase the salinity in Lake Roe. If no major runoff events occur during the LoM, the increased salinity may occur following mine closure. Based on the analysis of inundation extents relative to the elevations of riparian vegetation, the increased salinity would be expected to adversely impact some riparian vegetation, particularly in the immediate pans targeted for discharge.

#### **4.4.4 Outcomes**

Steady state discharge into any of the key pans modelled would increase surface water salinities during flood events as well as periodically inundating the riparian vegetation zone with hypersaline water, which will be exacerbated over the LoM. The impacts would be most pronounced in key pans targeted for discharge. Following dilution related to high runoff events, the total increase in surface water salinity is expected to be approximately 44,000 mg/L on average, across the entire lake system when subject to runoff events that connect the pans approximately once every five to ten years (major flood events). However, there is expected to be a localised buildup of salts that will occur in the target discharge pan that will not completely dissolve when inundated, resulting in hypersaline (>50,000 mg/L) conditions during flooding.

Salinities are expected to increase over the LoM, due to the relatively constrained nature of key pans on Lake Roe, and larger flood events will be unable to sufficiently dilute surface waters to within acceptable limits. Increasing salinities above the tolerance limits of aquatic biota and riparian vegetation may pose an unacceptable environmental risk and over time; the pan targeted for discharge may reach a tipping point, from which it cannot recover, due to residual salt build up. Therefore, steady state discharge does not appear to be a viable environmental option at the predicted rate of 30 L/s over the LoM for the Project.

## **5 Contingency Discharge Scenario**

The risk of environmental harm due to residual salts in key pans from proposed discharge was deemed unacceptable, with Ramelius instead investigating other potentially suitable options, including evaporation ponds. Maintenance activities associated with constructed evaporation ponds will allow for the periodic removal of accumulated salts and appropriate disposal. Evaporation ponds would be alternately operated to allow maintenance while pumping continues.

Evaporation ponds would be subject to direct rainfall only and protected from external runoff. However, they should be operated with sufficient freeboard to prevent overtopping in rare precipitation events. In extreme, greater-than-design events, or if pumping rates exceed evaporation pond capacity, an emergency spillway could allow discharge into Pan B.

To prevent environmental harm an assumed limit of a 2,500 mg/L increase in salinity is proposed. Based on the assessed storage volumes, a total discharge rate of 10 L/s for five days, occurring a maximum five times per year over the 9-year LoM, would result in approximately 5,000 tonnes of salt deposited annually into the target pan. Pan B has a total storage capacity of approximately 2 GL at its point of overtopping into Pan 2. The corresponding increase in background surface water salinity levels is approximately 2,500 mg/L, without precipitation. This level of increase would be further diluted following runoff events that result in interconnected ponds. This level of increase is assumed to avoid causing unacceptable environmental harm.

According to (Hammer 1986), freshwater is defined as having a salinity concentration of less than 3,000 mg/L, with concentrations above this considered saline. In addition, *Parartemia*, a characteristic aquatic invertebrate that inhabits salt lakes throughout Australian inland waters typically hatches in salinities ranging from 3,000 to 30,000 mg/L (Timms 2014). Although adult *Parartemia* can persist in hypersaline conditions (above 100,000 mg/L) the occurrence and distribution of some species is known to be restricted by elevated salinities (Timms 2014). There is limited understanding of comparative salinity tolerance limits for riparian vegetation subject to flooding.

Therefore, while steady state discharge at the 30 L/s scenario is not recommended into key pans, a contingency option of disposal of dewatering to Pan B may be suitable, based on limiting the volume and duration of proposed discharge, to maintain environmental values. Pan B has adequate storage capacity and is located adjacent to mining pits, allowing development of discharge infrastructure nearby.

