LAKE DISAPPOINTMENT POTASH PROJECT

EPA Assessment No. 2087

Environmental Review Document prepared by Reward Minerals Ltd

29 January 2019

Revision	Revision date	Reviewed by	Details
A	22/12/2017	DT/MR	Draft submitted to OEPA for review & comment
B	08/01/2018	DT	Resubmitted to OEPA for review & comment
0	31/10/2018	DT	Revised ERD incorporating results of additional technical studies and new content which seeks to address comments received from OEPA on draft RevB.
1	7/01/2019	LC	Minor editorial revisions to ensure accuracy of referencing and correct grammatical and formatting errors.
2	29/01/2019	DT	Editorial revisions to improve quality of graphics

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on the environmental review for this proposal. Reward Minerals Limited proposes to operate a solar evaporation Potash recovery facility at Lake Disappointment, located approximately 320 km east of the town of Newman, WA. The proposal would involve abstraction of approximately 60 gigalitres per year (GL/a) of potassium-rich brines from saline sediments associated with the Lake Disappointment playa, to produce sulfate of potash (SOP) by crude potash harvesting and crystallisation of SOP by means of solar evaporation of the harvested salts. The proposal includes the construction and use of associated mine infrastructure (evaporation ponds, water supply borefield, processing plant, offices, workshop, accommodation village and roads). Non-target salts, mainly consisting of sodium chloride, would be stored in stockpiles on the Lake Disappointment playa. Potash product would be transported by road to Newman and then to shipping facilities at Port Hedland or Geraldton.

Reward Minerals has prepared an Environmental Review Document (ERD) in accordance with the EPA's Procedures Manual (Part IV Divisions 1 and 2). The ERD is the report by the proponent on their environmental review which describes this proposal and its likely effects on the environment. The ERD is available for a public review period of 6 weeks from 4 February 2019, closing on 18 March 2019. Information on the proposal from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the proposal to the Minister for Environment.

Why write a submission?

The EPA seeks information that will inform the EPA's consideration of the likely effect of the proposal, if implemented, on the environment. This may include relevant new information that is not in the Environmental Review Document, such as alternative courses of action or approaches. In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*.

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on information in the Environmental Review Document. When making comments on specific elements in the ERD, ensure that you:

- Clearly state your point of view and give reasons for your conclusions
- Reference the source of your information, where applicable
- Suggest alternatives to improve the outcomes on the environment.

What to include in your submission

Include the following in your submission to make it easier for the EPA to consider your submission:

- Your contact details – name and address
- Date of your submission
- Whether you want your contact details to be confidential
- Summary of your submission, if your submission is long
- List points so that issues raised are clear, preferably by environmental factor
- Refer each point to the page, Section and if possible, paragraph of the ERD
- Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for public submissions is: 18 March 2019.

The EPA prefers submissions to be made electronically via the EPA's Consultation Hub at https://consultation.epa.wa.gov.au. Alternatively, submissions can be:

- Posted to: Chairman, Environmental Protection Authority, Locked Bag 33 Cloisters Square WA 6850, or
- Delivered to: the Environmental Protection Authority, Level 4, The Atrium, 168 St George's Terrace, Perth 6000.

If you have any questions on how to make a submission, please contact the EPA Services at the Department of Water and Environmental Regulation on 6364 7000.

SCOPING CHECKLIST

Task No.	Required work	Section
EPA factor 1: Flora and vegetation		
1	Undertake flora and vegetation surveys in accordance with the requirements of the EPA *Guidance Statement No. 51* and the *Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016k) in areas that are likely to be directly or indirectly impacted as a result of the proposal, including fringing samphires, groundwater dependent ecosystems (GDE) and aquatic flora. This should include a description of the surveys undertaken, the baseline data collected, and the environmental values identified. Where prior surveys are included, provide a literature review and justification to demonstrate those surveys are relevant, representative of the current proposal and were conducted consistent with EPA policy.	4.5 Appendix D
2	Describe the existing flora and vegetation within the development envelope, including its relevance within a wider regional context.	4.5.3
3	Include maps that illustrate the known recorded locations of conservation significant species and communities in relation to the proposed disturbance and areas to be impacted.	4.5.3
4	Conduct a detailed analysis of vegetation communities to establish local and regional conservation significance of each vegetation community. Identify those communities which are likely to be groundwater dependent ecosystems (GDE). Provide details of the methodology used in the identification and mapping of vegetation communities.	4.3.5 4.5.4 Appendix D
5	Assess the potential direct and indirect impacts associated with the proposal on the flora and vegetation within the development envelope. This should be a quantitative assessment that addresses numbers and proportions of individuals, populations and associations in the local and regional context; especially those species and communities of conservation significance as defined in Guidance Statement No. 51.	4.3.5 4.5.5 Appendix D
6	Provide comprehensive mapping of vegetation units and significant flora in relation to the proposed disturbance, including maps depicting vegetation boundaries overlaying aerial photography. Figures should show the likely spatial extent of loss of vegetation units from both direct and indirect impacts, particularly altered hydrology and dust.	4.5.3 Appendix D
7	Provide a discussion of the proposed management, monitoring and mitigation methods to be implemented demonstrating that the design of the proposal has addressed the mitigation hierarchy in relation to impacts (direct and indirect) on flora and vegetation and consideration of alternatives.	4.2.6 4.3.6 4.5.6
8	Complete EPA Checklist for documents submitted for Environmental Impact Assessment (EIA) on terrestrial biodiversity.	Note 1
9	To the extent that significant residual impacts cannot be avoided, reduced, mitigated, or subsequently restored – identify appropriate offsets.	Note 2
10	Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, to ensure impacts (direct and indirect) are not greater than predicted.	4.5.6

Task No.	Required work	Section
11	Provide a statement of how the proponent considers the EPA's objective for this factor has been addressed.	4.5.7
EPA factor 2: Subterranean fauna		
12	Conduct surveys within areas to be impacted and in surrounding areas in accordance with EPA guidance.	4.7.3 Appendix F
13	Present the results of the subterranean fauna surveys and discuss the direct and indirect impacts to subterranean fauna species and habitat in accordance with EPA guidance. Include figures (maps) and tables to summarise the results and illustrate the areas of impact in relation to subterranean fauna species and habitat.	4.7.3 4.7.4
14	Assessment of impacts (direct and indirect) to subterranean fauna taxa and assemblages at a local and regional scale. For species which are likely to be impacted, provide information including maps and figures to demonstrate habitat connectivity beyond the areas of impact.	4.3.5 4.7.5
15	Discussion of the proposed management, monitoring and mitigation methods to be implemented demonstrating that the design of the proposal has addressed the mitigation hierarchy in relation to impacts on subterranean fauna.	4.7.6
16	Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plan(s), to ensure impacts (direct and indirect) are not greater than predicted.	4.7.6
17	Demonstrate in the ERD how the EPA's objective for this factor can be met.	4.7.7
18	Complete the EPA Checklist for documents submitted for EIA of proposals that have the potential to significantly impact on sea and land factors for the factor subterranean fauna.	Note 1
EPA factor 3: Terrestrial fauna		
19	Conduct studies and surveys in accordance with EPA guidance, including for terrestrial vertebrate fauna, invertebrate short-range endemic (SRE) fauna and aquatic invertebrate fauna, within areas to be impacted and in surrounding areas, including the haul road. Conduct Level 2 surveys in areas not previously surveyed that are likely to be directly or indirectly impacted as a result of the proposal.	4.6 4.6.3 Appendix E
20	Targeted surveys for conservation significant fauna and fauna that are known or likely to occupy restricted habitats in the project area (SRE invertebrates, restricted reptile species) should be conducted in accordance with EPA guidance.	Appendix E

Task No.	Required work	Section
21	For each relevant conservation significant species, including bat species and short-range endemics within the proposal area, provide: • Baseline information on their abundance (including known occurrences), distribution, ecology, and habitat preferences at both the site and regional levels; • Information on the conservation value of each habitat type from a local and regional perspective, including the percentage representation of each habitat type on site in relation to its local and regional extent; • If a population of a conservation significant species is present on the site, its size and the importance of that population from a local and regional perspective and potential percentage loss of the conservation significant species locally due to loss of habitat; and • Maps illustrating the known recorded locations of conservation significant species and SRE invertebrates in relation to the proposed disturbance and areas to be impacted.	4.6.3 Appendix E
22	Provide comprehensive mapping of fauna habitats (including rare or unusual habitat types) in relation to the proposed disturbance and a comprehensive listing of fauna likely to occur in habitats within the areas to be cleared or indirectly impacted. Include figures showing the likely extent of loss of the habitat types from both direct and indirect impacts.	4.6.3 Appendix E
23	Undertake a quantitative analysis of the extent of loss (worst-case) of habitat, including areas in hectares and percentages of habitat types to be impacted (directly and indirectly), to assist in the determination of significance of impacts to fauna. The analysis should include identification and mapping of the known regional distribution of conservation significant species and an evaluation of the impact of activities, including assessment of condition, for conservation significant species.	4.6.5 Appendix E
24	Description (including figures) of the expected direct and indirect impacts to vertebrate and SRE invertebrate fauna and their associated habitat from all aspects of the proposal.	4.6.5 Appendix E
25	Discussion of potential impacts to terrestrial fauna, as a result of implementation of the proposal, with particular regard to state listed threatened fauna and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed threatened and/or migratory species, and provision of quantitative data on impacts of the proposal to species of conservation significance.	4.6.5
26	Description of impacts resulting from fauna, both native and feral, that may be attracted to the evaporation ponds.	4.6.5
27	Provide a detailed description of the potential direct and indirect (including downstream) impacts to species within the proposal area as a result of dewatering, alterations and disruptions to surface water flows, groundwater drawdown and changes in water quality. Discuss proposed management, monitoring and mitigation methods to be implemented, any statutory or policy basis for the methods and demonstrating that the design of the proposal has addressed the mitigation hierarchy in relation to impacts on fauna.	4.6.5 4.6.6
28	Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plan(s), to ensure impacts (direct and indirect) are not greater than predicted.	4.6.6

Task No.	Required work	Section
29	Demonstrate in the ERD how the EPA's objective for this factor can be met.	4.6.7
30	Complete the EPA Checklist for documents submitted for Environmental Impact Statement (EIS) on terrestrial biodiversity.	Note 1
EPA factor 4: Hydrological processes		
31	Characterise the baseline hydrological and hydrogeological regimes, both in a local and regional context, including, but not limited to, water levels, stream flows, flood patterns, and water quantity and quality. This is to include a detailed description of the geological framework within the zone to be impacted by groundwater abstraction and any interdependence between surface and groundwater features/bodies.	4.2.3 4.3.3 Appendix H Appendix I
32	Model the impact of different flooding scenarios during operations and post closure on infrastructure and final landforms.	4.2.4 Appendix H Appendix I
33	Investigate groundwater drawdown due to groundwater abstraction associated with the proposal.	4.3.4 Appendix I
34	Identify borefield locations and design requirements to meet project needs (water supply and extraction of brine), expected abstraction over life of project, and sustainability of borefields.	2.4.1 2.4.4 Appendix I
35	Assess nature, extent and duration of potential impacts of groundwater abstraction with a focus on possible impacts on creeks, soaks/wetlands and GDE.	4.3.5 Appendix I
36	Establish potential impacts and consequences that proposed mine infrastructure could have on existing surface drainage.	4.2.4 Appendix H
37	Analyse, discuss and assess surface water and groundwater impacts. The analysis should include: • Changes in groundwater levels and changes to surface water flows associated with the proposal; • The nature, extent and duration of impacts; and • Changes in water quality (including modelling plumes) associated with the proposal.	4.2.5 4.3.5 4.4.5 Appendix H Appendix I Appendix G6
38	Identify any mine waste water discharges in the site water circuit (balance) and establish possible impacts these may have on the environment.	2.4.5 Appendix G7
39	Discuss the proposed management, monitoring and mitigation to prevent significant adverse impacts to groundwater and surface water hydrology as a result of implementing the proposal.	4.2.6 4.3.6
40	Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	4.2.7 4.3.7

Task No.	Required work	Section
EPA factor 5: Inland waters environmental quality		
41	Characterise the hydrological processes within the development envelope and determine what effect the proposal will have on surface water and groundwater quality.	4.2.3 4.3.3 4.4.3
42	Characterise the surface water and groundwater quality, both in a local and regional context.	4.4.3
43	Provide a detailed description of the design and location of the proposal with the potential to impact surface water or groundwater quality.	2.3
44	Analyse, discuss and assess potential surface water and groundwater quality impacts, including changes in groundwater chemistry associated with the proposal.	4.4.5
45	Discuss the proposed management, monitoring and mitigation to ensure impacts on inland water quality are not greater than predicted as a result of implementing the proposal.	4.4.6
46	Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	4.4.7
EPA factor 6: Heritage [no longer recognised by EPA as a standalone factor]		
47	Characterise the heritage and cultural values of proposed disturbance areas and any other areas that may be indirectly impacted to identify sites of significance and their relevance within a wider regional context.	4.8.3
48	Conduct Aboriginal heritage surveys, with the appropriate Aboriginal people who have knowledge of the heritage places within the area and who have appropriate cultural standing to be able to speak for this area, to identify Aboriginal sites of significance and identify concerns in regard to impacts from proposed mining operations.	4.8 4.8.3 Appendix J Note 3
49	Provide a description of the heritage values within the development envelope and provide a figure(s) of the heritage locations and proposed disturbance in a manner that is acceptable to Traditional Owners.	4.8.3
50	Assess the impacts of the proposal on heritage sites and/or cultural associations as a result of implementation of the proposal, including those arising from changes to the environment which may impact on ethnographic and archaeological heritage significance. This assessment will be conducted in accordance with EPA Guidance Statement No. 41 (EPA 2004).	4.8.4 4.8.5
51	Predict the residual impacts on heritage, for direct, indirect and cumulative impacts after considering avoidance and minimisation measures.	4.8.4 4.8.5
52	Outline the outcomes/objectives, management, monitoring, trigger and contingency actions to ensure impacts to heritage (direct and indirect) are not greater than predicted.	4.8.6
53	Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	4.8.7

Task No.	Required work	Section
EPA factor 7: Rehabilitation and decommissioning [No longer recognised by EPA as a standalone factor]		
54	Provide an assessment of the physical and chemical characteristics of waste landforms.	Appendix G Appendix K
55	Assess potential impacts to groundwater, surface water and soil quality from acid mine drainage (AMD) and waste landforms.	4.4.5
56	Prepare a conceptual rehabilitation and mine closure plan consistent with the *Joint Guidelines for Preparing Mine Closure Plans* (DMP & EPA 2015). The plan should include, but not be limited to: • Topsoil management; • Retention or reuse of cleared vegetation material; • Return of species and communities (where feasible) consistent with the pre-existing composition of the affected area; and • Timeframes for rehabilitation, including sequencing of operations, and progressive rehabilitation.	Appendix K
57	Describe and document in the ERD how the EPA's objective for this factor can be met.	4.9.7
EPA factor 8: Offsets [No longer recognised by EPA as a standalone factor]		
58	Describe the residual impacts for the proposal and analyse these impacts to identify and detail any that are significant.	4.10
59	If the proposal is likely to have any significant residual environmental impacts, identify environmental offsets, consistent with the requirements in the: • WA Environmental Offsets Guidelines, which includes the use of the WA Environmental Offsets Calculation Spreadsheet (where significantly impacted threatened species or ecological communities have been assigned International Union for Conservation of Nature (IUCN) criteria) and EPA Environmental Protection Bulletin No.1: Environmental Offsets.	4.10
60	Develop offset strategy following application of the 'mitigation hierarchy'.	Appendix M

Note 1: The 'EPA Checklist' referred to in the Environmental Scoping Document is no longer used by EPA.

Note 2: No significant residual impacts requiring an offset (as defined in *WA Environmental Offsets Guidelines* (EPA, 2014)) have been identified.

Note 3: Information on the heritage surveys so far completed at Lake Disappointment are provided in Section 4.8. For cultural reasons, copies of the survey reports are *not* appended to this ERD.

EXECUTIVE SUMMARY

Introduction

Reward Minerals Limited proposes to extract potassium-rich brines from sediments of the Lake Disappointment playa and to use solar evaporation of the brine to produce potassium sulfate (potash), a compound used mainly as an agricultural fertiliser. The proposed project life is 20 years (not including the construction and rehabilitation phases). The potash produced at Lake Disappointment will be transported by road to Newman and/or Port Hedland for distribution to domestic and overseas customers.

This document is an Environmental Review Document (ERD), prepared in accordance with *Instructions on how to prepare an Environmental Review Document* (EPA 2016i). It fulfils the environmental impact assessment requirements of Part IV of the *Environmental Protection Act 1986* (WA) (EP Act) and also of the *Environment Protection and Biodiversity Conservation Act* 1999 (Cwlth) (EPBC Act). The assessment of the Lake Disappointment Potash Project under the EPBC Act is being conducted as a separate assessment by the Australian Government Department of the Environment and Energy.

Background and context

Potash is a fertiliser of major importance in crop production. It helps to improve plant nutritional characteristics, yield, flavour and disease resistance, and improves soil moisture retention. In 2015/2016, over 2.3 million hectares of Australian agricultural land were amended with potash fertiliser (ABS, 2016). All potash fertiliser currently used in Australia is imported from overseas. The proposed Lake Disappointment Potash Project aims to abstract and treat natural potassium-rich brines to produce potash for domestic and overseas use. The project location is approximately 320 km east of the town of Newman in Western Australia, in the semi-arid Little Sandy Desert region.

Overview of the proposal

Potash production involves pumping of brine from trenches excavated in the playa sediments into ponds, where the brine is concentrated by solar evaporation to crystallise a series of evaporite salts. The project will involve:

- Abstraction of natural brines and evaporative concentration of potassium salts in on-playa ponds;
- Purification of potassium sulfate at an off-playa plant;
- Storage of halite in on-playa stockpiles;
- Abstraction of brackish groundwater from two borefields to supply process water to the plant and accommodation village;
- Development and use of support infrastructure;
- Upgrade and minor realignment of existing tracks for use as access/haul roads; and
- Road transport of potash product.

Construction of the project is scheduled to start in Quarter 4 2019, with brine abstraction and production scheduled to commence in Quarter 2 2020. The project will be operational in 2021 with the first export of product anticipated by Quarter 4 2021.

Key physical and operational characteristics of the proposal are summarised in Tables ES1 and ES2.

Table ES1: Summary of the proposal – Lake Disappointment Potash Project

Summary of the proposal	
Proposal title	Lake Disappointment Potash Project
Proponent name	Reward Minerals Limited
Short description	The proposal is to abstract potassium-rich brines from sediments associated with Lake Disappointment to produce sulfate of potash by means of solar evaporation of harvested salts, followed by a washing step to remove impurities. The resulting potash product would be transported by road to Newman, WA and thence to regional centres for sale and/or export.

Table ES2: Location and proposed extent of physical and operational elements

Element	**Location**	**Proposed extent/magnitude/duration**
Physical elements		
Mine and associated infrastructure	Figures 2-5, 2-6 and 2-7	Disturbance of up to 7776 hectares (ha) of which 410 ha is vegetated, with the remaining land forming part of the playa surface of Lake Disappointment
Rehabilitation and decommissioning	Appendix K	Approximately 5763 ha of disturbed land would be rehabilitated. The remaining disturbed land (approximately 2013 ha) would remain as halite landforms
Operational elements		
Brine abstraction	Figure 2-5	Up to 63 GL/a from shallow trenches and production bores over a period of 20 years
Fresh to brackish groundwater abstraction (for processing and operational purposes)	Figure 2-7	Up to 3.4 GL/a over a period of 20 years
Potash production	Figure 2-7, 2-18	Production and transport of up to 400,000 tpa of potassium sulfate (potash) salt over a period of 20 years

Stakeholder consultation

During the project definition and impact assessment stages of project development, Reward has deliberately emphasised engagement with stakeholders in regional areas, as these individuals, communities and organisations are more likely to be directly affected by project implementation (or by refusal of project consents). In the early stages of project development, Reward has consciously chosen to adopt methods involving direct communications with stakeholders, avoiding (to the extent possible) working through third parties. This approach was selected as a matter of respect and also to support the objective of establishing an enduring and constructive relationship between the Company and stakeholders.

With the public release of the Lake Disappointment ERD, the project enters a new phase. The ERD will serve as the vehicle for providing project information to the wider community. The 'Invitation to Comment' at the beginning this document describes how anyone can make a submission on the ERD. Additionally, contact details of the Lake Disappointment project manager are provided in Section 1.2.

Impact assessment

Reward has assessed potential environmental impacts of implementing the Lake Disappointment potash project in accordance with requirements set out in an Environmental Scoping Document (ESD) prepared by the Office of the EPA. The ESD outlined the preliminary key environmental factors and the work required to investigate potential impacts of the project on those factors. An annotated scoping checklist with Section references is provided at the start of this document to help readers navigate to topics of interest. A copy of the scoping document is provided in Appendix A.

The EPA identified the following 'preliminary key environmental factors' for the Lake Disappointment Potash Project:

- Flora and vegetation
- Terrestrial fauna
- Subterranean fauna
- Hydrological processes
- Inland waters environmental quality
- Heritage
- Offsets
- Rehabilitation and decommissioning.