Even if no runoff events providing dilution through basin connections were to occur during the LoM, the maximum increase in total salinity to Pan B would be limited to 2,500 mg/L in a given year under a contingency discharge scenario. The salt input would be restricted to 5,000 tonnes annually, well within the natural variation of surface water salinities from salt lakes in the Goldfields. Existing baseline data from Lake Roe and surrounding regional wetlands indicates salinity ranges from 22,000 to over 180,000 mg/L (Stantec 2025), while water quality results from rewetting trials ranges from approximately 10,000 to 70,000 mg/L (Stantec 2020). Therefore, it is expected that Pan B could adequately accommodate the contingency discharge scenario, while preventing adverse effects on aquatic biota (including emergence and persistence) and indirect effects on riparian vegetation during flooding.

## 6 Conclusions

Drainage at Lake Roe is endorheic and is constrained and convoluted by a complex series of pans. These pans support a range of biological values including three potentially significant (undescribed) ostracod taxa, one BC-listed waterbird species and six significant (four sterile and two novel taxa) *Tecticornia* species. Several key pans hold water more frequently (typically in the northern part of the lake), and therefore support higher ecological values compared to less frequently inundated pans in the central and particularly southern parts of the lake.

A preliminary risk assessment ranked several northern pans in Lake Roe as 'High' to 'Extreme', due to the potential to cause environmental harm (including on potentially significant species). This is related to residual salt loading impacts from the proposed discharge on aquatic biota and riparian vegetation. In contrast, some pans in the central part of the lake and all pans in the south were ranked at 'Moderate' risk of potential impacts.

Subsequent hydraulic modelling of pans ranked as 'Moderate' in the preliminary risk assessment indicated that at a proposed discharge rate of 30 L/s, key pans in the central and southern parts of the lake would overtop during flood events. Over the 9-year LoM, salt build up in these pans would also result in the inundation of riparian vegetation with hypersaline water causing plant deaths, considered an unacceptable environmental risk.

The construction of evaporation ponds is an alternative and viable option to dispose of mine dewatering from the Project. Appropriate design and periodic salt removal and disposal would prevent runoff of hypersaline water into the surrounding environment. However, in extreme, greater-than-design events, or if pumping rates exceed evaporation pond capacity, Pan B, located adjacent to mining pits, has the potential to accommodate a contingency discharge. A contingency discharge rate of 10 L/s for five days, utilised at most, five times per year over the 9-year LoM, would result in approximately 5,000 tonnes of salt deposited into Pan B annually. This corresponds to an increase in the surface water salinity of approximately 2,500 mg/L, considered conservative and environmentally acceptable; within natural variation for the lake and known tolerance limits of aquatic biota and riparian vegetation.

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# Appendices



# Appendix A Significant Taxa Records



**Table A1: Summary of significant aquatic invertebrate taxa (ostracods) and waterbirds recorded from Lake Roe and surrounds during baseline studies.**

Significant Taxa Aquatic Invertebrates & Waterbirds	Lake Roe													L. Yindarlgooda	Peripheral Salinas				
	Rewetting Trials												Sample	Rewetting Trials		Rewetting Trials			
	2019						2025						2025	2025		2019			
	LR01	LR02	LR03	LR04	LR05	LR07	LR13	LR14	LR04_W	LR07	LR09	LR06	LR04_W	LYG03	LYG06	PW01	PW02	PW03	PW04
	Pan B	Pan 4	Pan 3	Pan A	Pan A	Pan D	Pan B	Pan B	Pan A	Pan D	Pan E	Pan D	Pan A	N/A	N/A	N/A	N/A	N/A	N/A
<i>Australocypris</i> 'BOS1364'		•		•	•			•					•		•				
<i>Diacypris</i> 'BOS1969'								•		•	•		•	•					
<i>Reticocypris</i> 'BOS1088'	•	•	•		•	•	•		•	•		•		•	•	•	•	•	
<i>Reticocypris</i> 'BOS1363'								•						•	•				•
<i>Charadrius cucullatus</i> (P4)								•											