Guidelines released by the EPA in December 2016 have slightly modified some of the key factors used by the EPA in its impact assessment framework. Accordingly, this ERD has addressed heritage considerations under the heading 'Social surroundings'. Environmental offsets and rehabilitation, and decommissioning are not considered as standalone factors. Instead, offsets and rehabilitation are discussed where relevant and appropriate under the other key factor headings. A preliminary mine closure and rehabilitation plan is provided in Appendix K. An offsets form is provided in Appendix M. Each of the other key factors is discussed in Section 4 of the ERD. Technical reports used in preparing the assessments presented in Section 4 are appended to the ERD.

Reward has used a risk-based approach to assessing impacts and has structured its assessment around a 'source – receptor – pathway' model. This conceptual framework asks the following questions:

- What project activities could cause environmental harm or pollution (what are the sources)?
- What environmental or social values could be affected by project implementation (what are the receptors)?
- What are the mechanisms by which project activities could cause adverse impacts to environmental or social values (what are the pathways)?

In cases where a source, receptor and pathway have been identified, Reward has considered the possible consequences of impacts. In defining consequences, the following attributes have been considered:

- Type of impact
- Scale and location of impact
- Frequency and duration of impact
- Reversibility of impact.

The likelihood of a given impact has been considered systematically. Initially, the 'inherent' likelihood was considered (that is, the likelihood in the absence of planned avoidance or control measures). After identifying feasible mitigation and management measures, the likelihood of risk events and the consequence of the event were reviewed to determine the residual risk of project implementation. A copy of the project risk assessment matrix is provided in Appendix L2.

Table ES3 provides a summary of potential impacts, proposed mitigation measures and predicted outcomes. Where appropriate, environmental offset measures have been identified.

Table ES3: Summary of potential impacts, proposed mitigation and outcomes

Key environmental factor 1: Flora and vegetation	
EPA objective	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
Potential impacts	• Loss of native vegetation communities as a result of clearing • Loss of conservation significant flora as a result of clearing • Dust generated by vehicle movements or materials handling affects vegetation health • Introduction or spread of weeds as a result of movement of vehicles, equipment or materials • Altered surface hydrology (changed magnitude, frequency, extent or duration of flooding) adversely affects vegetation health • Groundwater abstraction causes adverse impacts on groundwater dependent vegetation • Seepage from evaporation ponds causes groundwater mounding and adversely affects vegetation health • Altered fire regime results in loss of native vegetation Note: Vegetation impacts associated with altered surface water or groundwater hydrology are discussed primarily in the sections on surface hydrology and groundwater hydrology.
Mitigation	
Avoid	• Land disturbance will be kept to the minimum necessary for development of the project. • Infrastructure will be sited preferentially on unvegetated areas or existing disturbed areas. • Wherever practicable, a 200 m buffer zone will be established and maintained between on-playa infrastructure and riparian vegetation. • No clearing for road upgrades will be carried out within the Karlamilyi National Park. • No water will be sourced from McKay Creek or from the unconfined aquifer beneath McKay Creek and its delta.
Minimise	• Targeted pre-construction flora surveys will be conducted in parts of the disturbance footprint that cannot avoid riparian vegetation near the Lake Disappointment playa to check for the presence of priority or novel *Tecticornia*. If required, permits to take will be sought. • A ground disturbance procedure and clearing permitting system will be implemented. • The site induction program will provide information on protection of vegetation and ground disturbance authorisation procedures. • A weed hygiene system will be developed and implemented. • Weed surveillance will be conducted annually and, if required, weed control will be carried out. • Vehicles will not be permitted to leave designated access tracks or cleared areas.

<table>
<tr><th colspan="2">Key environmental factor 1: Flora and vegetation</th></tr>
<tr><td></td><td>Routine groundwater monitoring and vegetation health monitoring will be carried out to check that water abstraction at the Northern Borefield is not adversely affecting riparian vegetation associated with McKay Creek.
Routine groundwater monitoring, opportunistic surface water monitoring and vegetation health monitoring will be carried out to check that brine abstraction and treatment operations on the Lake Disappointment playa are not significantly impacting the health of riparian vegetation.
Dust suppression will be carried out, as required, during project construction and operation.
A hot work permit system will be developed and implemented.
In consultation with Traditional Owners, a program of fire risk reduction will be planned and implemented.
Firefighting equipment will be located on site and project personnel will be trained in fire response.
Where required, lightning protection equipment will be installed as part of project implementation.</td></tr>
<tr><td>Rehabilitate</td><td>Progressive rehabilitation will be undertaken on disturbed areas as they become available.
Topsoil and vegetation (including woody debris) will be respread over rehabilitated areas to act as a seed source and to protect the soil surface.
Local provenance seed will be collected and used to rehabilitate disturbed areas.
Monitoring of analogue and rehabilitated areas will be undertaken to enable assessment of rehabilitation progress.</td></tr>
<tr><td colspan="2">Outcomes</td></tr>
<tr><td>Residual impacts</td><td>No threatened flora species, vegetation assemblages or ecological communities will be impacted by project implementation. No vegetation type will have a reduced conservation status as a result of project activities.

No groundwater dependent vegetation has been shown to occur in the project area; notwithstanding this, mitigation and monitoring actions will be implemented to protect riparian vegetation from indirect impacts potentially arising from brine abstraction or groundwater abstraction. Significant impacts on riparian vegetation are unlikely.

Indirect impacts associated with dust are unlikely, as the production methods mostly involve wet processing and vehicular movements, except in the plant area, are relatively infrequent. Dust control will be implemented as required to limit wheel generated dust.</td></tr>
<tr><td>Offset</td><td>No offsets are proposed for this factor.</td></tr>
</table>

Key environmental factor 2: Hydrological processes	
EPA objective	To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.
Potential impacts	• Establishment of on-playa infrastructure results in altered surface water flooding regimes, causing disruption to migratory bird breeding/feeding • Establishment of on-playa infrastructure results in altered surface water flooding regimes, causing decline in riparian vegetation health • Establishment of infrastructure on the playa causes localised changes to flow velocities, causing localised erosion, scouring or backwater effects • Establishment of infrastructure across drainage lines causes localised changes to flow velocities, causing localised erosion, scouring, flow reduction or backwater effects • Brine abstraction results in lowering of groundwater levels, causing a decline in riparian vegetation health • Groundwater abstraction from borefields lowers groundwater levels, causing decline in vegetation health • Seepage from evaporation ponds causes groundwater mounding and adversely affects vegetation health
Mitigation	
Avoid	• No on-playa infrastructure will be located within the exclusion area at the mouth of Savory Creek. • No on-playa infrastructure will be sited within 200 m of any island on the Lake Disappointment playa. • On-playa infrastructure will approach no closer than 200 m to riparian vegetation around the playa edge. • No water will be taken from Savory Creek or McKay Creek. • Production bores in the Northern Borefield will be screened only in the confined aquifer.
Minimise	• Pond infrastructure will be developed progressively. • Where required, suitable floodways, drains and culverts will be installed to divert flow past on-playa infrastructure and return it to its natural flow path. • Brine abstraction rates will be managed to limit groundwater drawdown, especially in the riparian zone. • Monitoring bores will be established upstream and downstream of on-playa infrastructure to check groundwater drawdown and mounding impacts. • Roads and access tracks will be constructed with appropriate surface water drainage structures to minimise impacts on surface water flows. • Seasonal flow measurement will be conducted at McKay Creek and Savory Creek to allow calibration and updating of the surface hydrology model. • All groundwater abstraction, monitoring and reporting activities will be conducted in accordance with applicable permits and licences. • Monitoring bores will be established upstream and downstream of the process water borefields to check groundwater drawdown impacts.

Key environmental factor 2: Hydrological processes	
	• Monitoring bores associated with the Northern Borefields will include bores screened to enable checking of water levels in both the shallow unconfined aquifer and the confined aquifer from which water will be abstracted. • Flow meters will be fitted to groundwater abstraction bores to enable monitoring of abstraction volumes. Only the volume of water required for ore processing and associated support operations will be abstracted. • Process water storage facilities will be designed to minimise seepage.
Rehabilitate	• At closure, causeways will be removed and brine trenches will be backfilled. • Pond embankments will be breached at closure to allow rainfall to flow from the pond surface to natural flow paths on the playa. • Drainage diversions around evaporation ponds and salt stockpiles will be retained at closure to maintain flow across former operational areas. • Off-playa disturbance will be rehabilitated at closure; land surfaces will be graded to blend with surrounding topography.
Outcomes	
Residual impacts	Evaporation ponds and salt stockpiles will remain on the playa for many years post-closure and will permanently alter the playa topography at a local scale. However, no significant impacts to the depth or duration of flooding on the playa are likely, either during operations or in the post-closure phase, as the footprint of on-playa infrastructure represents less than 5% of the playa surface. The distribution of surface flows across the brine collection network will be maintained by the implementation and adaptive management of an engineered drainage system. Drawdown of the groundwater table as a result of brine abstraction will result in minor and transient changes in groundwater depth beneath the playa. The effect of brine abstraction on groundwater levels is unlikely to persist more than one year after cessation of pumping. Drawdown of the groundwater table resulting from groundwater abstraction from the water supply borefields will cause some reduction in the available subterranean fauna habitat. Significant impacts on vegetation are unlikely as: • No groundwater dependent vegetation occurs within the Cory Borefield zone of influence; and • Water abstraction at the Northern Borefield will target a confined aquifer zone, which is separated from the shallow alluvial aquifer along McKay Creek by a substantial aquiclude. Monitoring bores are proposed as a precautionary measure. Management trigger levels and adaptive management responses will be implemented under Reward's groundwater operations strategy. No other existing groundwater users—including occasional travellers along the Canning Stock Route—are likely to experience reduced groundwater availability as a result of Reward's use of the proposed process water borefields.
Offset	No offsets are proposed for this factor.

Key environmental factor 3: Inland waters environmental water quality	
EPA objective	To maintain the quality of groundwater and surface water so that environmental values are protected.
Potential impacts	• Brine abstraction lowers the water table and allows oxidation of acid-generating sediments • Excavation of sediment from shallow trenches allows oxidation of acid-generating sediments • On-playa or off-playa earthworks result in sediment mobilisation and increased surface water turbidity • On-playa infrastructure obstruction of surface water movement affects salinity of playa surface water • Loss of containment from evaporation ponds impacts playa surface water quality • Runoff or seepage from salt stockpiles impacts playa surface water quality • Accidental spills of fuels or hydrocarbons cause contamination of surface water and groundwater • Poor waste management at landfill or sewage treatment plant causes contamination of surface water and groundwater
Mitigation	
Avoid	• No waste treatment or disposal facility will be sited within the 1-in-100 year flood zone. • Bulk hydrocarbon storage, vehicle servicing areas and maintenance workshops will be located outside the 1-in-100 year flood zone. • No explosives will be stored or used at the site.
Minimise	• A field procedure to enable identification and management of acid sulfate sediments will be developed and implemented. • Where required, suitable floodways, drains and culverts will be installed to divert flow past on-playa infrastructure and return it to its natural flow path. • Routine groundwater monitoring will be conducted upstream and downstream of on-playa infrastructure. • Brine ponds will be designed and constructed to minimise seepage losses and prevent overtopping. • Routine inspections and planned audits will be implemented to monitor integrity of containment systems. • Diesel fuel and emissions reduction fluid will be stored in self-bunded tanks. Refuelling facilities will be constructed with concrete or HDPE-lined pads to contain any drips and spills. The pads will drain to a sump to allow removal of collected material. • All hydrocarbon and chemical storages will be designed and constructed in accordance with relevant requirements of Australian standards AS 1940 and AS 1692. • Vehicles and equipment will be regularly inspected and maintained to reduce the likelihood of spills and leaks. • Hydrocarbon wastes will be segregated from other wastes and collected for offsite disposal by a licensed contractor.

Key environmental factor 3: Inland waters environmental water quality	
	• Spill kits will be located at strategic locations throughout the project area and employees trained in their use. • Spills will be contained, remediated, investigated and reported to the relevant authorities as required. • The transport, storage or use of any designated Dangerous Good or substance will be conducted in accordance with Dangerous Goods permits and in accordance with relevant provisions of the *Dangerous Goods Safety Act 2004* and the *Dangerous Goods Safety (Road and Rail Transport of Non-Explosives) Regulations 2007*. • Monitoring and assessment program for surface and groundwater will be implemented as required and will include environmental quality analysis for parameters agreed with by regulatory authorities. • Both the sewage treatment facility and the putrescible waste landfill will be set back from the playa and positioned in accordance with recommended separation distances described in relevant Australian standards and Department of Water and Environment Regulation (DWER) water quality protection notes. • Effluent from the waste water treatment plant (WWTP) will be managed to allow effluent to infiltrate or evaporate and prevent surface ponding or runoff from the irrigation area.
Rehabilitate	• All chemicals, fuels and non-process wastes will be removed from the site and disposed of appropriately at closure. • The site landfill and WWTP will be decommissioned and rehabilitated as part of mine closure activities. • At project completion, a site contamination assessment will be carried out and rehabilitation works will be implemented (if required) to remediate contamination. • Stockpiled salts will be allowed to dissolve over time and re-infiltrate the shallow playa sediments.
Outcomes	
Residual impacts	The risk of significant residual impacts arising from acidification of playa sediments is low. Sediment testing has not identified significant acid generation potential in playa sediments and the predicted changes in groundwater levels associated with brine abstraction are minor, relative to natural seasonal variations in groundwater depth. Impacts of salt release from on-playa pondage and salt stockpiles are predicted to be minor. This is because the amount of salt that can be mobilised is controlled by salt solubility limits and the playa setting is already hypersaline. The operational area potentially contributing salt is small, relative to the total playa extent and the 'contributing catchment' area that would receive freshwater inputs from rainfall and runoff. The selected potash production route involves very limited use of chemicals, as it chiefly relies on solar evaporation and washing of raw salt with natural groundwater. Fuels and lubricants stored at the site will be positioned outside potential flood zones. Reward considers that the potential impacts of project implementation on inland water quality can be adequately managed such that the environmental objective for inland environmental quality will be met, and that the residual impacts are therefore acceptable. There are no other major developments taking place in the project locality. Accordingly, there will be no cumulative impacts on inland water quality at Lake Disappointment.
Offset	No offset is proposed for this factor.

Key environmental factor 4: Terrestrial fauna and habitats	
EPA objective	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.
Potential impacts	• Habitat clearing causes injury, death or disturbance of conservation significant fauna species • Altered hydrology on-playa disrupts breeding or feeding cycles of migratory birds • Fragmentation of vertebrate fauna habitat results in displacement of fauna • Vehicle strike causes injury or death of native fauna • Loss of SRE fauna habitat results in loss of SRE fauna • Project activities result in an increase in introduced predators or herbivores, causing impact to native fauna • Altered fire regime impacts native fauna or fauna habitat • Light and noise pollution disrupt native fauna behaviour • Fauna entrapment leads to injury or death • Putrescible water or fresh water impoundments attract pest animals
Mitigation	
Avoid	• No access will be permitted to islands used for breeding by banded stilts and gull-billed terns. A 200 m exclusion zone will be maintained around all islands and between any on-playa infrastructure and the riparian zone (except at the main access causeway). • To avoid disturbance to breeding waterbirds, all anthropogenic activity on Lake Disappointment will cease when more than 150 mm of rainfall in less than a week has been recorded at the Reward weather station. Activities on the lake will only resume once juvenile banded stilts and gull-billed terns have fledged and left site or died. • Signage and permanent video cameras (monitored in the Reward administration building) will be placed to deter and detect unauthorised persons from entering potential special fauna habitat areas. • The boundaries of all vegetation clearing will be clearly demarcated before vegetation clearing commences. • Isolated rocky outcrops will be avoided during ground disturbing activities, to reduce risk of impacts on SRE fauna. • Fauna information and training are included in all site inductions.
Minimise	• A Fauna Management Plan (FMP) will be implemented and maintained. Performance and compliance against FMP requirements will be reviewed and reported on annually. • A structured program to address data deficiencies (as described in the Fauna Management Plan) will be implemented to support adaptive management of fauna. • Prior to vegetation clearing, all mature spinifex and chenopod shrubland within the proposed clearing footprint will be surveyed to determine whether it is possible that night parrots are nesting under the vegetation. Acoustic recorders (ARUs) will be deployed in sufficient density (i.e. <300 m apart) for a period of

Key environmental factor 4: Terrestrial fauna and habitats	
	five nights within two weeks of the scheduled vegetation clearing program to determine the presence of night parrots. • If calls are identified, then a thorough search of the area will be undertaken to determine whether night parrot nests are present. If nests are present, then all habitat within 500 m of the nest will quarantined until the chicks have fledged. • Ongoing ARU surveys will be conducted over the relevant habitat areas. Surveys will cease if no night parrots are recorded after three years of surveys. • All areas scheduled for vegetation clearing are searched by a suitably qualified and experienced person within four weeks of the proposed vegetation clearing. Where practicable, areas containing bilbies will be quarantined with a 500 m exclusion zone until they have left the area. Where required, bilby, great desert skink and mulgara will be captured and relocated. • A suitably qualified and experienced person will be present during vegetation clearing in the dune and swale fauna habitat to catch and relocate any northern marsupial moles disturbed during vegetation clearing. • Areas characterised by halophytic riparian vegetation will be searched for Lake Disappointment dragon burrows prior to vegetation clearing. If present, dragons will be dug from their burrows and relocated into suitable habitat at least 1 km from where they were caught to prevent them from returning to the capture location. • Vegetation will be cleared directionally, and towards remaining fauna habitats. • Appropriate speed limits will be established and maintained on project access and haul roads. Any fauna injured or killed on the road will be recorded and removed. Any mortally injured conservation significant fauna will be frozen, then provided to the WA Museum. • Any water pipelines that are not buried will be elevated ≥100 mm above the ground every 100 m to avoid impeding movement of fauna. • The landfill will have a boundary fence to prevent fauna access (specifically feral animals) and to create a wind barrier. • Feeding of fauna will be prohibited onsite. • The presence of silver gulls in the project is a reportable incident. A log of all silver gull sightings is maintained onsite. • Records will be maintained of silver gull breeding and roosting locations. If required, nests, eggs and chicks of silver gulls in the project area will be destroyed during the breeding season. • If required, silver gulls will be culled by shooting, or netting and shooting. A specialist contractor will be notified within 10 days after 10 birds are recorded in the project area for a week when Lake Disappointment is dry.
Rehabilitate	• A feral and pest animal management program will be implemented annually for the life of the project. • Feral herbivores will be opportunistically shot during the cat and fox trapping and baiting programs. A ground cull of large feral herbivores will be implemented if the population in the project area exceeds 50. An aerial cull of large feral herbivores will be implemented if the population in the project area exceeds 500. • Reward will investigate the possibility of using a broad scale bait to reduce feral cats. • Records will be maintained of all feral and pest fauna sightings (dead or alive).

Key environmental factor 4: Terrestrial fauna and habitats	
Outcomes	
Residual impacts	Project implementation will result in a moderately increased risk of banded stilt breeding failure following large summer lake-filling events. Given that failure of banded stilt to breed in large numbers is a common event under natural conditions, the resultant reduction on in the population size of the species will usually be low. It would only be after many years of no successful breeding anywhere in Australia that failure of a breeding event at Lake Disappointment would be likely to result in a substantial reduction (25–50%) in the regional or national population. No significant adverse impacts or increased risk to other terrestrial fauna are likely if the proposed impact avoidance, mitigation and management measures outlined in the Fauna Management Plan (Appendix L4) are implemented. Predevelopment vertebrate fauna assemblages and the ecological processes that support those assemblages will be maintained.
Offset	No significant residual adverse impacts on terrestrial fauna are considered likely and the measures proposed in the Fauna Management Plan should be sufficient to realise the EPA's objectives for this factor. Nonetheless, in recognition of the significant scientific uncertainty associated with night parrot occurrence and ecology, and with nomadic water bird use of arid zone salt lakes, Reward has proposed a significant offset package which includes works to combat existing, known threatening processes and a research component in order to reduce scientific uncertainty through targeted observations and studies.

Key environmental factor 5: Subterranean fauna	
EPA objective	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.
Potential impacts	Loss of potential subterranean fauna habitat due to borefield pumping. The saturated zone beneath and immediately surrounding the playa is too shallow to provide suitable troglofauna habitat. Field investigations within proposed borefield areas found only a single troglofaunal specimen, a dipluran *Projapygidae* sp. B20, recorded as a singleton at LDRC1601 in Round 3. This specimen was not considered likely to indicate the presence of a significant troglofauna assemblage.
Mitigation	
Avoid	Production bores in the Northern Borefield will be screened only in the confined aquifer.
Minimise	• The Cory and Northern Borefields will each be designed and operated as distributed water supply systems with sufficient redundancy to allow adaptive management of borefield operations. • Continuous monitoring and regular review of groundwater levels will be implemented to allow management of groundwater drawdowns. • Additional monitoring bores will be installed outside the predicted zone of influence of the proposed borefields. The monitoring bores will be used to verify groundwater drawdown predictions and will also be used in additional subterranean fauna sampling prior to commencement of full scale operations. • Monitoring bores associated with the Northern Borefields will include bores screened to enable checking of water levels in both shallow unconfined aquifer and the confined aquifer from which water will be abstracted. • Borefields will be operated in accordance with an operations strategy approved by the DWER.
Rehabilitate	At project completion, well heads and other borefield infrastructure will be decommissioned, unless retention of infrastructure is requested by stakeholders and approved by relevant regulatory authorities.
Outcomes	
Residual impacts	The residual risk of significant reduction in subterranean fauna diversity or abundance as a result of project implementation is low. Some transient loss of stygofauna habitat will occur at a local scale, but this is unlikely to materially reduce the amount of comparable habitat available in nearby areas or to compromise the EPA objectives for this factor.
Offset	No offsets are proposed for this factor.

Social surroundings: Aboriginal culture and heritage	
EPA objective	To protect social surroundings from significant harm.
Potential impacts	• Ground disturbance or unauthorised access causes impacts to known Aboriginal heritage sites and cultural values • Ground disturbance or unauthorised access causes impacts to unknown Aboriginal heritage sites and cultural values • Project implementation constrains land access for customary uses by Traditional Owners
Mitigation	
Avoid	• Exclusion zones established under the Lake Disappointment Project Mining and Indigenous Land Use Agreement (ILUA) WI2012/009 and through any additional agreements with Traditional Owners will be rigorously enforced. • Additional surveys of proposed disturbance areas will be conducted in consultation with Traditional Owners. • Site inductions and cultural awareness training will be provided to all project participants to ensure staff and contractors are aware of heritage requirements. • An internal ground disturbance permitting procedure will be implemented. • Aboriginal monitors will be employed during ground disturbance activities. • Traditional Owners will continue to have uninterrupted access along existing tracks.
Minimise	• Maintain consultation with Traditional Owners • Establishment of an operational Aboriginal heritage management framework, developed in consultation with Traditional Owners • Development and implementation of a Cultural Heritage Management Plan (CHMP) • Disturbance of Aboriginal heritage sites will comply with agreements with Traditional Owners and with the requirements of the *Aboriginal Heritage Act 1972* • Detailed design (including for access road upgrades) will consider the results of the archaeological and ethnographic surveys
Rehabilitate	Seek input from Traditional Owners on future revisions of the mine closure and rehabilitation plan
Outcomes	
Residual impacts	The ILUA established between Reward and the Traditional Owners of the Lake Disappointment area emphasises avoidance of culturally significant sites. The intentions of the ILUA will be delivered through the implementation of an operations heritage management framework and cultural heritage management plan. With careful management, the Lake Disappointment project can be implemented in a way that is consistent with EPA objectives and beneficial to the interests of Traditional Owners.
Offset	No offsets are appropriate for this factor. Any compensation agreements required in relation to Reward's access to/use of Aboriginal land are addressed under the ILUA.

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Abbreviations and acronyms

Abbreviation	Meaning
µS/cm	MicroSiemens per centimetre: A measure of conductivity
ABS	Australian Bureau of Statistics
AEP	Annual exceedance probability: The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year
AHD	Australian Height Datum
AMD	Acid mine drainage
ARI	Average recurrence interval
ARU	Acoustic recorder
ASRIS	Australian Soil Resource Information System
ASS	Acid sulfate soil
ASX	Australian Securities Exchange
AVS	Acid volatile sulfur
BOM	Bureau of Meteorology
CCWA	Conservation Council of Western Australia
CEMP	Construction Environmental Management Plan
CHMP	Cultural Heritage Management Plan
CMP	Conservation Management Plan
CRS	Chromium-reducible sulfur
Cwlth	Commonwealth
DAA	Department of Aboriginal Affairs (now DPLH)
DBCA	Department of Biodiversity Conservation and Attractions
DER	Department of Environment Regulation
DEWHA	Department of Environment, Water, Heritage and Arts
DAFWA	Department of Agriculture and Food, Western Australia (now DPIRD)
DFES	Department of Fire and Emergency Services
DI	Deionised (water)
DMIRS	Department of Mines, Industry Regulation and Safety (was DMP)
DMP	Department of Mines and Petroleum (now DMIRS)
DoH	Department of Health
DotEE	Australian Government Department of the Environment and Energy

Abbreviation	Meaning
DOW	Department of Water (now part of DWER)
DPaW	Department of Parks and Wildlife (now DBCA)
DPC	Department of Premier and Cabinet
DPIRD	Department of Primary Industries and Regional Development (was DAFWA)
DPLH	Department of Planning, Lands and Heritage (was DAA)
DWER	Department of Water and Environment Regulation
EEB	Evaporation end brine
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental management plan
EMS	Environmental management system
EP Act	*Environmental Protection Act* 1986
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999 (Cwlth)
EPA	Environmental Protection Authority
ERD	Environmental Review Document
ESA	Environmentally Sensitive Area
ESD	Environmental Scoping Document
FMP	Fauna Management Plan
GDE	groundwater dependent ecosystem
GL	Gigalitre (1,000,000,000 litres)
GL/a	Gigalitre per year (1,000,000,000 litres per year)
GOS	Groundwater Operating Strategy
GP	Geoprobe
ha	Hectares (10,000 m^2)
HDPE	High density polyethylene
IBRA	Interim Biogeographic Regionalisation of Australia
ILUA	Indigenous Land Use Agreement
IUCN	International Union for Conservation of Nature
kL	Kilolitres (1,000 litres)
LD	Lake Disappointment
LDDH	Lake Disappointment diamond drill hole
LOM	Life of mine

Abbreviation	Meaning
LOD	Limit of detection
LOR	Limit of reporting
LSD1	Little Sandy Desert Sub-bioregion 1
LSD2	Little Sandy Desert Sub-bioregion 2
m^2	Square metres
m^3	Cubic metres
MBO	Monosulfidic black ooze
mg/L	Milligrams per litre (1/1000 gram per litre): A measure of concentration
ML	Megalitre (1,000,000 litres)
Mm^3	Mega cubic metres (1,000,000 m^3)
mmol/L	Millimoles per litre (1/1000 moles per litre): A measure of concentration
MOP	Muriate of potash, potassium chloride (KCl)
Mt	Mega tonnes (1,000,000 tonnes)
N/A	Not applicable
NDVI	Normalised Difference Vegetation Index
NVIS	National Vegetation Information System
OEMP	Operational Environmental Management Plan
OEPA	Office of Environmental Protection Authority
PEC	Priority Ecological Community
PER	Public Environmental Review (now ERD)
ppb	Parts per billion (1 in 1,000,000,000)
ppt	Parts per trillion (1 in 1,000,000,000,000)
RIWI Act	*Rights in Water and Irrigation Act 1914*
RL	Reduced level
RO	Reverse osmosis
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SOP	Sulfate of potash (K_2SO_4)
sp.	Species
SPOCAS	Suspension peroxide oxidation combined acidity and sulfate
SRE	Short-range endemic
SWL	Standing water level
TDS	Total dissolved solids

Abbreviation	Meaning
TEC	Threatened ecological community
tpa	Tonnes per annum
WC Act	*Wildlife Conservation Act 1950*
WDLAC	Western Desert Lands Aboriginal Corporation
WMP	Water Management Plan
WWTP	Waste water treatment plant

1 INTRODUCTION

1.1 Purpose and scope of this document

This Environmental Review Document (ERD) presents an assessment of the potential environmental impacts of implementing the proposed Lake Disappointment Potash Project. The objectives of the ERD are to:

- Clearly describe all key components of the Lake Disappointment project proposal;
- Place the proposal in the context of the local and regional environments;
- Identify and assess the potential impacts of project implementation;
- Describe Reward Minerals Limited's proposed environmental management program and the management strategies planned to avoid, minimise, manage and rectify adverse impacts;
- Explain how implementing the project in accordance with the proposed management measures will deliver outcomes consistent with applicable legal requirements and WA Environmental Protection Authority (EPA) policy objectives; and
- Serve as a tool for communicating project information to stakeholders.

This ERD report addresses each of the key environmental factors nominated by the EPA in the scoping document prepared for the Lake Disappointment project.[1] It considers all phases of the proposed Lake Disappointment project, including construction, commissioning, operation and closure. Where relevant, cumulative impacts are addressed. The activities addressed in this ERD include site preparation works, project operations and associated support activities, mineral processing and transport of product to Newman, WA. Product transport beyond Newman and use of potash product are not considered.

This document has been prepared in accordance with relevant requirements of the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016* (EPA 2018) and with EPA's *Instructions on how to prepare an Environmental Review Document* (EPA 2016i). The content of the ERD aligns with the requirements of the Environmental Scoping Document (ESD) prepared by the EPA for the Lake Disappointment Project, and is structured as shown in Table 1–1.

The ERD aims to provide an accessible, non-technical summary of a range of environmental studies conducted for the Lake Disappointment Project. Copies of the technical reports used in preparing the ERD are referenced throughout the document. Readers seeking more detailed information about specific technical aspects of the Environmental Impact Assessment are invited to read the technical reports appended to the ERD.

[1] Readers should note that EPA guidelines on 'environmental factors' changed between the time that the Environmental Scoping Document was approved and the submission of this ERD. Reward has nonetheless addressed all factors originally nominated by the EPA, notwithstanding that two of these (offsets and mine closure) are no longer listed in current EPA guidelines relating to environmental factors (EPA, 2016j).

Table 1–1: Structure of ERD

Section	Content
Section 1: Introduction	Explains purpose and structure of ERD; identifies proponent; provides an overview of the Environmental Impact Assessment process; summarises other environmental assessment and permitting requirements.
Section 2: Proposal description	Presents a comprehensive description of physical and operational elements of the project, and outlines alternatives considered for significant project components, including the 'no-project' option. Presents contextual information about the region in which the proposal would be implemented.
Section 3: Stakeholder engagement	Identifies key stakeholders; describes the processes used for stakeholder engagement; provides details of stakeholder consultation to date.
Section 4: Environmental principles and factors	Explains how the environmental protection principles set out in the *Environmental Protection Act 1986* have been considered in relation to the Lake Disappointment Potash proposal; for each key environmental factor nominated by EPA in its scoping document, describes EPA objectives, identifies relevant policy and guidelines; presents an overview of current environmental conditions relevant to the factor; identifies potential impacts of project implementation; assesses the magnitude, extent, duration and significance of potential project impacts; describes how potential impacts would be avoided or mitigated; describes predicted environmental outcomes.
Section 5: Other environmental factors	Presents information on other environmental factors raised by stakeholders during consultation or identified in the approved environmental scoping document.
Section 6: Impact assessment	Provides a holistic assessment of the impacts of the proposal on the whole environment. Describes the connections and interactions between key environmental factors and discusses predicted outcomes in relation to EPA's environmental objectives.
Section 7: References	Lists the sources of information upon which Reward has relied in preparing the ERD. Key references not in the public domain are appended to the ERD. Information that is in the public domain (usually accessible via the internet) is referenced, but not attached.

1.2 Proponent

The proponent of the Lake Disappointment Potash Project is Reward Minerals Limited (ASX:RWD; ABN 50 009 173 602), an Australian company focussed on the exploration and development of potash resources amenable to the production of potassium sulfate. The key contact for Reward Minerals is:

Mr Daniel Tenardi
Project Director
PO Box 1104
Nedlands, WA, 6909
Tel: (08) 9386 4699
Email: daniel.tenardi@rewardminerals.com

1.3 Environmental Impact Assessment process

Reward referred the Lake Disappointment Potash proposal to the EPA on 13 June 2016. On 18 July 2016, the EPA published its decision to formally assess the Lake Disappointment proposal (Assessment No. 2087) under Part IV of the *Environmental Protection Act 1986* (EP Act). The EPA determined that the proposal should be assessed through the Public Environmental Review (PER) process[2], on the basis that several complex environmental factors would need to be considered and that, in the EPA's view, a detailed assessment would be required to determine the extent of the proposal's direct and indirect impacts and how environmental issues associated with project implementation could be managed. The EPA has recommended a six-week public comment period.

The Office of the EPA (OEPA) prepared a draft scoping document for the Lake Disappointment proposal, which was circulated for comment on 30 August 2016. Reward submitted comments to the OEPA on 16 September 2016. The EPA approved a revised scoping document on 25 October 2016. In the course of further project impact assessment and progressive engineering design, some aspects of the project as referred to the EPA in July 2016 have been slightly modified. A summary of the project modifications is provided in Table 1–2.

In conducting its assessment of the Lake Disappointment proposal, the EPA will consider whether the information presented in the ERD satisfies the requirements of the approved scoping document and has been prepared in accordance with EPA guidelines, administrative procedures and other relevant standards and guidelines. The EPA will also consider whether the environmental outcomes predicted in the ERD are consistent with EPA policy objectives, as described in EPA's published policy documents. Information on relevant EPA and other policies and guidelines is presented under each of the preliminary key environmental factors set out in the Lake Disappointment ESD (refer to Section 4).

[2] Readers should note that changes to the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures* came into effect on 13 December 2016. The PER process no longer exists as a separate administrative pathway under the updated Administrative Procedures (EPA 2018).

Table 1–2: Changes to project definition (post-referral)

Project element	As described in referral	As currently proposed
Development envelope extent (ha)	40,195	39,977
Disturbance footprint extent (ha)	Up to 7758	7776
Extent of vegetated areas within disturbance footprint (ha)	436.5	410
Average annual brine abstraction (GL/a)	63	No change
Fresh to brackish water abstraction (GL/a)	3.4	No change
Life of mine (year)	20	No change
Layout of project elements: minor adjustments to proposed layout of infrastructure	Figures 2, 4 and 5 of referral; Attachment 1.12 of referral	Figures 2–5, 2–6 and 2–7 of ERD; Appendix B of ERD

Once the EPA has completed its assessment of the Lake Disappointment proposal, it will prepare a report for the Minister for Environment; Disability Services, setting out:

- What the EPA considers to be the key environmental factors identified in the course of the assessment;
- The EPA's recommendations as to whether or not the proposal may be implemented; and
- Recommended implementation conditions and procedures to which the proposal should be subject if the Minister approves project implementation.

The EPA's report to the Minister is published on the EPA website.

If the Minister approves the Lake Disappointment proposal, a range of other authorisations would be required before the project could be implemented. These additional permitting requirements are summarised in Section 1.4.

1.4 Land tenure

The whole of the Lake Disappointment proposal is located within the determined Native Title claim area held by the Martu People (WCD2013/002) and is on vacant crown land (Figure 1-1). The project lies approximately 40 km south of the Karlamilyi (Rudall River) National Park, which is managed by the Department of Biodiversity Conservation and Attractions (DBCA). The southern extremity of the Lake Disappointment potash project development envelope intersects the north-eastern Section of a proposed 366,700 ha nature reserve listed under the EPA Red Book recommendations for Conservation Reserves (1975-1993, Figure 1-2). The proposed Lake Disappointment Nature Reserve was first listed in the EPA Red Book and was subsequently mentioned in the DPaW Goldfields, Regional Management Plan 1994-2004; however, the recommendation was for the reservation to be deferred and addressed in the Pilbara Regional Management Plan. To date, the proposed reserve has not been gazetted.

There is no pastoral tenure over any part of the project area.

Figure 1-1: Determined Native Title claim area WCD2013/002

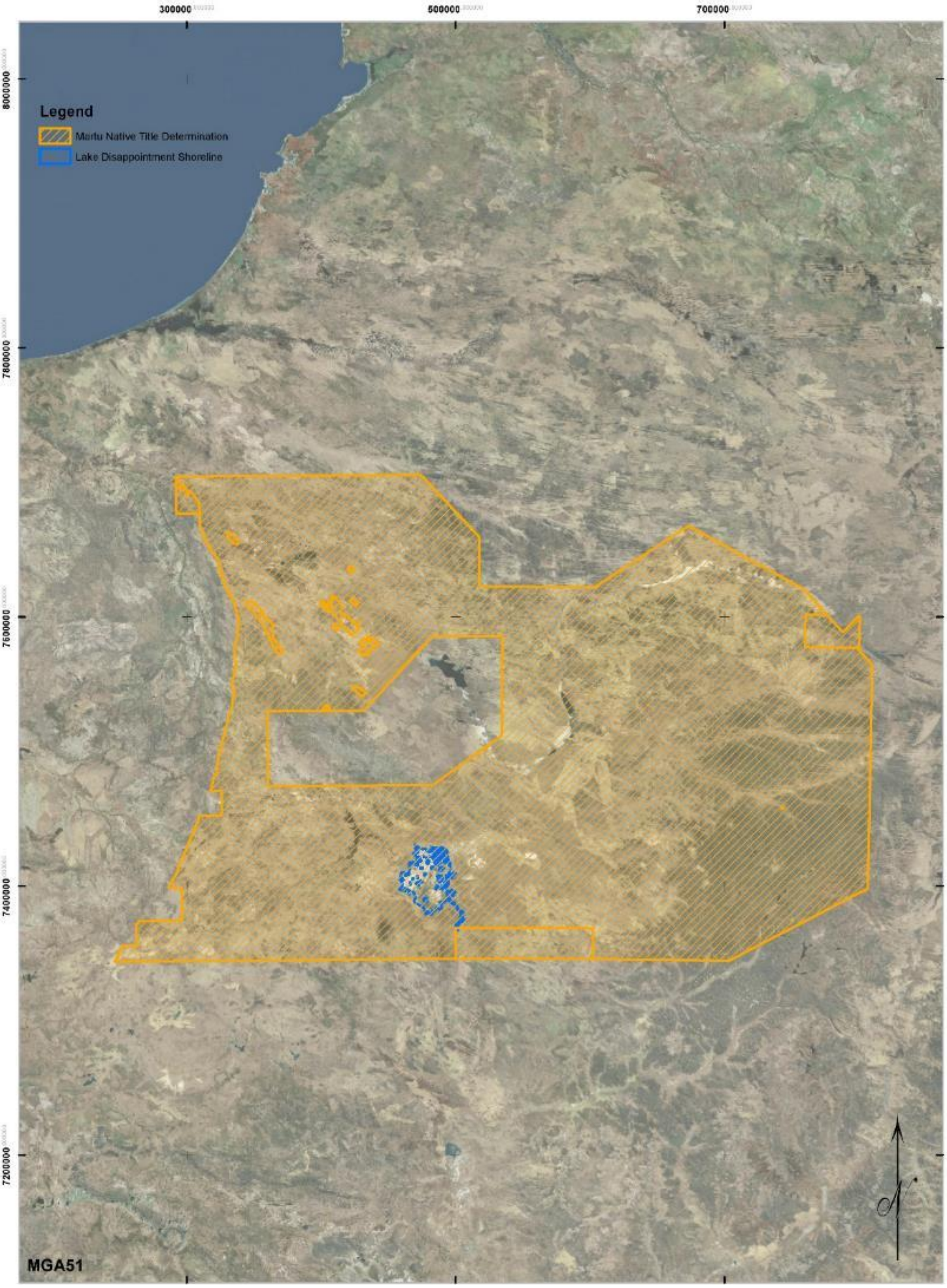
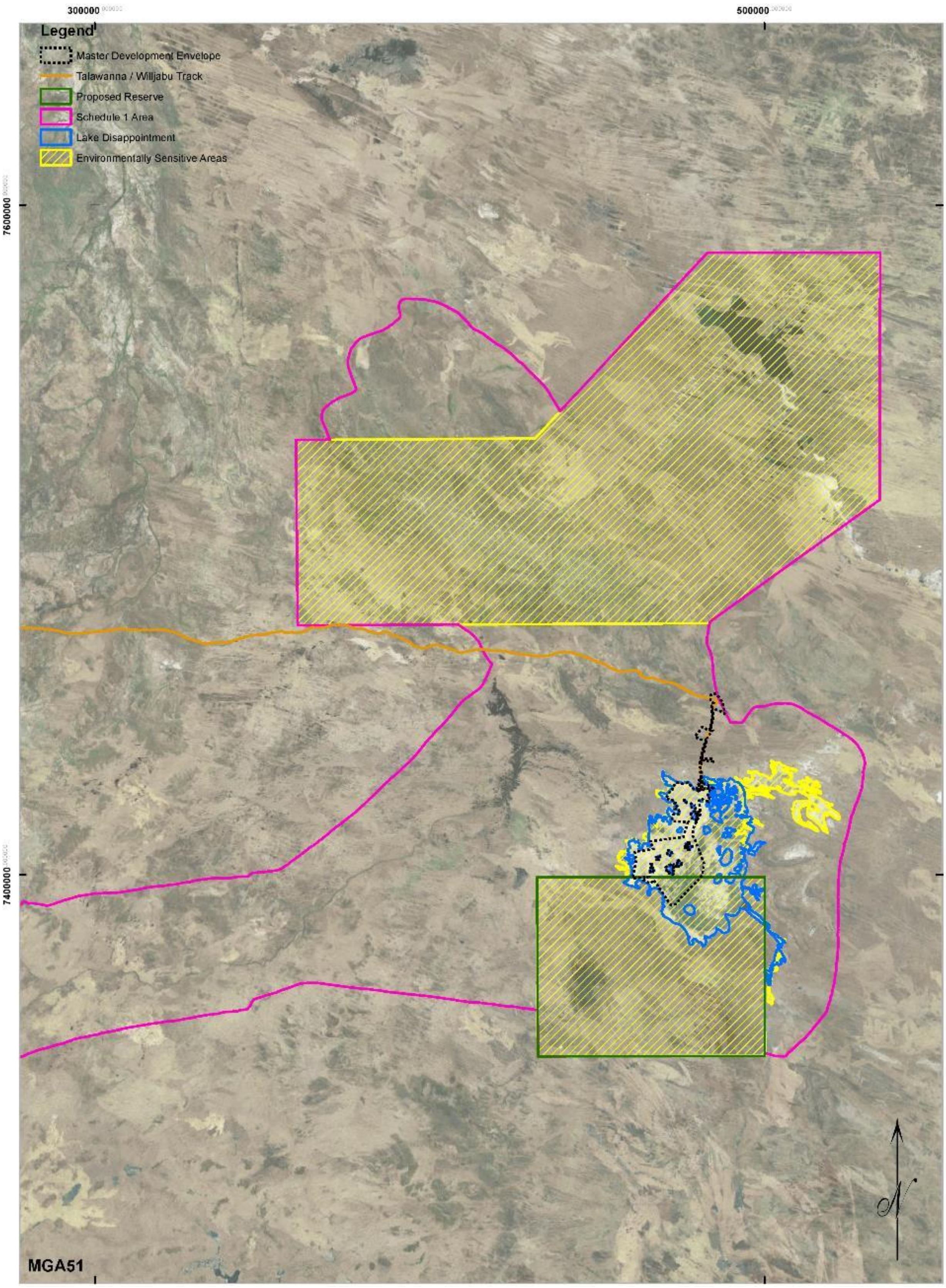
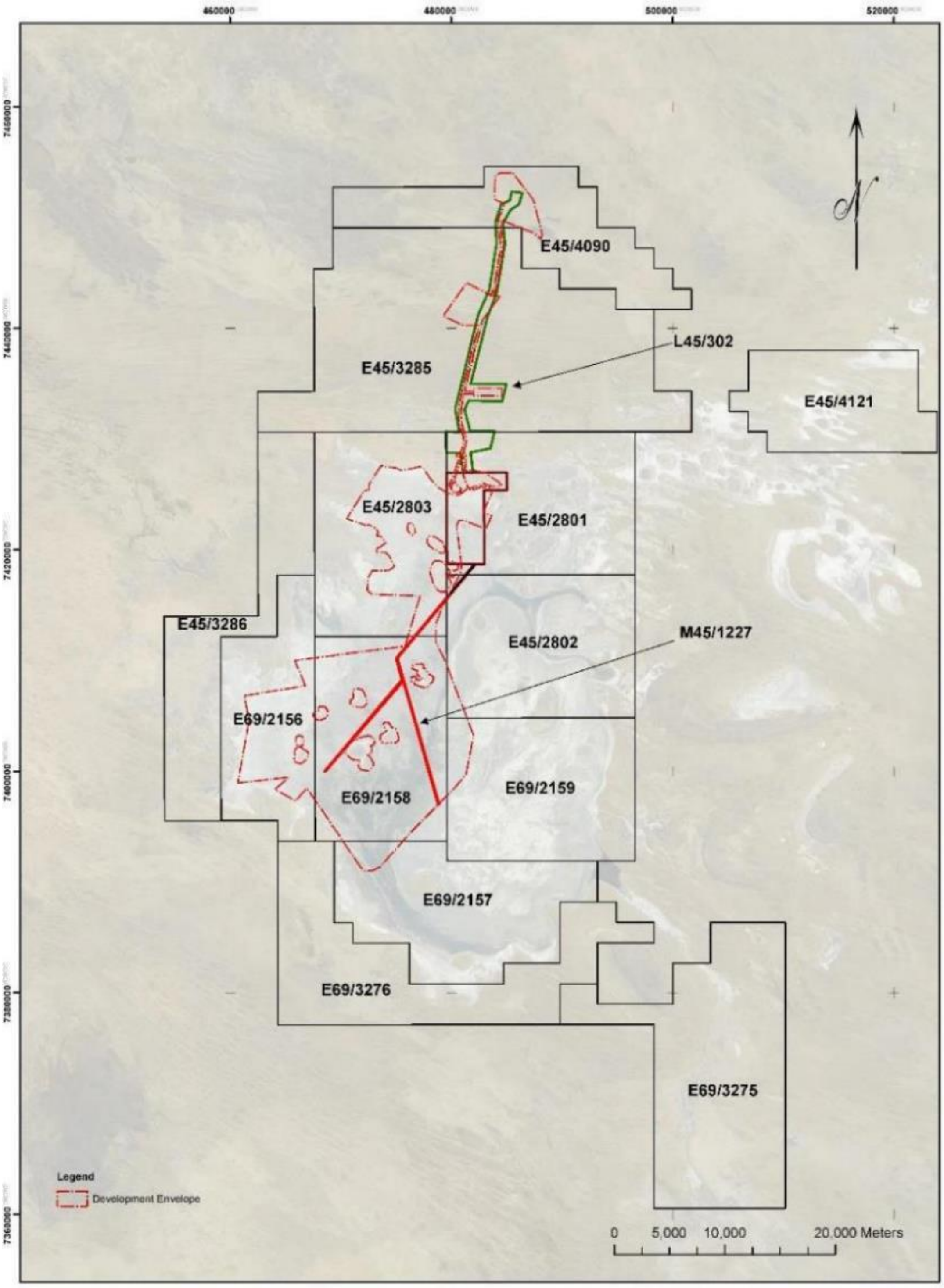