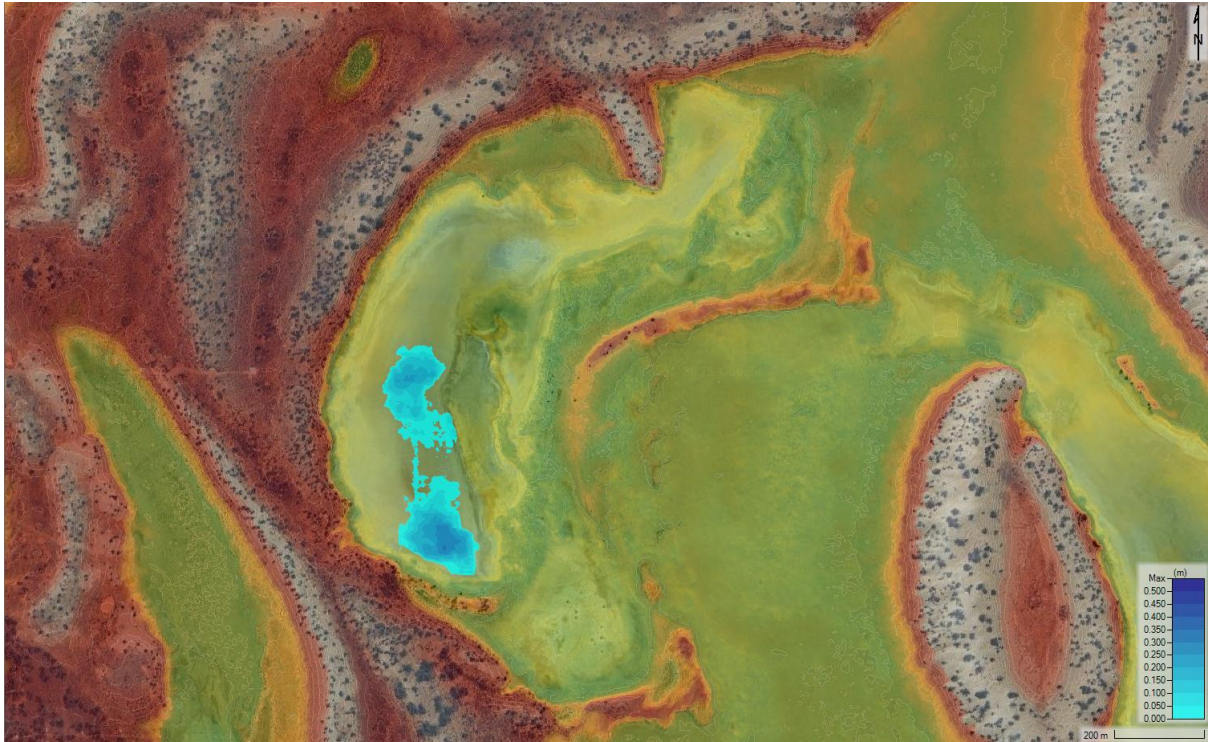
**Table A2: Summary of significant riparian vegetation taxa (*Tecticornia*) recorded from Lake Roe and surrounds during baseline studies.**

Significant Taxa Riparian Vegetation	Lake Roe														Salinas		Lake Roe					
	2019														2019		2025					
	LR01	LR02	LR03	LR04	LR05	LR06	LR07	LR08	LR09	LR10	LR11	LR12	LR13	LR14	PW01	PW02	LR03	LR04	LR06	LR07	LR10	LR11
	Pan B	Pan 4	Pan 3	Pan A	Pan A	Pan D	Pan D	Pan 2	Pan E	Pan E	Pan B	Pan B	Pan B	Pan B	N/A	N/A	Pan 3	Pan A	Pan D	Pan D	Pan E	Pan B
<i>Tecticornia</i> sp. 1 (sterile)															•							
<i>Tecticornia</i> sp. 2 (sterile)									•													
<i>Tecticornia</i> sp. 3 (sterile) (2019)						•				•			•		•							
<i>Tecticornia</i> sp. 3 (sterile) (2025)																					•	
<i>Tecticornia</i> sp. 4 (sterile)									•													
<i>Tecticornia</i> sp. 5 (sterile)										•			•									
<i>Tecticornia</i> sp. 6 (sterile)	•																					
<i>Tecticornia</i> sp. 7 (sterile)															•							
<i>Tecticornia</i> sp. nov. 1																						•
<i>Tecticornia</i> sp. nov. 2																	•	•	•	•	•	