Figure 1-2: Location of project envelope, relative to existing and proposed reserves



Reward holds a package of nine Exploration Licences of approximately 280,200 ha (2802 km^2), one Mining Lease of 3469 ha and one Miscellaneous Licence of 3258 ha over the land within (or partially within) the Lake Disappointment project development envelope (Figure 1-3). Parts of the area currently under exploration tenure will be converted to Mining Leases or Miscellaneous Licences subject to future environmental permitting.

Figure 1-3: Reward Minerals Limited mining tenure



1.5 Other approvals and regulation

1.5.1 Government of Western Australia legislation

In addition to the EPA's assessment of the proposal, a range of other environmental (and related) assessments and authorisations by Western Australian regulatory authorities will be required before the Lake Disappointment project can be implemented. These are summarised in Table 1–3.

Table 1–3: Other state environmental approvals and regulation

Regulated activity	Land tenure/ access	Approval required/ regulatory requirement	Legislation (administering body)
Ground disturbance for mining and ore processing	Mining tenure/ Crown land	Grant of tenure	*Mining Act 1978* (DMIRS)
Ground disturbance for access road upgrades (outside national park)	Mining tenure/ Crown land	Grant of tenure and/or access agreement	*Mining Act 1978* (DMIRS)
Land access and ground disturbance	Mining tenure/ Crown land	Section 18 approval(s)	*Aboriginal Heritage Act 1972* (DPLH)
Mining and ore processing	Mining tenure/ Crown land	Environmental approval via mining proposal and mine closure plan; lodgment of annual environmental report.	*Mining Act 1978* (DMIRS)
Mining and ore processing	Mining tenure/ Crown land	Approval to operate via project management plan	*Mines Safety and Inspection Act 1994* (DMIRS)
Mine rehabilitation	Mining tenure/ Crown land	Annual payment of Mining Rehabilitation Fund levy	*Mining Rehabilitation Fund Act 2012* (DMIRS)
Ground disturbance for access road upgrade	Crown land	Clearing permit for disturbance of any land not included in Part IV assessment and outside granted mining tenure.	EP Act; *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*
Taking or disturbing flora or fauna	Mining tenure/ Crown land	Permit to take	*Biodiversity Conservation Act 2016* (once *Wildlife Conservation Act 1950* is repealed) (DBCA)
Construction of process water production bores	Mining tenure/ Crown land	26D licence	*Rights in Water and Irrigation Act 1914* (RIWI Act) (DWER)
Groundwater and brine abstraction	Mining tenure/ Crown land	5C licence	RIWI Act (DWER)

Regulated activity	Land tenure/ access	Approval required/ regulatory requirement	Legislation (administering body)
Surface works that may obstruct or interfere with waters, bed or banks or a watercourse or wetland and/or diversion of a watercourse or wetland	Mining tenure/ Crown land	Bed and banks permit	RIWI Act (DWER)
Potash production by solar evaporation	Mining tenure/ Crown land	Works approval and licence	EP Act – Part V (DWER)
Electrical power generation	Mining tenure/ Crown land	Licence or registration	EP Act – Part V (DWER)
Treatment of septic wastes	Mining tenure/ Crown land	Licence or registration	EP Act – Part V (DWER)
Operation of a putrescible waste landfill	Mining tenure/ Crown land	Licence or registration	EP Act – Part V (DWER)
Operation of waste water treatment plan	Mining tenure/ Crown land	Approval of WWTP installation	*Health Act 1911* and Regulations (Shire of East Pilbara)
Construction and operation of accommodation village.	Mining tenure/ Crown land	Planning and building consents	*Planning and Development Act 2005*; *Health Act 1911* (Shire of East Pilbara)

1.5.2 Australian Government legislation

The Lake Disappointment Potash Project was referred to the Department of the Environment and Energy (DotEE) for possible assessment under the EPBC Act on 21 June 2016 (DotEE reference number 2016/7727). On 23 May 2018, the DotEE decided that the project constitutes a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) because of the potential for impacts on threatened or migratory species (Table 1–4). The DotEE has elected to conduct a separate assessment of the Lake Disappointment project, rather than using the accredited assessment process available under the bilateral agreement between the Government of Western Australia and the Australian Government. Therefore, a separate assessment and environmental consent (in addition to the assessments and consents from Western Australian regulators) will be required from the Australian Government.

No other categories of Matters of National Environmental Significance are triggered by the Lake Disappointment project.

Table 1–4: Federal environmental approvals and regulation

Regulated activity	Land tenure/ access	Approval required/ regulatory requirement	Legislation (administering body)
Implementation of a 'controlled action': impacts on Matters of National Environmental Significance (protected and migratory fauna)	Mining tenure/ Crown land	Ministerial approval (Cwlth)	EPBC Act (DotEE)

2 THE PROPOSAL

2.1 Background

Reward referred the proposed Lake Disappointment Potash Project to the EPA on 13 June 2016. On 18 July 2016, following a 2 week public comment period, the EPA set the level of assessment for the project as Public Environmental Review (PER, now ERD) with a six week public review period. An Environmental Scoping Document (ESD) was prepared by the EPA and released as a final document on 25 October 2016 (Appendix A). The ESD outlined the preliminary key factors and the work required to investigate potential impacts of the project on those factors. An annotated scoping checklist with section and page references is provided in the executive summary section of this document.

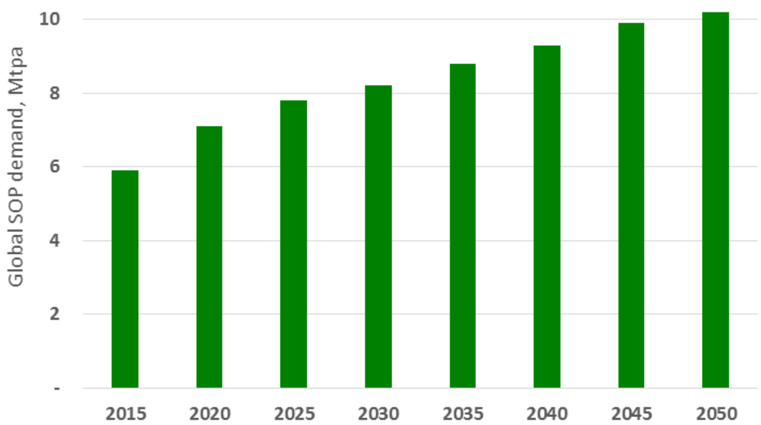
2.2 Project justification

Sulfate of potash (SOP) is a source of potassium, an essential plant nutrient. Most SOP is used as agricultural fertiliser. A small proportion of the potash produced is used in water softeners, soaps, batteries, food products, pharmaceuticals and livestock feed supplements. As a fertiliser, SOP is preferred to chloride forms of potassium because chloride is harmful to many crops and soils. There are two main ways of producing SOP:

- Brines or solid mineral deposits rich in potassium and sulfate can be mined and refined to remove unwanted salts; or
- Potassium chloride (also known as muriate of potash (MOP)) can be chemically reacted with sulfate salts or sulphuric acid to yield SOP.

At present, the Australian market currently relies entirely on imported potash, principally from Canada and Germany. The lack of domestic production means that potash prices in Australia are high, relative to competing agricultural regions. The discovery of lake brines containing potentially economic SOP grades is relatively recent in Australia. Australia currently consumes in the order of 450,000 tpa of potash comprising approximately 400,000 tpa of MOP and 50,000 tpa of SOP, with a combined retail value in excess of $300 million. The proportion of SOP:MOP has risen sharply in recent years. Globally, the annual demand for SOP is approximately 5.5 Mt and is projected to increase by at least 4% per year to 2023 (Figure 2-1).

Figure 2-1: Predicted global trend in SOP demand (Company research)



Production of SOP from MOP in Australia is problematic, as currently both ingredients must be imported and markets for the byproducts of SOP manufacture are absent or variable. The process of converting MOP to SOP also involves significant environmental risks (e.g.

management of acid or bitterns byproducts and disposal of bitterns). Production of SOP from sea water is not (currently) viable due to its low potassium content and the large pond areas required to evaporate sea water to the potash crystallisation stage.

Production of potash from potassium-enriched natural brines offers many advantages to the alternative production method (manufacturing SOP by reacting potassium chloride salts with sulphuric acid). Potash sourced from natural brines can be produced using less energy per unit of product and does not result in an acid waste product. It is a production method that offers lower operating costs and takes advantage of the warm, arid climate of inland northern Australia. However, production of SOP from brine resources involves large capital investment, hence requires a substantial resource base to justify project development. The production of potash from natural brines relies on solar evaporation of the resource brine and requires high evaporation conditions. Lake Disappointment fulfils both of these requirements: it is currently the largest SOP resource in Australia and is located in the highest evaporation region of the country. The estimated extractable SOP resource is 153 Mt from an in situ SOP resource estimated at 590 Mt (Skidmore, 2017).

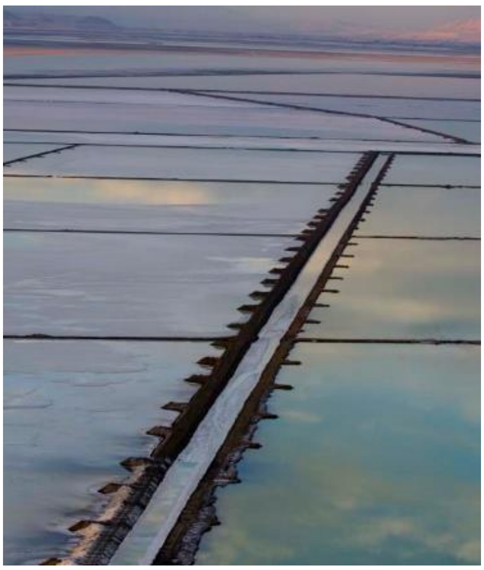
In the course of project definition, Reward has considered alternative options relating to brine extraction methods, location of processing facilities and mitigation strategies to avoid or minimise adverse environmental impacts. A description of the key alternatives considered is provided in Section 2.5.

2.3 Proposal description

Reward proposes to produce SOP from potassium-rich brine abstracted from the sediments of the Lake Disappointment playa, located approximately 320 km east of the town of Newman, Western Australia, in the Little Sandy Desert region (Figure 2.4).

The process involves pumping of brine from trenches up to 6 m deep excavated in the lake sediments into ponds, where the brine is concentrated by solar evaporation to crystallise a series of evaporite salts. Figure 2-2 shows a typical pond and trench system at a potash production facility in the United States.

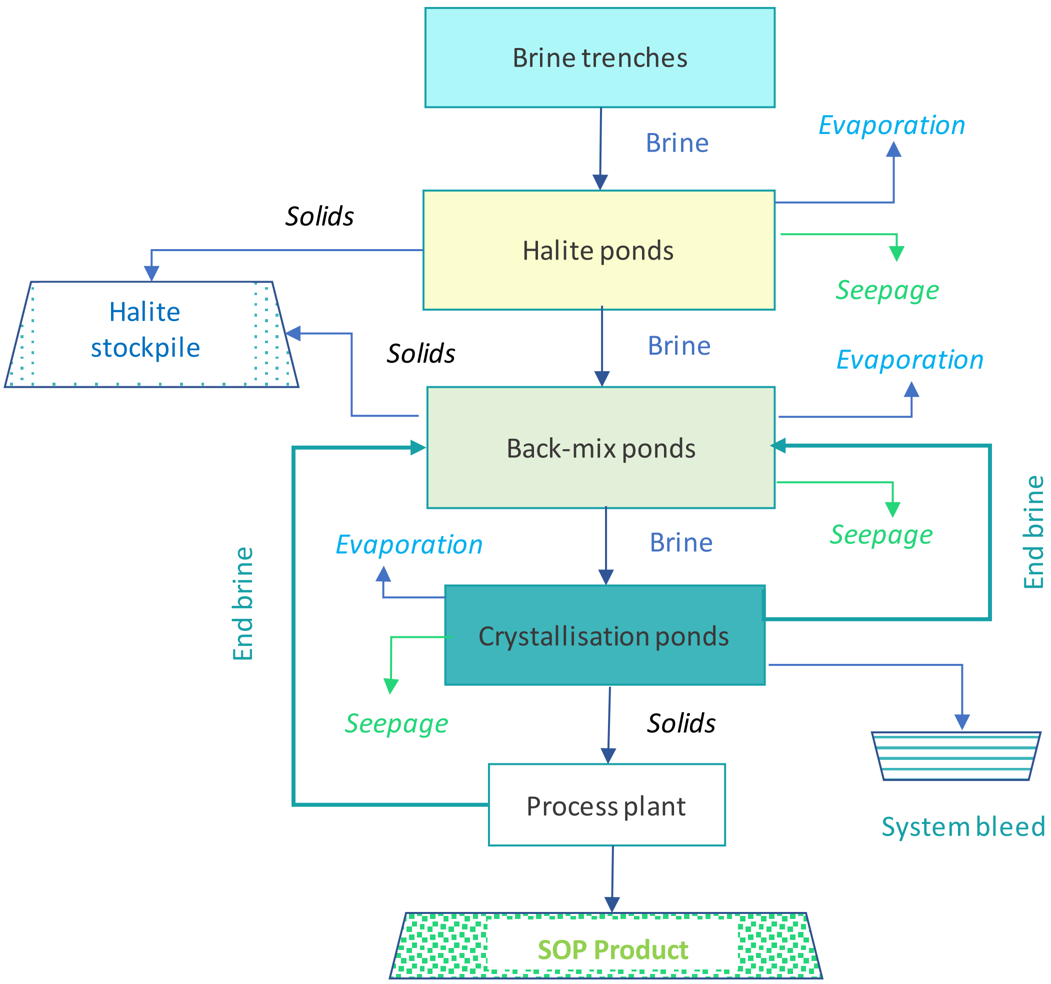
Figure 2-2: Appearance of typical trench and pond system (Ogden, Utah, USA)



Initially, sodium chloride is deposited in the evaporation ponds, followed by mixed potassium and magnesium salts (potash) which are the value components. The crude potash salts are mechanically harvested and delivered to the SOP recovery plant.

In the SOP plant, the harvested salts are leached with water (process water) to remove sodium and magnesium salts, thereby producing pure SOP which is dried prior to transport off site for sale. The plant exit brine is recycled to the evaporation ponds for recovery of additional potassium values. The overall potash production process is shown diagrammatically in Figure 2-3.

Figure 2-3: Simplified process flow diagram (block diagram)



The proposal includes construction and use of evaporation ponds, a brine supply network, a processing plant, workshop, offices, accommodation village, airstrip and two process water borefields and associated pipework. Non-target salts (mostly sodium chloride) would be stored in stockpiles on the Lake Disappointment playa.

2.4 Key characteristics

Reward proposes to recover potassium sulfate from brines contained in the lakebed sediments of Lake Disappointment. Key operational and physical elements of the proposal are summarised in Table 2–1.

Table 2–1: Summary of the proposal – Lake Disappointment Potash Project

Summary of the proposal	
Proposal title	Lake Disappointment Potash Project
Proponent name	Reward Minerals Limited
Short description	The proposal is to abstract potassium-rich brines from sediments associated with Lake Disappointment to produce sulfate of potash by means of solar evaporation of harvested salts, followed by a washing step to remove impurities. The resulting potash product (SOP) would be transported by road to Newman, WA and thence to regional centres for sale and/or export.

Table 2–2: Location and proposed extent of physical and operational elements

Elements	Location	Proposed extent/magnitude/duration
Physical elements		
Mine and associated infrastructure	Figures 2–4 through 2–7	Disturbance of up to 7776 ha of which 410 ha is vegetated, with the remaining land forming part of the playa surface of Lake Disappointment
Rehabilitation and decommissioning	Appendix K	Approximately 5763 ha of disturbed land would be rehabilitated. The remaining disturbed land (approximately 2013 ha) would remain as halite stockpiles
Operational elements		
Brine abstraction	Figure 2-5 Figure 2-10	Up to 63 GL/a (average annual brine abstraction) from shallow trenches over a period of 20 years
Fresh to brackish groundwater abstraction (for ore processing and operational purposes)	Figure 2-7	Up to 3.4 GL/a over a period of 20 years
Potash production	Figures 2-5 to 2-7	Production and transport of up to 400,000 tpa of potassium sulfate (potash) salt over a period of 20 years

Figure 2-4: Project overview, showing Talawana Track and development envelope

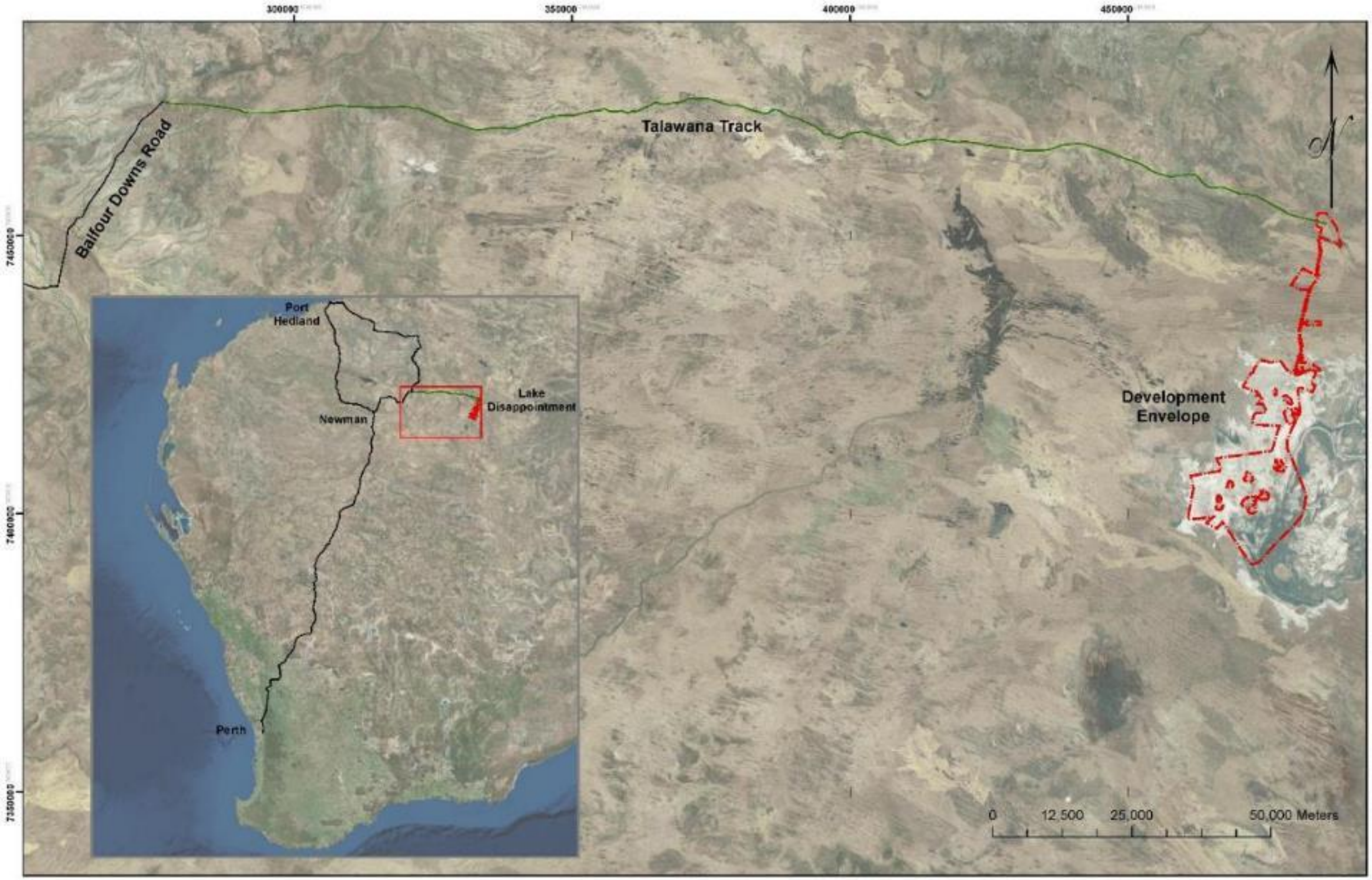
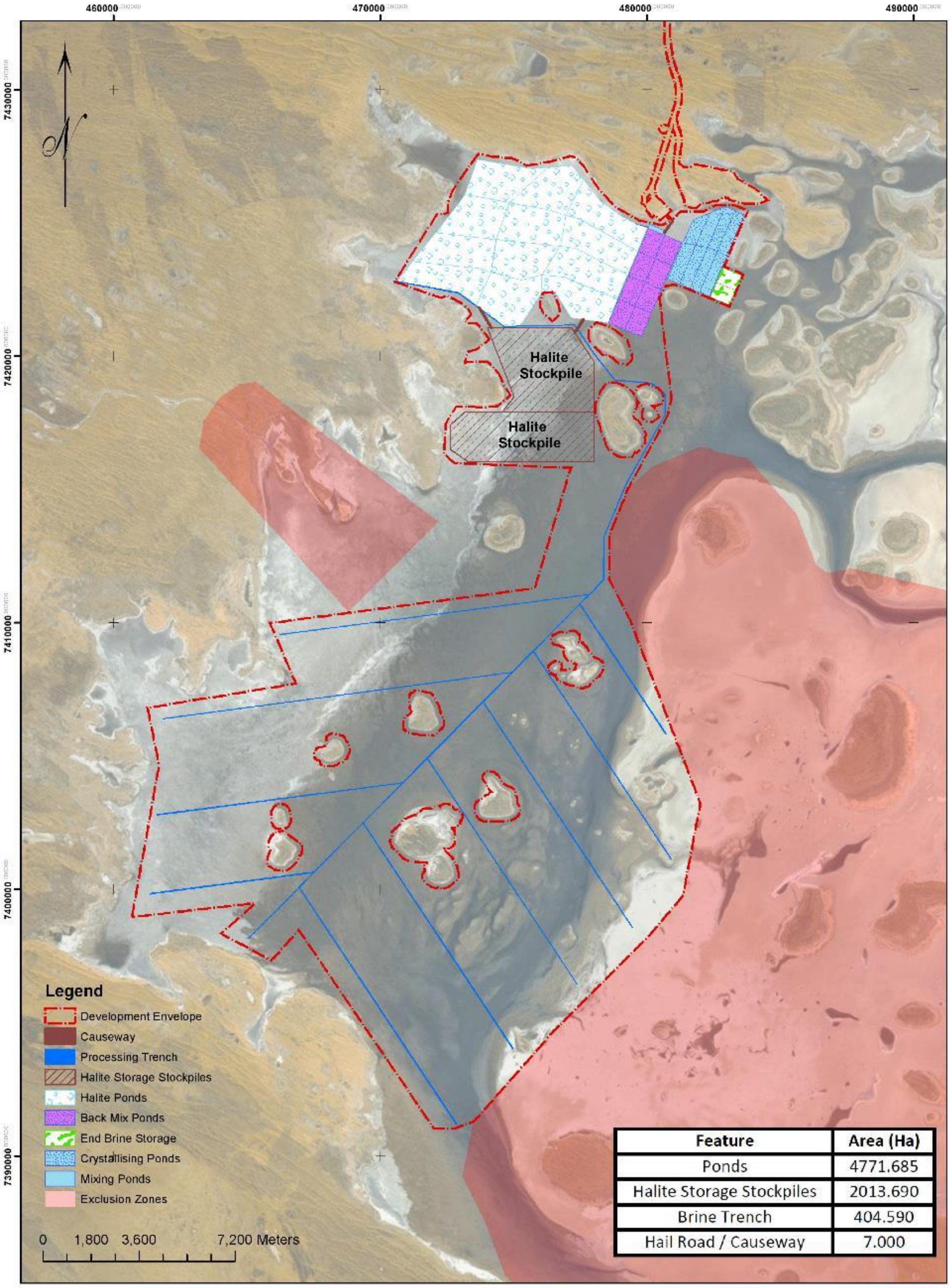


Figure 2-5: On-playa infrastructure – indicative layout



Feature	Area (Ha)
Ponds	4771.685
Halite Storage Stockpiles	2013.690
Brine Trench	404.590
Hail Road / Causeway	7.000

Figure 2-6: On-playa infrastructure – pond and halite stockpile detail

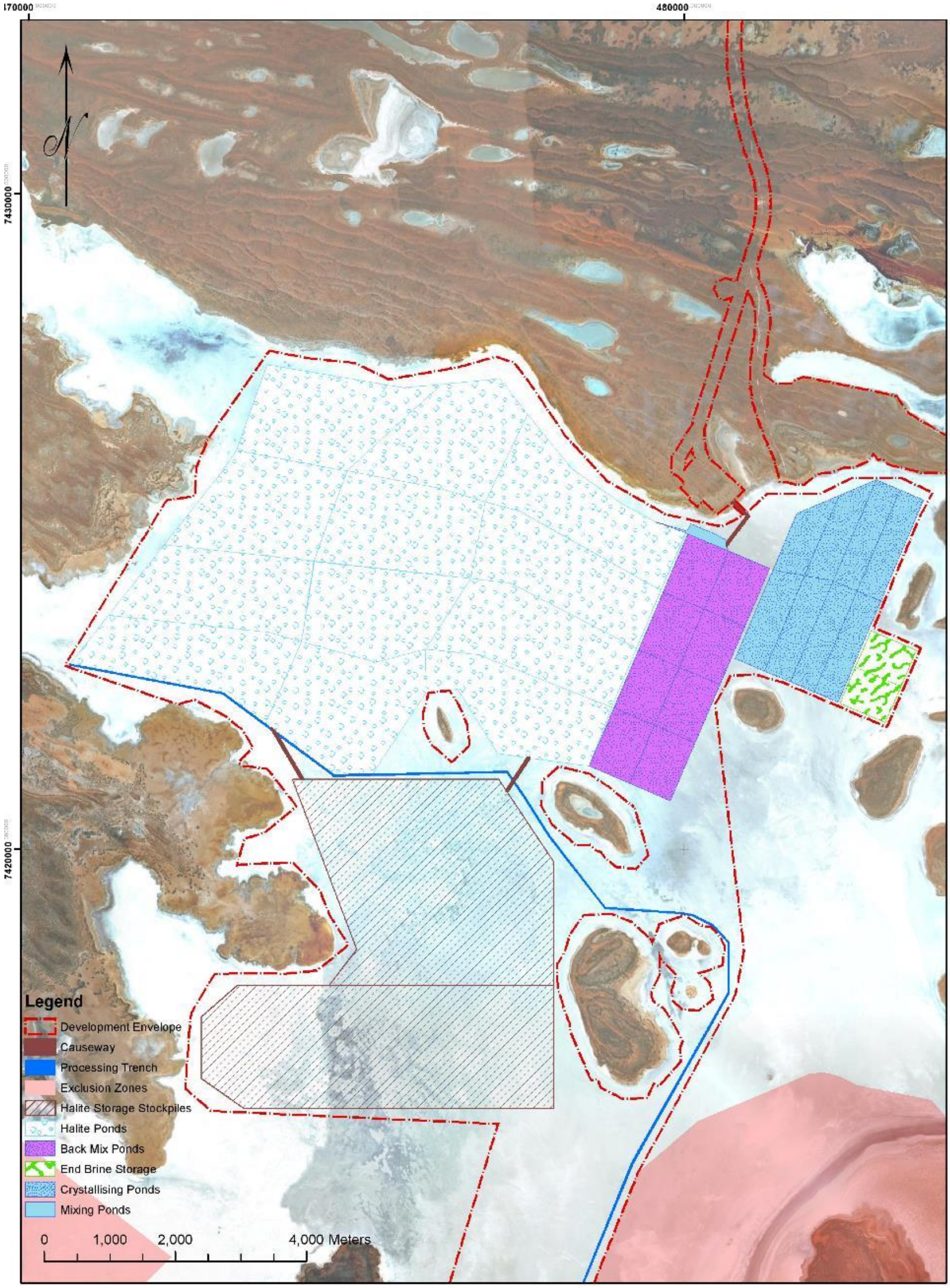
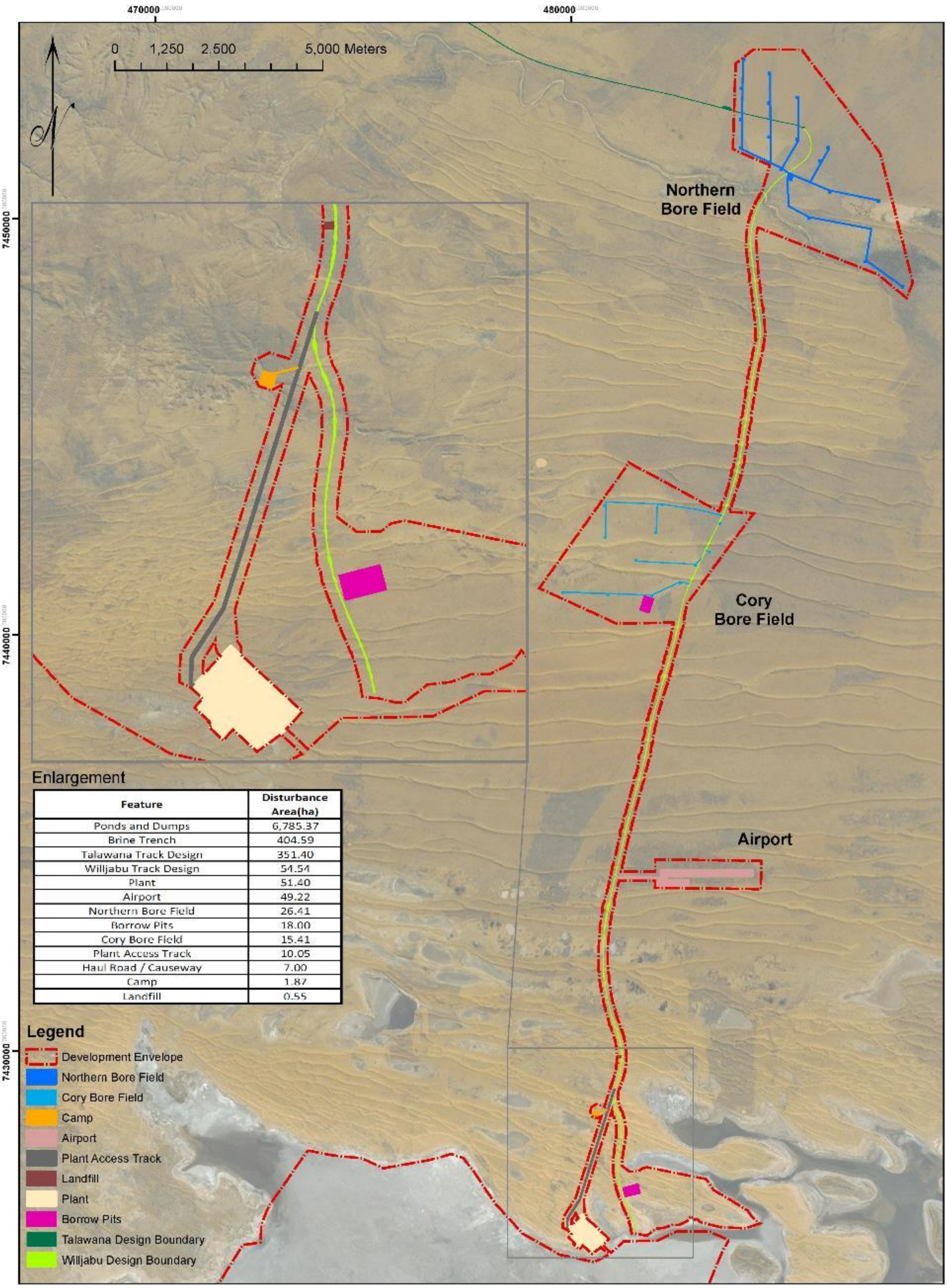


Figure 2-7: Off-playa infrastructure layout (not including Talawana Track)

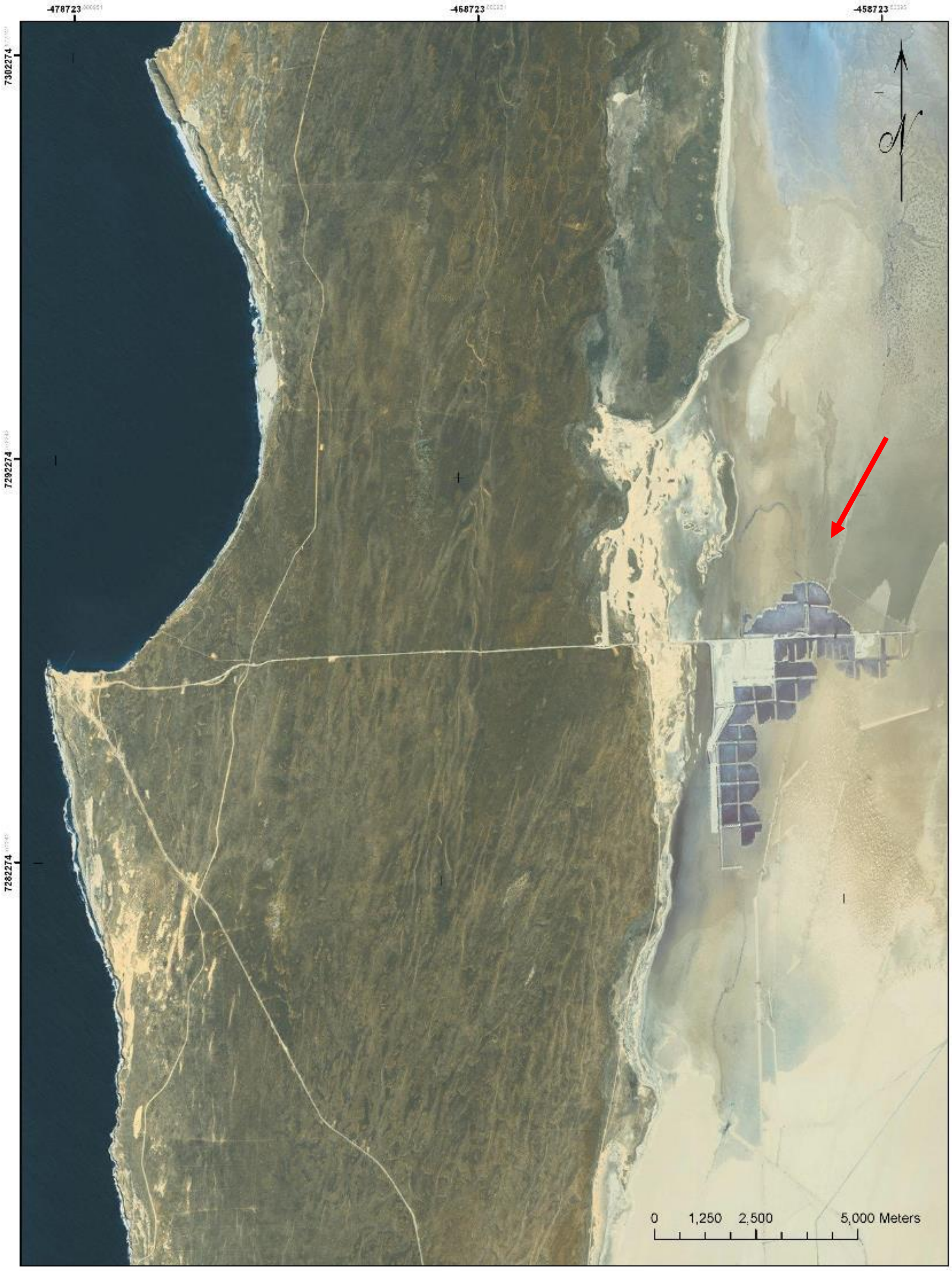


Feature	Disturbance Area(ha)
Ponds and Dumps	6,785.37
Brine Trench	404.59
Talawana Track Design	351.40
Willjabu Track Design	54.54
Plant	51.40
Airport	49.22
Northern Bore Field	26.41
Borrow Pits	18.00
Cory Bore Field	15.41
Plant Access Track	10.05
Haul Road / Causeway	7.00
Camp	1.87
Landfill	0.55

2.4.1 Brine abstraction

Up to 63 Mm^3 of hyper-saline brine (total dissolved solids (TDS) of approximately 300,000 mg/L) will be abstracted from the lake sediments on an annual basis when the project attains full operational capacity to produce 400,000 tpa of potassium sulfate (SOP). The proposed method closely resembles the methods used at existing salt works operated by Dampier Salt at Lake MacLeod, approximately 55 km north of Carnarvon, Western Australia (Figure 2-8).

Figure 2-8: Aerial view of Lake MacLeod salt works, Western Australia



A network of benched trenches up to 6 m deep will be installed across the playa surface to collect brine. The brine will drain by gravity into the trenches and then flow into a main feed canal, from where it will flow 20 km to the evaporation ponds at a rate of around 2000 L/s (~63 GL/a). The brine collection trench design is based upon brine extraction parameters derived from test pumping of 16 trenches distributed over Lake Disappointment during resource estimation field trials conducted in 2016/2017 (Figure 2-9).