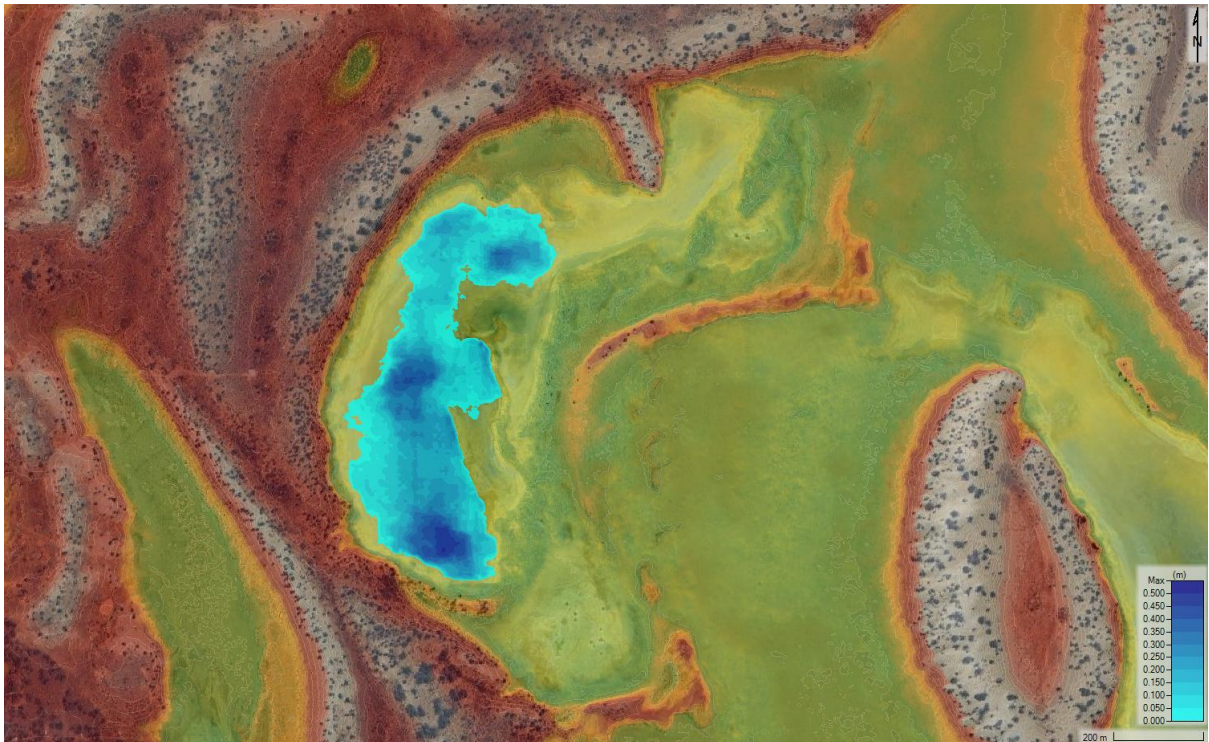


## **Appendix B Lake Roe Superseded Modelling Results**



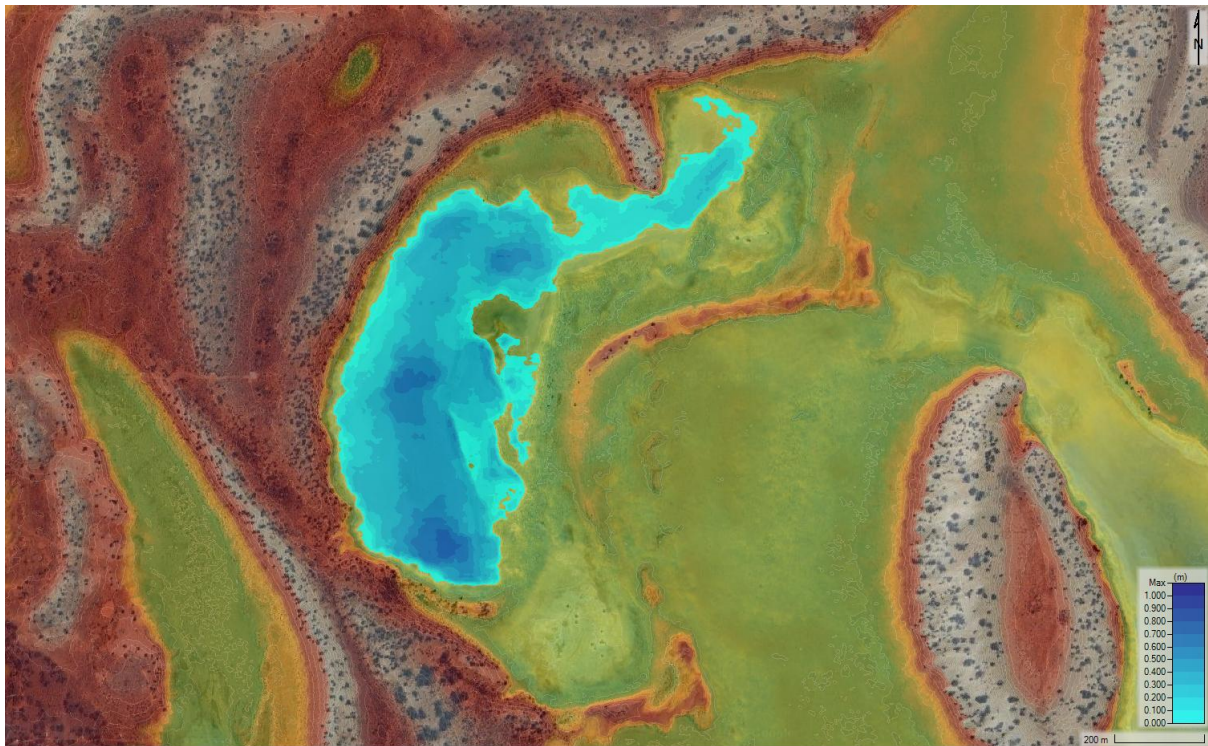


**Figure B1: Pan 1W, 5 L/s steady discharge maximum inundation extents without precipitation.