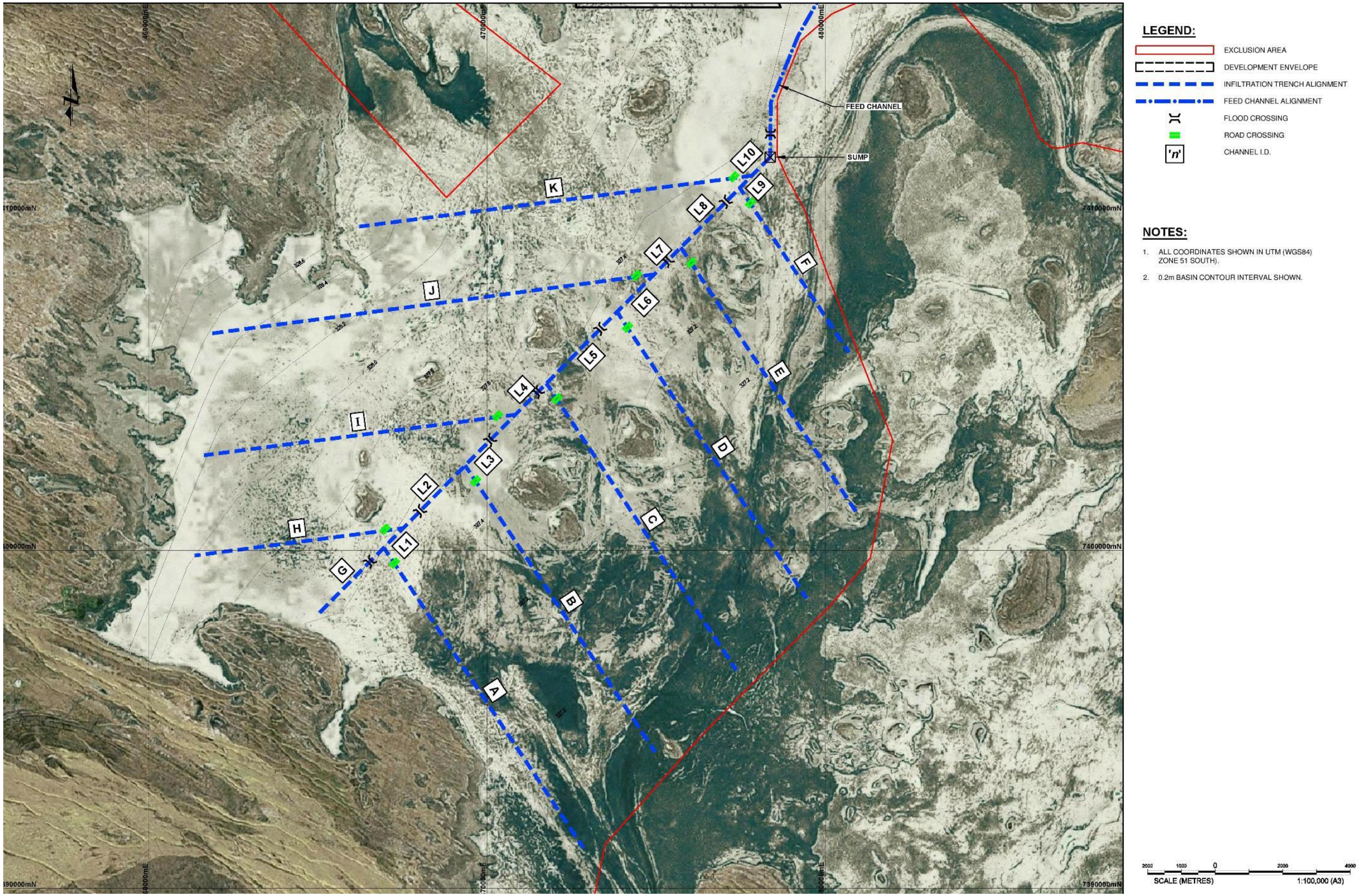
Figure 2-9: Close up view of trial trench at Lake Disappointment (2016)

The overall orientation and geometry of the trench network is dictated by the variable nature and distribution of upper lacustrine sediments, which influence the hydraulic conductivity of shallow playa sediments. Approximately 133 km of trenches will be required to provide the volumes of brine required to produce 8 Mt of SOP over the 20-year project life (Figure 2-10).

Only a part of the trench network would be active at any given time. Reward proposes to source brine from three basic operational zones, each comprising around 50 km of trenches. The zones will be operated cyclically. As a zone becomes effectively dewatered, the drainage channels are closed off to enable recharge of the dewatered zone. The zones are accessed in cyclical fashion to ensure continual brine supply to the ponds.

Excavated material side cast during construction of trenches will be used to form access embankments (causeways) for service vehicles alongside each trench. Owing to the relatively consolidated nature of sediments below a nominal depth of 1.0 m, the trenches are expected to stand up well over considerable time. Nonetheless, ongoing maintenance will be required to keep the excavations open and to allow brine to flow unimpeded to the feed canal. Amphibious excavators will service the trench network on a continual basis to ensure serviceability and integrity of the surface water control system.

Figure 2-10: Lake Disappointment trench network (indicative)



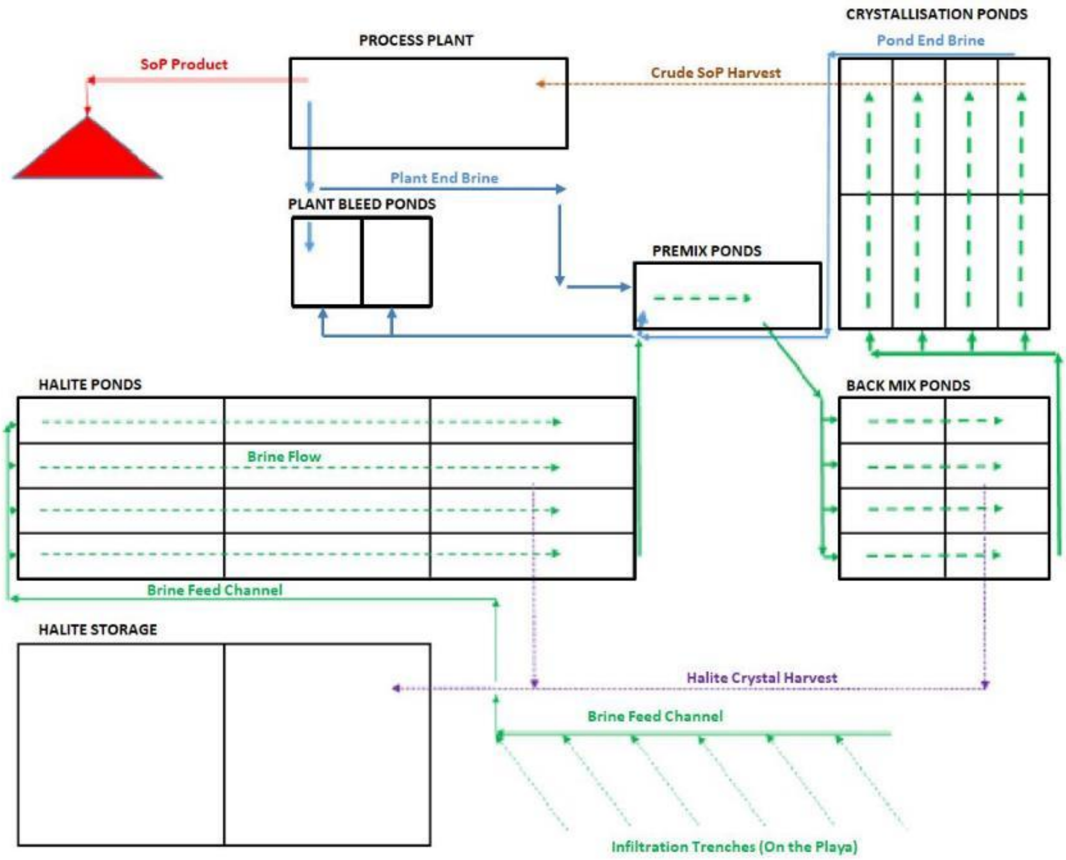
2.4.2 Processing

Brine from the collector trenches is directed to a series of shallow ponds (Figure 2-6), where it will be concentrated by solar evaporation. The natural near–surface brines at Lake Disappointment have a TDS concentration of around 300 g/L (300,000 mg/L), which is approximately ten times the salinity of seawater and close to the salt saturation limit.

Insoluble matter such as sand and clay suspended in the brine will settle to the bottom of the evaporation ponds. As the brine moves through the series of evaporation ponds it becomes increasingly concentrated. Sodium chloride is the dominant salt in the brine and is the first salt to crystallise out of solution (as the mineral halite). The target potassium and magnesium salts are more soluble and will remain in solution, continuing to concentrate as evaporation proceeds and further halite is removed. The evaporation ponds where this process occurs are called 'halite ponds'. They are configured as banks of three ponds in series.

As the brine becomes more concentrated, the target potassium and magnesium salts in solution reach a concentration where they also begin to crystallise. At that stage, after approximately 85% of the water in the starting brine has been evaporated, the brine is transferred via the premix pond to the back mix ponds, where the brine is back mixed with recycled plant end brine and high magnesium chloride brine from the final evaporation pond (Figure 2-11). A large proportion of the sodium chloride has also been removed (through crystallisation), with minimal losses of the potassium and magnesium values to that stage.

Figure 2-11: Schematic layout of solar ponds and associated halite stockpiles



The brine from the back mix ponds is transferred to the crystalliser ponds. As evaporation continues in the crystalliser ponds, the target potassium salts crystallise out of solution as a number of different potassium and magnesium salts, together with some halite. The potassium in these salts is expected to contain >8% potassium, mainly in the form of kainite ($KClMgSO_4 \bullet 3H_2O$). Evaporation and crystallisation in the crystalliser ponds continues until the potassium concentration of the remaining brine is so low that crystallisation of the potassium salts ceases.

The remaining brine is a highly concentrated magnesium brine called evaporation end brine (EEB). This liquid is drained to a separate storage/holding pond, as shown in Figures 2-11 and 2-12. The high magnesium brine will be recycled to an early stage of the evaporation cycle or stored in dedicated brine ponds. Two EEB ponds of 44 ha each are proposed. The ponds would have a combined capacity of 880,000–1,110,000 m^3 (at a brine depth 1–1.25 m). This relatively small storage capacity is possible because Reward has adopted a strategy of recycling high magnesium brine, rather than treating it only as a byproduct. Recycling of high magnesium brine results in a chemical environment more closely resembling the conditions that arise in solar salt production by evaporation of seawater (which generally has a higher proportion of magnesium chloride than does the potassium-rich brine at Lake Disappointment). Back mixing of high magnesium EEB reduces the amount of end brine storage required and also offers processing advantages by removing the need for an intermediate flotation step and the use of associated flotation reagents.

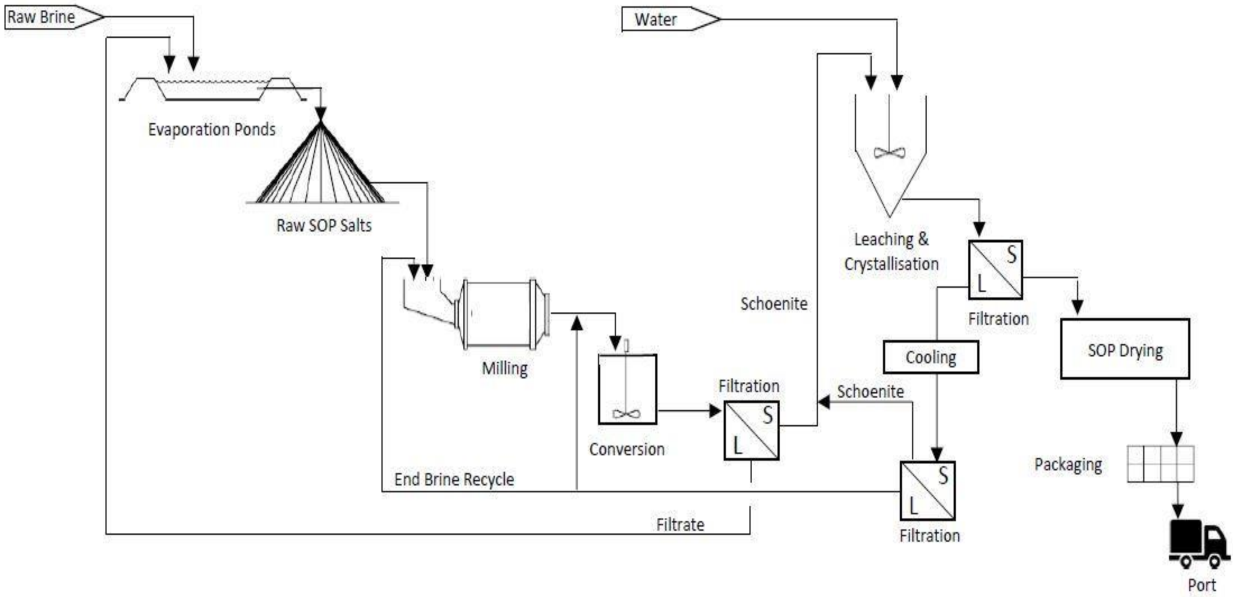
Once the crystallisers are drained of magnesium-rich brine, the precipitated potassium salt is collected by specialised salt harvesters and trucked to the plant storage stockpile. The stockpiled salt (at a grade of 7–9% potassium) contains around 80% of the potassium in the original brine drawn from the collector trenches and has a moisture content of approximately 16%. Further processing of the harvested salt is required to produce high grade SOP product containing 43% potassium. That refining process involves several steps:

- Crushing and milling of the stockpiled salt to reduce the salt lump to a size suitable for processing (<0.5 mm);
- Leaching with plant recycle brine to produce an intermediate potassium magnesium product (leonite); and
- SOP leaching and crystallisation.

The further refining of harvested potassium salts is illustrated in Figure 2-12.

The final step in SOP production involves leaching the intermediate 'schoenite/leonite' solids with warm (50°C), low salinity water (<2,500 mg/L TDS). This results in leaching of essentially all the magnesium and a portion of the potassium. The solid that remains is high grade SOP which is filtered, dried and packed for sale. The leach solution contains valuable potassium and is recycled back to the conversion step. The end brine from the conversion step also contains significant potassium values and is recycled to the evaporation ponds (Figure 2-12).

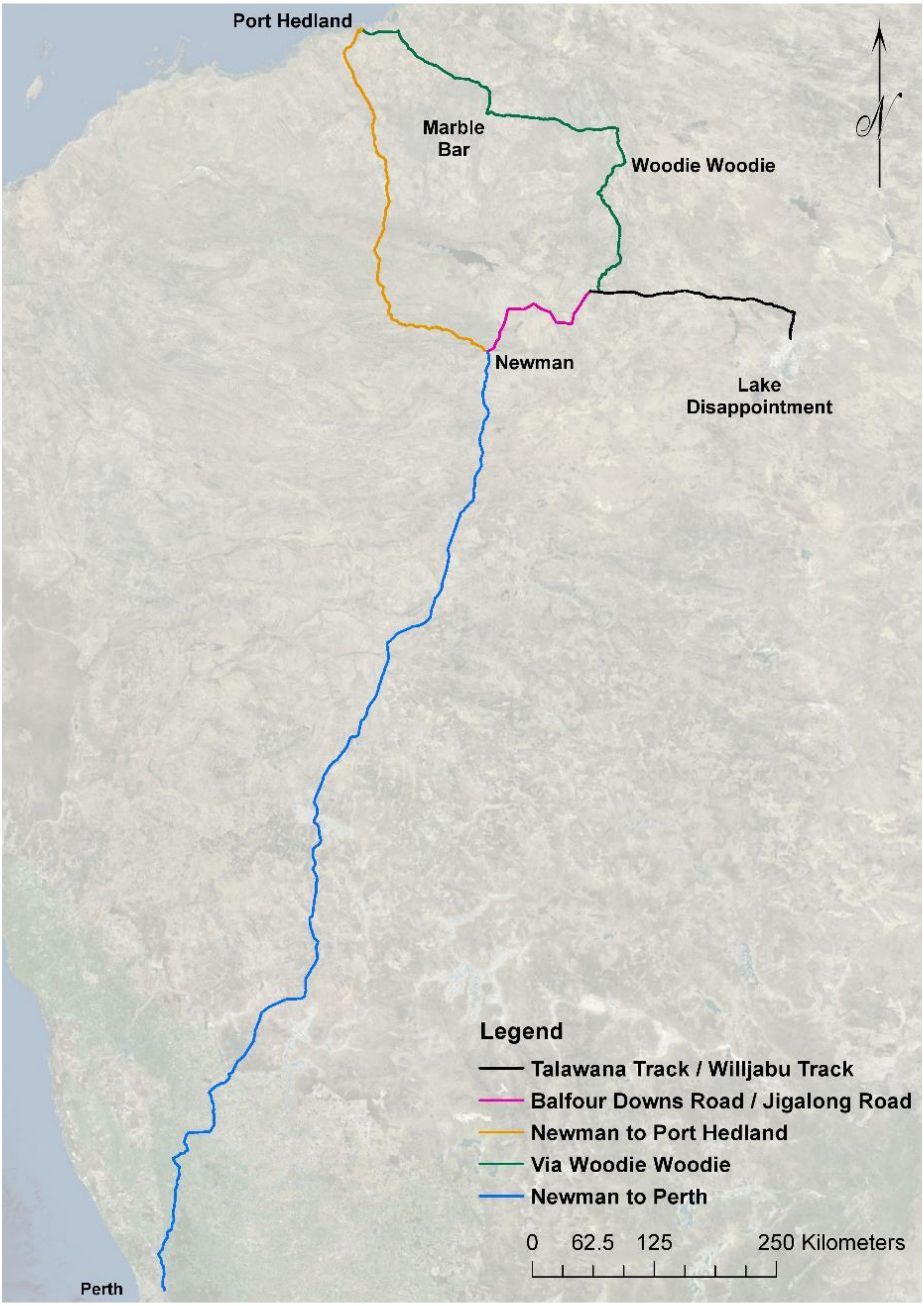
Figure 2-12: Potash processing plant (schematic)



2.4.3 Product transport

The SOP product will be transported in bulk by trucks with either three or four trailers (i.e. 'triples' or 'quads'). Production will ramp up progressively over the first three years of operation, reaching full production in Year 3 of operations. By Year 3 of operations, approximately 1200 tonnes per day of product will be produced (on average). The number of truck shipments per day will range between 15 and 20 (in one direction). Reward has assumed that haulage will be possible for approximately 330 days per year (allowance for haulage interruption due to inclement weather or impassible roads). SOP for export would be transported by road to Port Hedland via Newman. SOP for domestic use will be transported to Perth or possibly Geraldton via Newman (Figure 2-13).

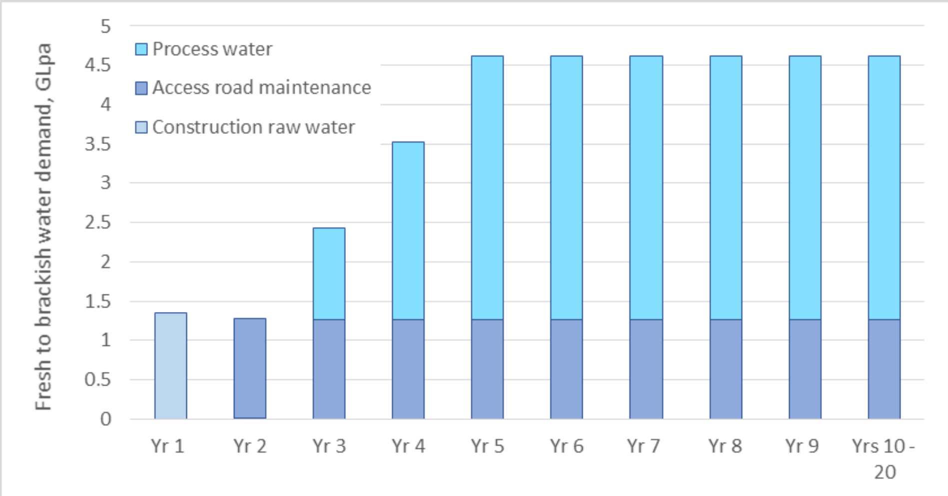
Figure 2-13: Transport routes – Lake Disappointment potash



2.4.4 Process water supplies

The project will initially target an output of approximately 200,000 tpa of SOP. This output will require approximately 1.8 GL/a of water for processing (process water). As production is ramped up to 400,000 tpa (Year 3 of operations; Year 5 from commencement of site works), the process water requirement is expected to increase to 3.4 GL/a (Figure 2-14).

Figure 2-14: Project water demand



Reward has identified two potential borefield locations (Figure 2-7). The Cory Borefield, located approximately 16 km north of Lake Disappointment, would draw water from a fractured rock aquifer within the Coolbro (previously the Gunanya) Sandstone formation. Bores will be drilled to a depth of between 100 m and 120 m and water will be pumped from depths ranging from 80 m to 100 m below ground level at an average rate of 8 L/s. The water available from the Cory Borefield is brackish (TDS approximately 2500 mg/L), with the dissolved salt being primarily sodium chloride (NaCl). Test pumping analysis indicates that a network of approximately six bores can deliver the required 1.5 GL/a on a sustainable basis for the life of the operation (Appendix I3).