**

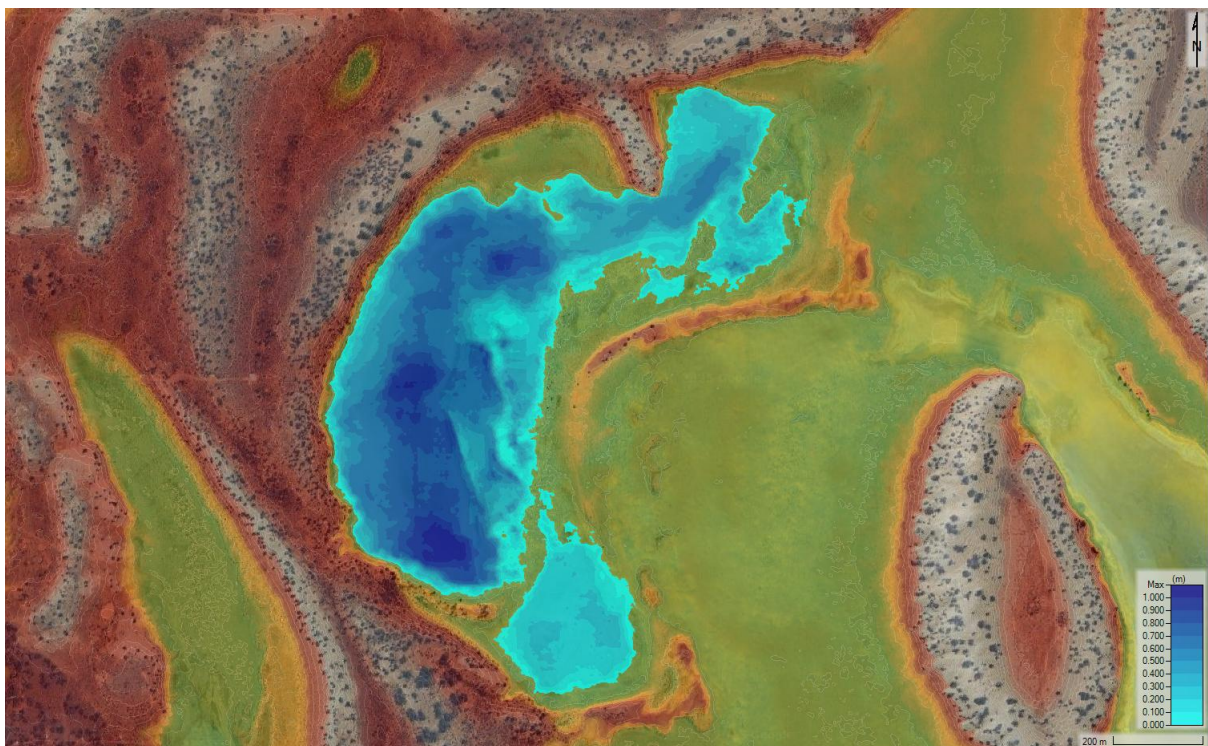


**Figure B1: Pan 1W, 10 L/s steady discharge maximum inundation extents without precipitation.**





**Figure B2: Pan 1W, 15 L/s steady discharge maximum inundation extents without precipitation.**



**Figure B3: Pan 1W, 20 L/s steady discharge maximum inundation extents with salt buildup.**



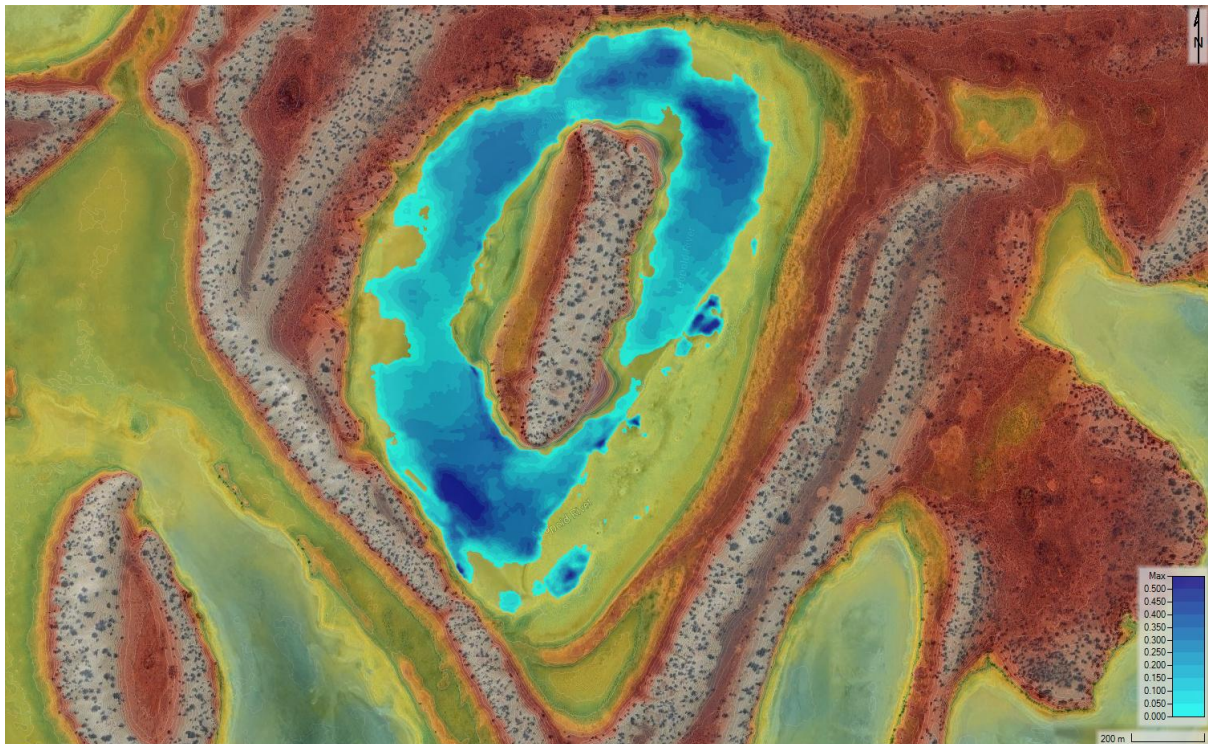


Figure B4: Pan C, 30 L/s steady discharge maximum inundation extents without precipitation.