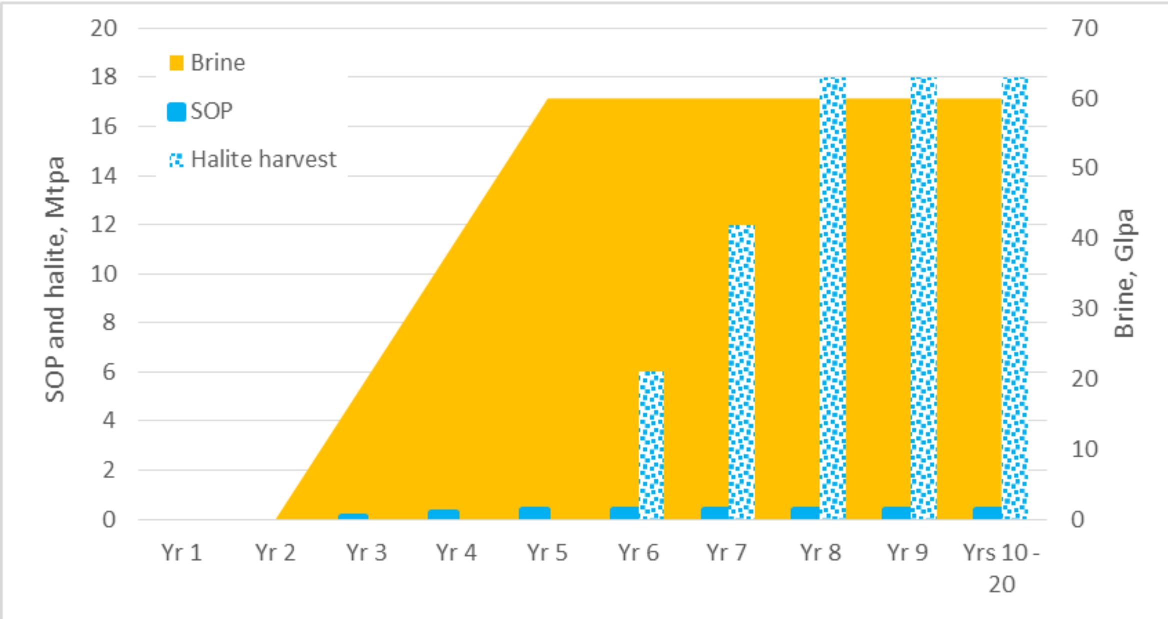
The Northern Borefield is located approximately 25 km north of the Lake Disappointment shoreline. The aquifer from which the Northern Borefield would draw is hosted in a shallow Quaternary and Tertiary alluvial sequence that overlies the McKay fault at a depth of about 100 m. Test pumping analysis indicates that flows ranging from approximately 5 L/s to 10 L/s are possible (Appendix I4). Numerical modelling has shown that the borefield is capable of sustainably delivering the required 2 GL/a for the life of the mine. The salinity of water from the Northern Borefield is brackish, with an average TDS of approximately 3500 mg/L.

Additional information on the hydrogeology of the proposed borefields is presented in Section 4.3.

2.4.5 Process byproducts

The main byproducts arising from potash manufacture are halite (sodium chloride salt) and a high magnesium brine. As outlined in Section 2.4.2, halite will precipitate from the brine and be deposited in the halite ponds. Periodically, starting in about Year 6 of operations, it will be necessary to harvest the salt from the halite ponds so that the evaporation capacity of the ponds is maintained (Figure 2-15). Alternatively, halite ponds could be progressively abandoned as the accumulated halite fills the ponds. If this alternative approach were adopted, it would be necessary to construct replacement ponds (approximately 660 ha/a) as the original ponds fill up with salt, amounting to approximately 13,300 ha of pond footprint over 20 years. Although this approach is operationally simpler, it would involve greater overall disturbance of the playa and for this reason, Reward proposes to continually refurbish the halite ponds by periodic harvesting of halite.

Figure 2-15: Brine abstraction, SOP production and harvesting of halite



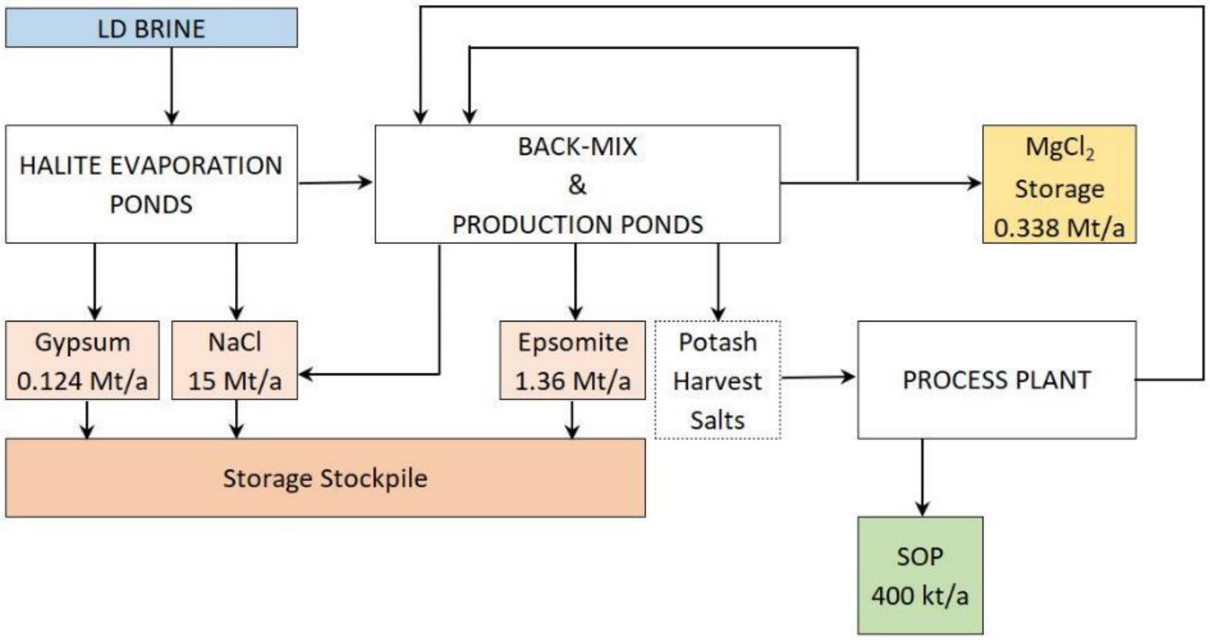
The halite harvested from the halite ponds would be stockpiled on the playa surface in stacks up to 13 m high. By project completion, the estimated extent of halite stockpiles would be approximately 2000 ha. At present, it is not economically viable to sell the halite, because of the high cost of handling and transporting this low-value commodity to any point of sale.

Magnesium sulfate (epsomite) and magnesium chloride salts in the brine entering the Lake Disappointment evaporation pond system report to two main outlet streams. For a 400,000 tpa SOP operation, the brine input required (63 GL/a) contains approximately 373,000 t of magnesium, of which 287,000 t is present in the form of magnesium sulfate (1.42 Mt $MgSO_4$) and 86,300 t in the form of magnesium chloride (0.338 Mt $MgCl_2$).

Most of the magnesium sulfate reports in the solid form (1.36 Mt) in harvested salts stored in the halite stockpiles. Approximately 720,000 m^3 (979,000 t) of EEB would be produced annually based on feed brine analysis. This brine would contain 61,000 t of magnesium sulfate and most of the 338,000 t of magnesium chloride entering via the feed brine. There is potential to sell magnesium byproduct salt from operations at Lake Disappointment. Further testwork is in progress to ensure this byproduct stream would meet market requirements.

The operational process proposed by Reward involves recycling of the EEB back to the evaporation ponds to control the brine chemistry and improve harvest grade. A schematic diagram showing production of SOP product and salt byproducts is provided in Figure 2-16.

Figure 2-16: Output streams – SOP and salt byproducts



2.4.6 Support infrastructure

Existing facilities at Lake Disappointment consist of a small exploration camp and laydown area located near the proposed mine operations centre. In order to implement the project, the following additional infrastructure will be required:

- Upgrades to existing tracks
- An accommodation village
- An airstrip
- An operations centre comprising:
  - Administration offices
  - Workshops
  - A power station
  - A fuel farm
  - A water treatment facility
  - A laboratory
  - Stockpile areas
  - General laydown compounds.

A suitably experienced contractor will be engaged to complete the bulk earthworks for this project infrastructure. The bulk earthworks for all infrastructure will involve clearing, storing and reusing vegetation; topsoil stripping, storage and reuse; installing access roads; and foundation preparation and the sheeting of pads to allow site drainage works to be established.

Road upgrades

Movements of vehicles, people and materials (including potash product) will generally follow routes defined by the existing Willjabu Track and Talawana Track (Figure 2-13). The Talawana Track is not gazetted as a public road. It is categorised by Main Roads WA as having a 'special use', namely Indigenous access (to the Parnngurr community). The Talawana Track also provides access for tourist traffic to the Karlamilyi National Park.

Road upgrades and minor road realignment would be required in order to provide safe and reliable access between Lake Disappointment and Newman. Upgrade works may include:

- Installation of culverts or other drainage structures;
- Repair or replacement of the running surface; and
- Realignment to provide better lines of sight.

No road realignment or additional clearing would be carried out along the 4.4 km section of track that lies within the National Park boundary.

The total footprint for the combined Talawana and Willjabu access routes is approximately 406 ha. This includes the cleared areas (approximately 180 ha) currently occupied by the existing tracks.

Reward does not currently hold tenure over the Talawana Track access road; however, the Lake Disappointment Project Mining and Indigenous Land Use Agreement (ILUA) allows Reward to use that portion of the Talawana Track within the Martu determination area for Lake Disappointment project operations. Access arrangements would be finalised following completion of further heritage surveys and in parallel with final road design. Access arrangements would be determined prior to submitting a Mining Proposal to the Department of Mines, Industry Regulation and Safety (DMIRS).

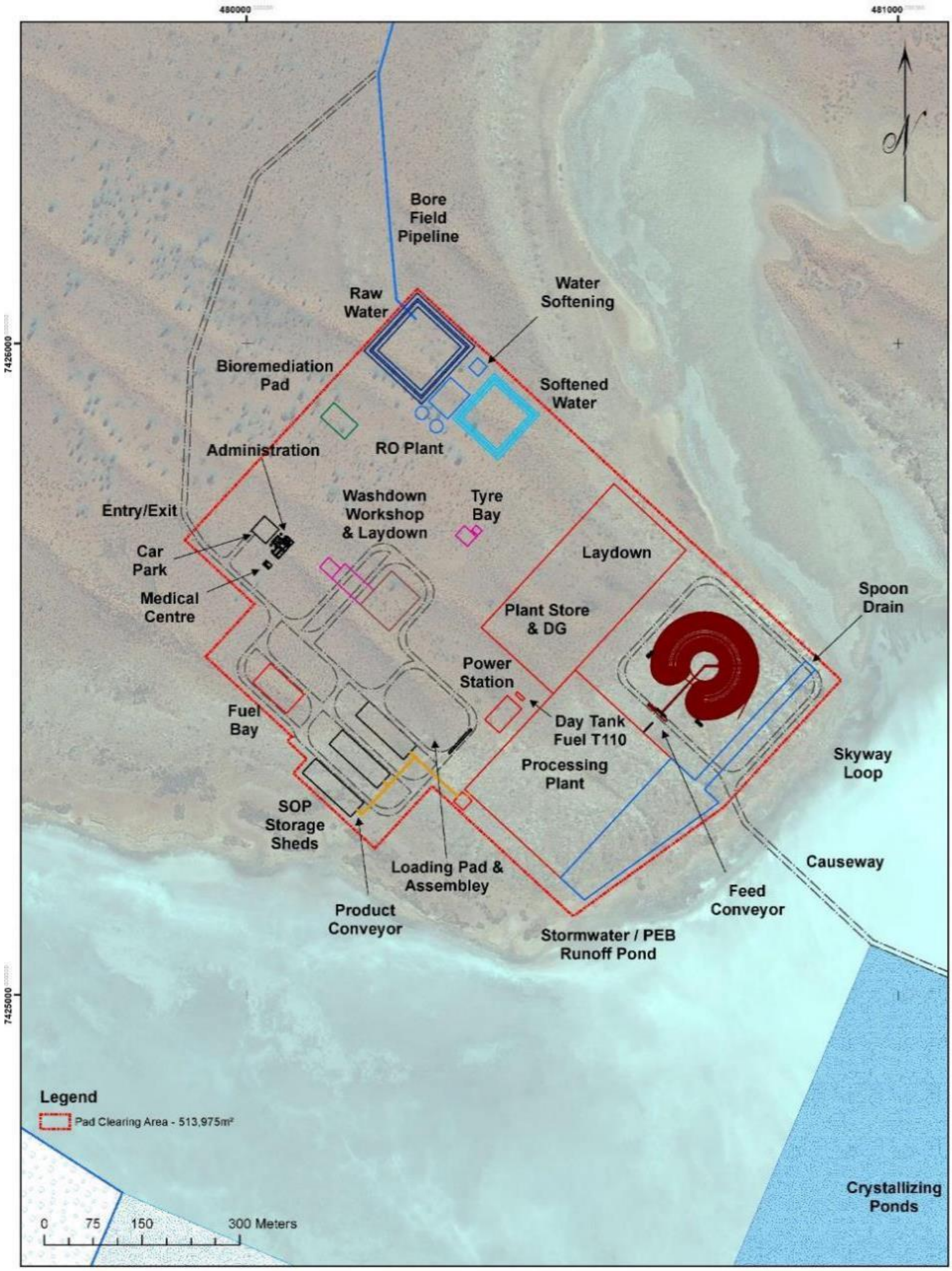
Operations centre

A nominal 52 ha area has been set aside for the mine operations centre. This area will be cleared and stripped of vegetation and topsoil prior to foundation preparation works. The area has been engineered to ensure a cut/fill balance for all in situ materials (sand and gypcrete).

The water storage ponds include the provision of suitable liners, fencing and associated equipment.

The process plant at Lake Disappointment will be similar those used in processing of evaporite minerals in other parts of the world (e.g. Compass Minerals' operations at Ogden, Utah, USA and SQM's solar salt operations in Chile). The plant will cover approximately 51.4 ha. An indicative general arrangement/layout is shown in Figure 2-17.

Figure 2-17: Indicative layout: process plant and other support infrastructure



Stockpile areas

The plant feed stockpile area earthworks will be completed in conjunction with the general pad area earthworks. The drainage system will collect all surface runoff, as well as brine draining from the plant feed stockpiles. The seepage and drainage water will be directed to the plant holding pond and then pumped to the evaporation ponds on the lake. Once the general formation and paved materials have been placed and compacted to the design levels, a polyethylene liner will be installed under the plant feed stockpile area. This liner will allow the recovery of any brine solutions that drain out of the feed stockpile.

A thin layer of sand will be placed under and over the liner during the construction. A layer of gypcrete will then be placed over the liner and the stockpile area will then be raised to the design levels.

General laydown areas

A warehouse and stores facility will be located adjacent to the workshops and will contain necessary maintenance and operations consumables and spares to support the operation of the process plant and mobile equipment.

Laboratory

A conventional mine site laboratory covering approximately 115 m^2 will be established onsite adjacent to the administration centre. An additional area of 80 m^2 of semi-enclosed wet and dry sample receipt/preparation units with concrete base/wash down facilities will be established adjacent to the laboratory.

The laboratory facility will comprise sample preparation equipment, instrumentation for analysis of evaporite salts and brines from the brine supply/pond system and plant operation. Analysis for Ca, K, Mg, Na, SO_4 and chloride ions on approximately 200 samples per day is anticipated. No acid digestion methods are required for the laboratory procedures involved.

Power station

The provision of a diesel fired 10 MW power station will be contracted out as a build, own and operate facility with the Company buying power from the power station operator on a kWh basis.

Allowance has been made for overhead transmission lines to the village and pump lift stations at the potash crystalliser ponds on the lake. Allowance has been made for underground transmission lines to the process plant, workshops, fuel farm, administration offices and other supporting infrastructure within the operations center next to the lake.

Fuel farm

A fuel farm will be installed with a capacity of approximately 2 ML diesel fuel. This will provide approximately two weeks storage for fuel for the operation. The fuel farm will be equipped with pumps and piping to allow discharge from triple road tankers and filling of light vehicles and heavy equipment at separate bowser locations. Fuel will be piped to the power station, for use in power generation, and to the process plant for heating process water.

The fuel farm will consist of ten 200 m^3 self bunded fuel tanks and one self bunded diesel emission reduction fluid tank. The emissions reduction fluid is a fuel additive used in modern trucks that have a selective catalytic reduction system. Use of this product helps to reduce the quantity of nitrogen oxides emitted from engines.

Water treatment facility

The two raw water borefields will supply low salinity (~2,500 mg/L TDS) water for the project. This water will be treated so that it can be used to provide process water, fire water and potable water supplies for the project.

Raw water will be transferred from the borefields to the raw water pond through large diameter polyethylene pipelines. Generally, the pipeline will be laid on the surface, and only buried at road crossings. The pipelines will be constructed and pressure tested to meet requirements of Australian standard AS 4041 or other relevant standards. Borefield water supplies are expected to have salinities lower than <5,000 mg/L TDS, hence any spillage is unlikely to adversely affect surrounding vegetation.

Within the operations centre, two water storage ponds will be constructed to hold raw water and treated process water. The raw water pond has been designed with a capacity of 21 ML and the treated water pond has been designed with a capacity of approximately 12.5 ML. Both ponds will be lined with polyethylene membrane and fenced. Allowance has been made to install piping through the pond walls and liner to allow for suction lines to be installed in the ponds. Allowances have also been made for the supply of life buoys and fauna egress matting in both ponds.

The water supply to the process plant requires treatment to remove calcium and magnesium ions that would otherwise contribute to scale buildup in equipment such as boilers used to generate hot water and steam for processing salts. The raw water will initially be treated through a water softener plant, with some of this treated water then being treated further in a reverse osmosis (RO) plant to provide potable water for the village, offices and process plant.

Allowances have been made for the supply and installation for piping of water from the treatment plants to the village, project infrastructure and process plant. This allowance includes the provision of suitable water storage tanks across the project.

Administration offices

The administration offices will be located near the process plant and include a medical treatment facility within the complex, as well as offices, meeting rooms, training facility, lunch rooms and toilets for the project staff. The installation will include the provision of waste water treatment, and reticulation of power, water and communication services.

Workshop facilities

Separate workshops will facilitate process plant maintenance, mobile equipment maintenance and other supporting infrastructure, such as a boilermaker's workshop, equipment wash down facility and tyre fitting area.

The workshops will be equipped with tooling to allow efficient operation of the maintenance facility. The wash down facility has been designed to include a dirty water settling area and oil separation equipment.

Accommodation village

The location for a 150-person accommodation village has been selected to provide an elevated area that is anticipated to be well above a 1-in-100 year flood level.

The location will be cleared and stripped of topsoil prior to the construction a gypcrete pad approximately 300 mm thick. The pad will be designed to include a drainage system to divert surface water from significant rainfall events away from buildings. Where required, sediment basins will be constructed to allow all surface run-off water to be collected with the sediment load settled prior to any discharge to the local environment.

As part of the design of the village earthworks, service roads will also be designed and constructed during the bulk earthworks program.

The accommodation village will be built during the early part of the construction program and then used for the construction workforce before being handed over to operational teams. The village consists of four-room transportable accommodation units, gymnasium, recreation room, laundries, and kitchen, dining room and wet mess facilities.

The village may be managed by a catering contractor on the Company's behalf.

The village installation will include the provision of waste water treatment, landscaping and reticulation of power, water and communication services.

Airstrip

The location of the airstrip has been selected in an area that provides adequate line of sight for aircraft operation.

The location will be cleared and stripped of topsoil prior to the construction a gypcrete pad approximately 300 mm thick. Allowance has been made for the additional clearing of vegetation on approach paths to comply with all relevant legislation and codes.

The design of the airstrip is for an unsealed strip suitable for use by turbo prop aircraft up to 70 seat capacity. This will entail the construction of an approximately 2000 m long and 90 m wide pavement area for aircraft landing with associated hard stand areas for aircraft refueling and parking areas. Allowance has been made for fencing of the airstrip, fuel storage, passenger and freight handling for crew change operations.

2.4.7 Mine rehabilitation and closure

At closure, it is proposed that the pond walls be breached and smoothed out. The brine collection trenches and the feed channel will be backfilled using soil and rock salvaged from the bunds and roads that were constructed adjacent to them. The backfilling of the trenches and feed channel is required to ensure that no fauna can become trapped in the trenches and to help restore a surface flow system approximating the predevelopment surface hydrology.

The halite stockpiles will be left in place and allowed to reintegrate into the lake surface over time via rainfall infiltration. This is consistent with current industry practice for closure of salt stacks (halite stockpiles) in comparable arid zone solar salt operations (e.g. in North America).

The long-term impacts of the project on the Lake Disappointment playa are expected to be minimal, as disturbed areas will be reshaped to levels that approach natural conditions. Additionally, as all structures are to be constructed out of material borrowed from the lake and the process byproducts are concentrated salt, no long-term contamination is expected. Any erosion of the fill or mobilisation of the salts post-closure will only result in material and salts returning to their original source area. At closure, off-playa infrastructure will be decommissioned, chiefly comprising access roads, the processing plant and support infrastructure including the airstrip, the accommodation village, offices, workshops, water supply borefields and water pipelines. Areas used for storage of fuels and chemicals and other industrial operations areas will be checked for contamination and remediated, if required. All disturbed land will be recontoured to blend with the surrounding natural landscape and revegetated using local provenance species.

A conceptual mine closure and rehabilitation plan is provided in Appendix K.

2.5 Alternatives considered

By far the greater part of the project disturbance footprint is associated with the area occupied by brine evaporation ponds and by the area required for disposal of non-target salts (mostly halite). In developing the Lake Disappointment project, Reward carefully considered the following environmental aspects when selecting its preferred options for pond locations and layouts for management of salt byproducts:

1. Avoidance of culturally significant areas
2. Avoidance of high value bird breeding and feeding areas
3. Minimising disturbance of high-biodiversity areas
4. Minimising alterations to natural surface water flows/ponding
5. Limiting impact to flora and vegetation which may be significant at local and/or regional scales.