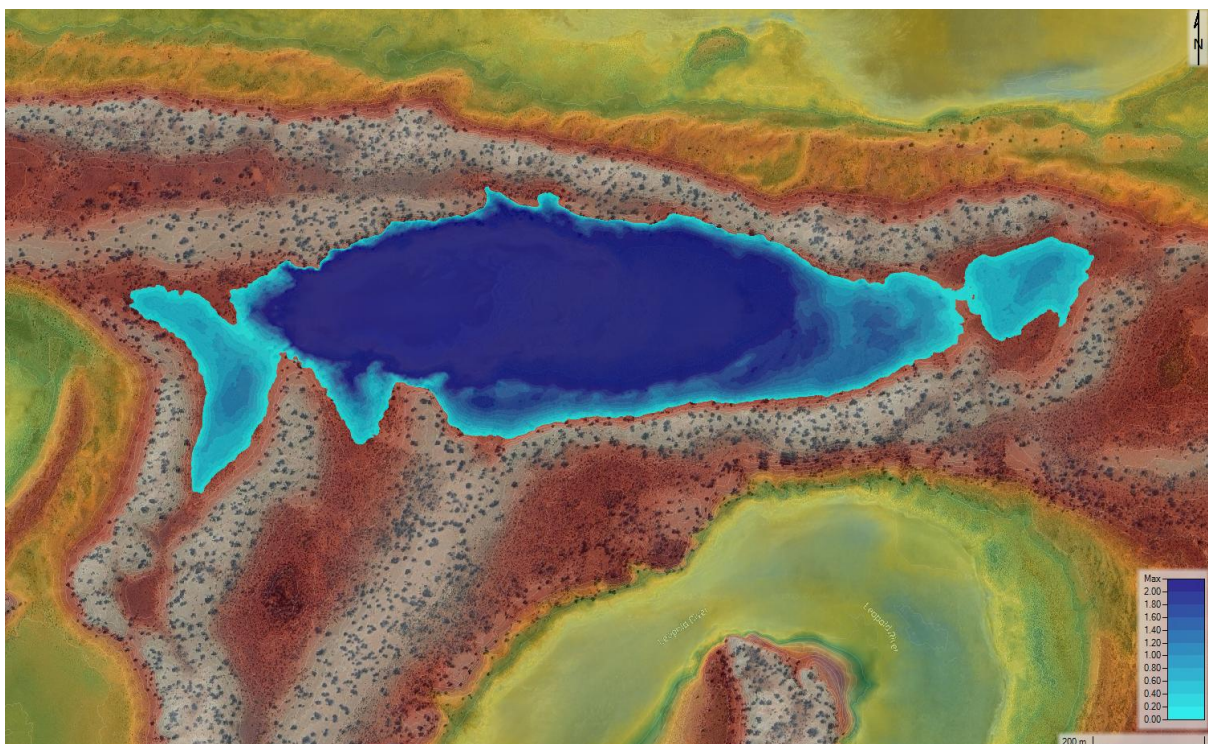
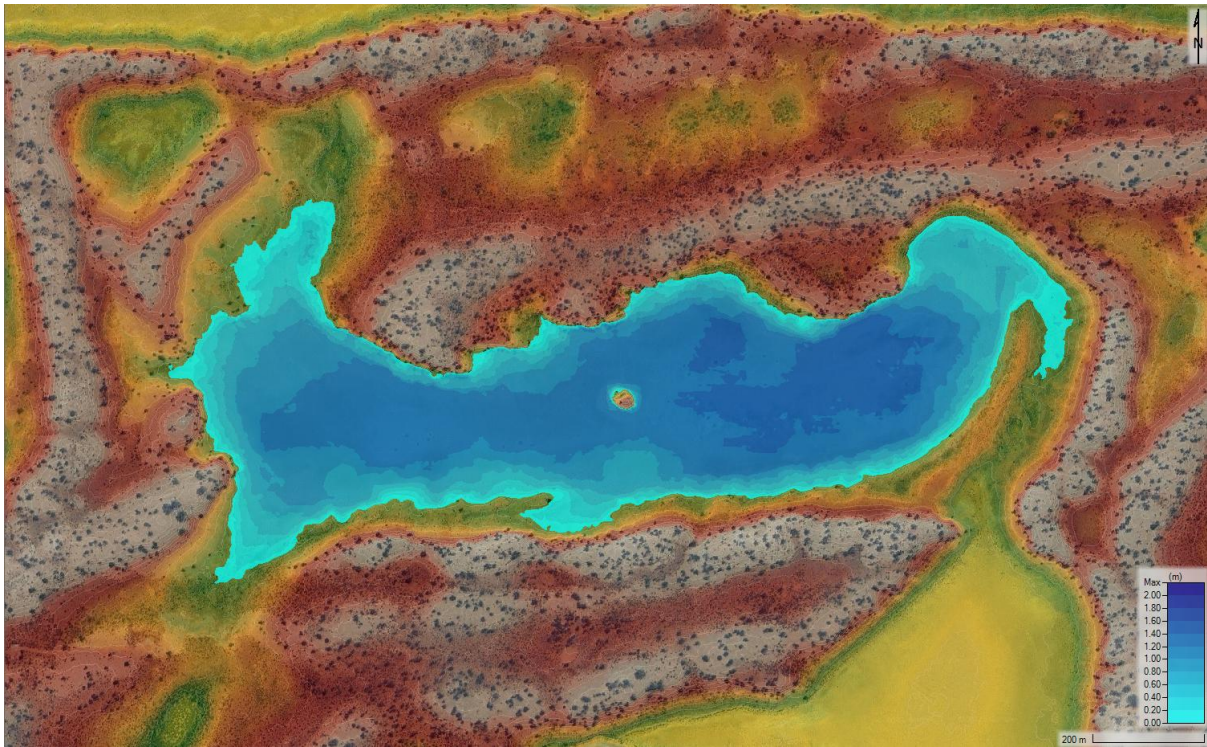


Figure B5: Pan C, North 20 L/s steady discharge max inundation extents without precipitation.





**Figure B6: Pan 1, North 25 L/s steady discharge max inundation extents without precipitation.**





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