No project infrastructure is located in heritage exclusion areas, as agreed with the Traditional Owners of the Lake Disappointment area, as set out in the ILUA established in December 2012. The ILUA also prohibits Reward from conducting investigations or operations in the heritage exclusion areas and this prohibition has been scrupulously adhered to throughout its baseline environment studies program.

2.5.1 Location of evaporation ponds

The brine evaporation ponds occupy the largest footprint of any project element. At an early stage of project development, Reward considered two options for location of the evaporation ponds and associated halite stockpiles:

- Landward of the northern shoreline of the Lake Disappointment playa; and
- On the playa surface, in areas devoid of vegetation and outside the heritage exclusion area.

After completing a first stage of flora and fauna assessments, it was apparent that siting the evaporation ponds on the playa would deliver a better outcome in terms of avoiding areas of high biodiversity (claypans north of the playa) and minimising vegetation clearing. The layout of the ponds and stockpiles has been further adjusted to avoid areas with greater value for bird breeding and feeding, and to minimise impacts on surface water flow that could affect riparian vegetation.

2.5.2 Management of halite

As explained in Section 2.4.5, Reward considered two options for storage of halite:

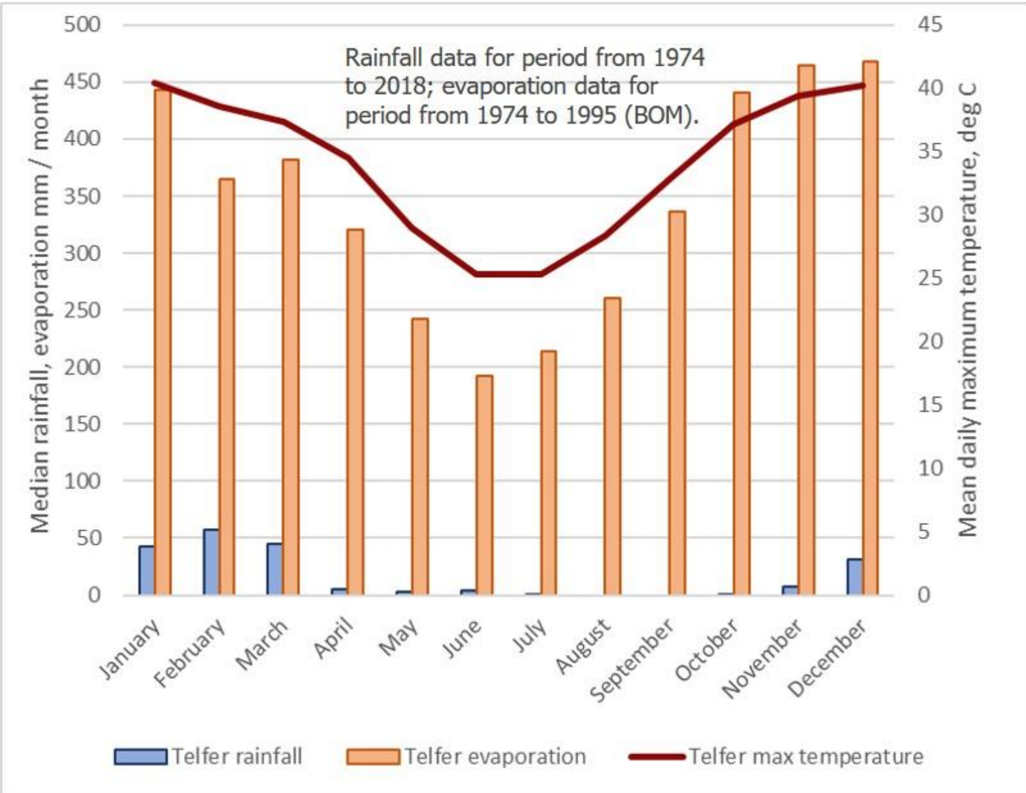
- Continuously expanding the on-playa pond areas; and
- Periodically refurbishing ponds by harvesting halite and storing it in permanent stockpiles.

The latter option, although more costly, was selected as it ultimately results in a considerably smaller project footprint, because the height of the halite stacks is higher than would be the height of ponds required to store and equivalent amount of halite. Reward has taken into account the potential visual impacts of permanent halite stockpiles; this aspect is addressed in Section 0. The potential for seepage or runoff from the halite stockpiles was also considered and is discussed in Section 4.4.

2.5.3 Climate

The climate in the project area is arid, with hot summers and mild winters. Average annual rainfall is in the order of 371 mm. Most rainfall occurs during the summer months (December through March). Annual average evaporation rate exceeds 4000 mm. Evaporation significantly exceeds rainfall in every month. The nearest Bureau of Meteorology (BOM) climate station to the project area is Telfer Aero, approximately 180 km north of Lake Disappointment. Pan evaporation data were available for 1974 through to 1995 and daily rainfall data were available from 1974 through to 2018 (Figure 2-18).

Figure 2-18: Monthly rainfall, evaporation and maximum daily temperature (Telfer, WA)



The region occasionally experiences intense cyclonic rainfall events: five cyclones passed within 100 km of Lake Disappointment during the 40 years from 1970 to 2010 (Figure 2-19). In 2013, Cyclone Rusty delivered approximately 260 mm of rain during a three-day period. The 2017 wet season delivered exceptionally high rainfall, estimated to correspond to at least a 1-in-200 year flooding event (Figure 2-20). Estimated rainfall depths for a range of durations and return intervals are summarised in Table 2–3. Rainfall intensity-frequency-duration curves are presented in Figure 2-21.

Figure 2-19: Cyclone tracks within 100 km of Lake Disappointment (1970–2010)

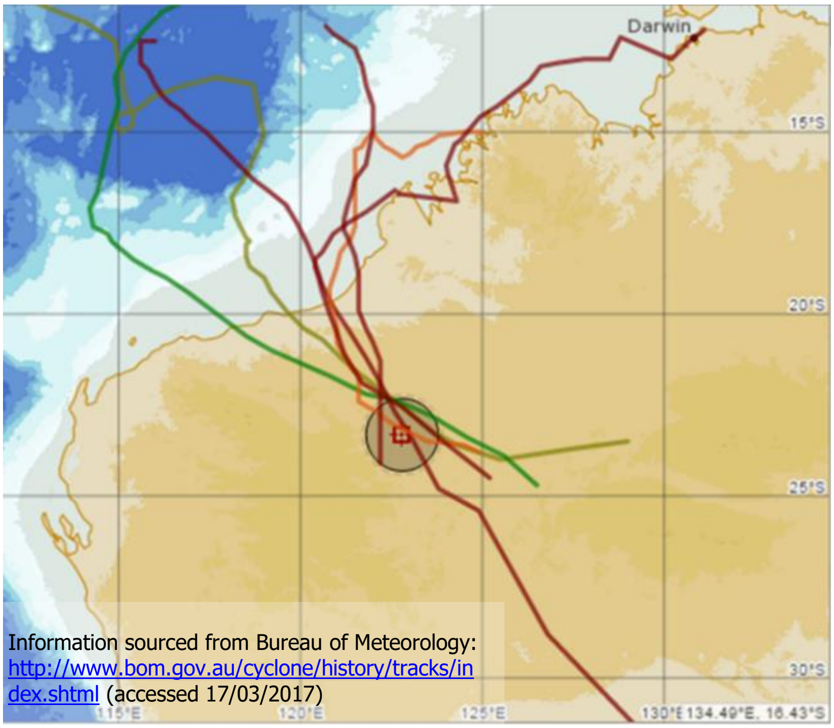


Figure 2-20: 2017 rainfall, relative to long-term monthly medians (Station No. 013030)

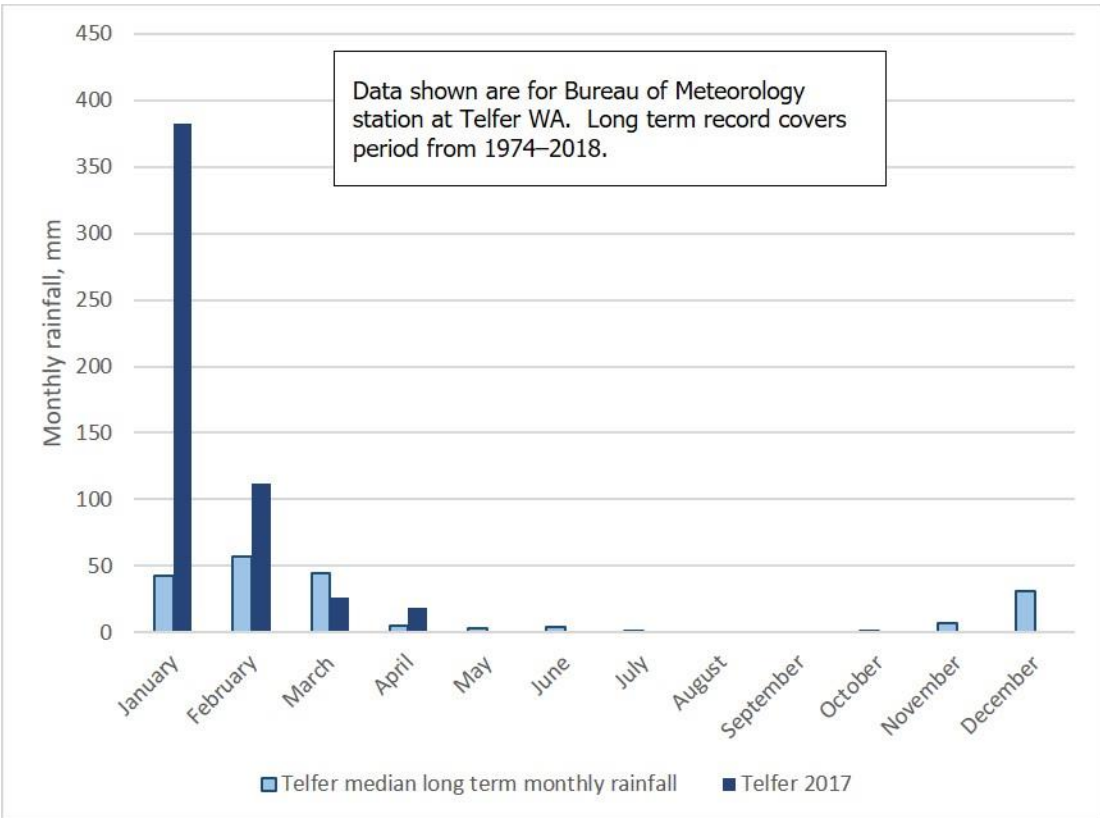
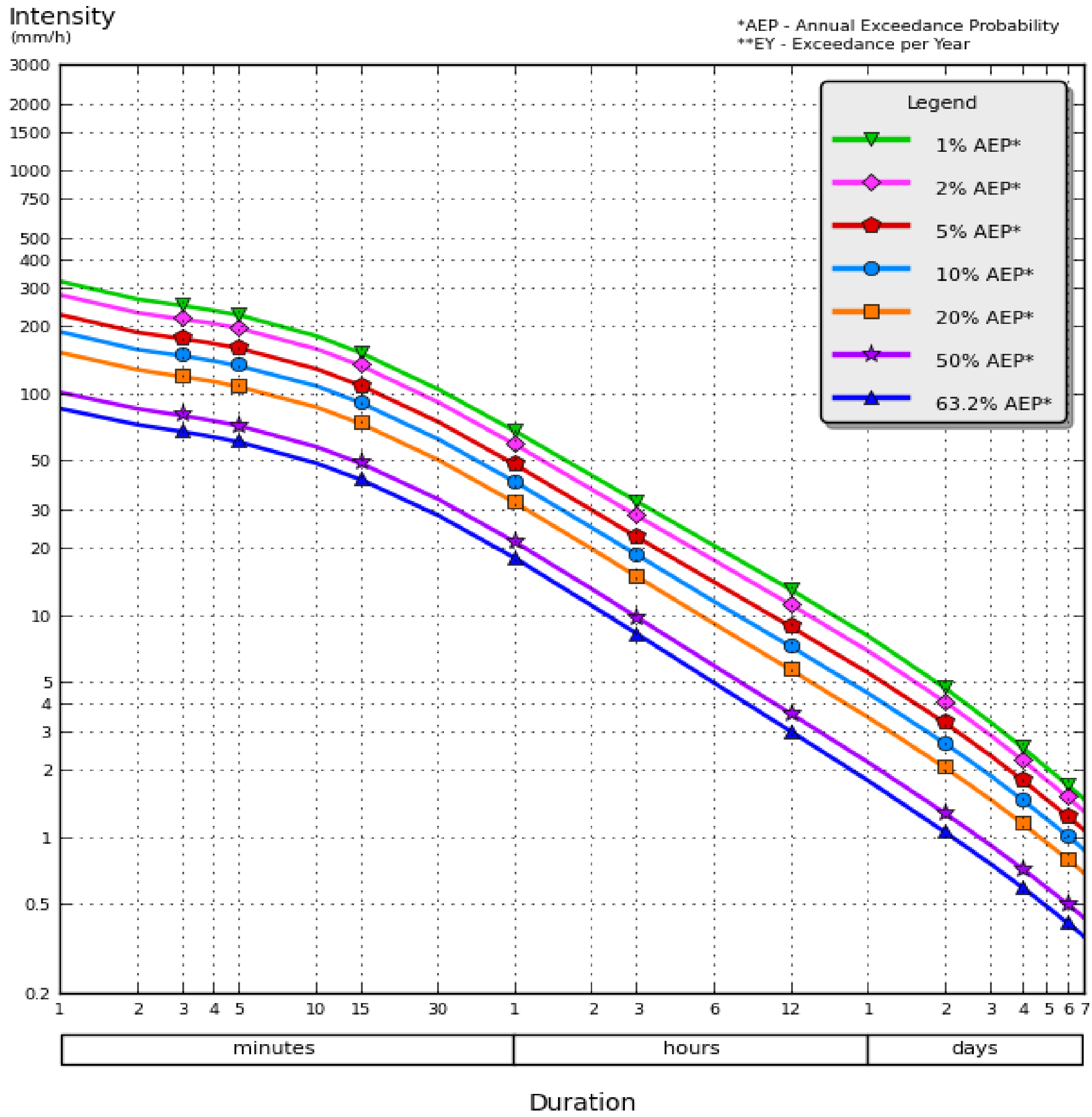


Table 2–3: Rainfall depths (mm), various durations and return intervals (Lake Disappointment)

Storm duration	Average recurrence interval (years)						
	1	2	5	10	20	50	100
5 mins	4.2	5.6	7.9	9.3	11.2	13.7	15.7
6 mins	4.69	6.25	8.82	10.5	12.5	15.3	17.6
10 mins	6.45	8.58	12.17	14.45	17.33	21.33	24.33
20 mins	9.7	12.93	18.33	21.80	26.20	32.17	37.00
30 mins	11.9	15.95	22.65	26.95	32.4	39.85	45.75
1 hour	15.9	21.3	30.7	36.7	44.3	54.8	63.1
2 hours	19.66	26.6	39	47.2	57.6	72	83.4
3 hours	21.72	29.52	44.1	53.7	66	83.1	96.9
6 hours	25.32	34.86	53.64	66.6	82.8	105.6	124.2
12 hours	30	41.52	65.52	82.2	103.32	133.2	158.4
24 hours	36.48	50.64	80.64	101.76	128.16	166.32	198.24
48 hours	44.02	60.96	96.96	122.4	154.08	200.16	238.56
72 hours	46.73	64.66	103.68	131.04	165.6	216	257.76

Figure 2-21: Rainfall intensity-frequency-duration curves – Lake Disappointment



2.6 Local and regional context

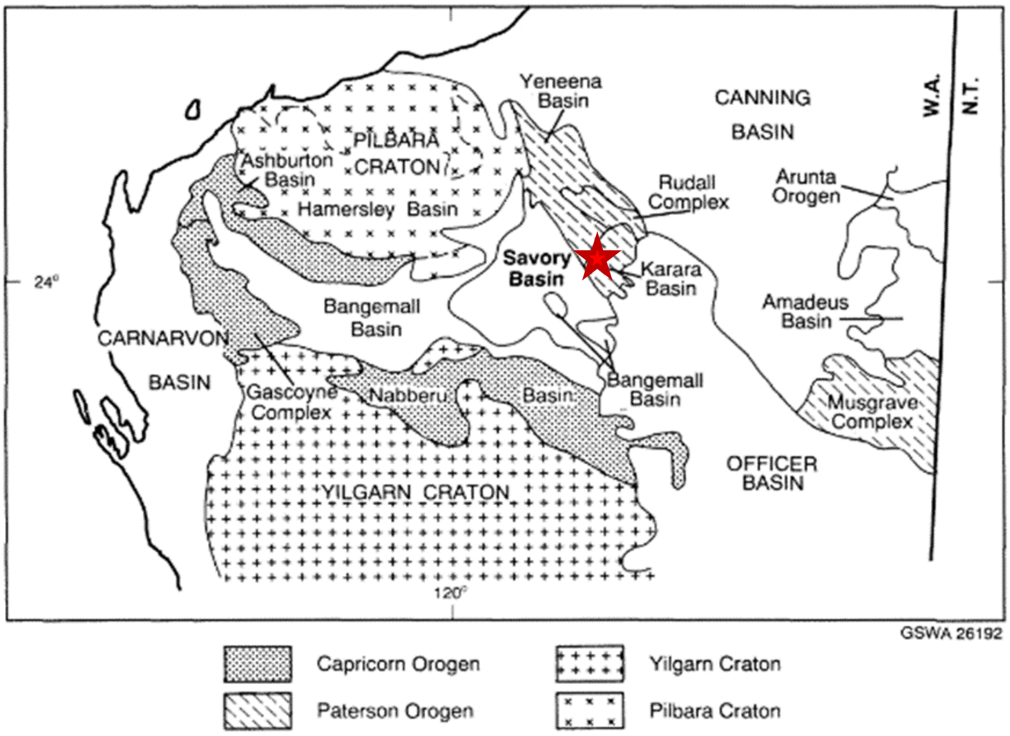
2.6.1 Geology

Regional geology

The Little Sandy Desert region, within which the project is proposed, is underlain by the Savory Basin, a late Proterozoic sedimentary formation dating from about 900 to 600 million years ago, and by the sediments of the south-western part of the Yeneena Basin, which experienced deformation and metamorphosis under the influence of the Paterson Orogeny approximately 550 million years ago. The region is bounded to the north-east by the Canning Basin and to the south-east by the Officer Basin (Figure 2-22).

The shallow sediments of the Savory and south-western Yeneena Basins generally comprise gently east-dipping medium to coarse-grained sandstone and pebbly conglomerate. The underlying bedrock outcrops infrequently: more than 90% of the basin is covered by unconsolidated or semi-consolidated Cainozoic deposits, consisting largely of windblown sands in the form of dunes and sandplains (Williams 1992). The sand is composed of medium to medium-coarse quartz grains, with occasional ferruginised grains or ironstone pebbles. The wide-spread longitudinal dunes that occur throughout the Savory Basin are thought to have formed during the intensely arid conditions that prevailed during the last glacial maximum (about 13,000 to 25,000 years ago). Colluvial deposits occur to a limited extent in the basin and are mostly located adjacent to infrequent rocky outcrops. Alluvial deposits of unconsolidated silt, sand and gravel are also relatively uncommon and are restricted mostly to drainage lines and to the terminal Lake Disappointment playa.

Figure 2-22: Regional geology (Williams 1992)



Note: Approximate position of Lake Disappointment is indicated by red star

Local geology

Published regional-scale geological maps[3] (Figure 2-23, Figure 2-24) indicate the following surficial geological units occur in association with Lake Disappointment and the surrounding areas:

- Aeolian deposits, comprising sand and clayey sand present as flat to undulating sandplains and seif (longitudinal) dunes up to 30 m in height, formed extensively adjacent to Lake Disappointment;

[3] Gunanya 1:100,000 Geological Series Sheet (Bagas, 1998), Blanche-Cronin 1:100,000 Geological Series Sheet (Bagas, 1999) and Gunanya 1:250,000 Geological Series Sheet (Williams and Williams, 1980)

- Dune-free sandplains comprising clays, silt and sands;
- Quaternary age lacustrine deposits, comprising clay, silt, sand and evaporite minerals;
- Quaternary age kopi (flour gypsum) deposits, comprising sand, silt, clay and gypsum, present as stabilised dunes adjacent to lacustrine deposits along the western margin of Lake Disappointment;
- Reworked Quaternary age aeolian deposits, comprising clay, silt and sand, present throughout the western side of Lake Disappointment; and
- Quaternary age sandplain deposits also occur as discontinuous 'islands' of shallow relief within the extent of Lake Disappointment.

The superficial sequences are underlain at variable depth by members of the Neoproterozoic Tarcunyah Group, which comprises an interbedded sequence of sandstone, siltstone and shale deposited around 800 Ma. These bedrock materials outcrop locally to the east and the south-west of Lake Disappointment (e.g. Durba Hills and Diebal Hills, located approximately 25 km south-west of the Lake Disappointment playa).

Figure 2-23: Cenozoic geology – Lake Disappointment

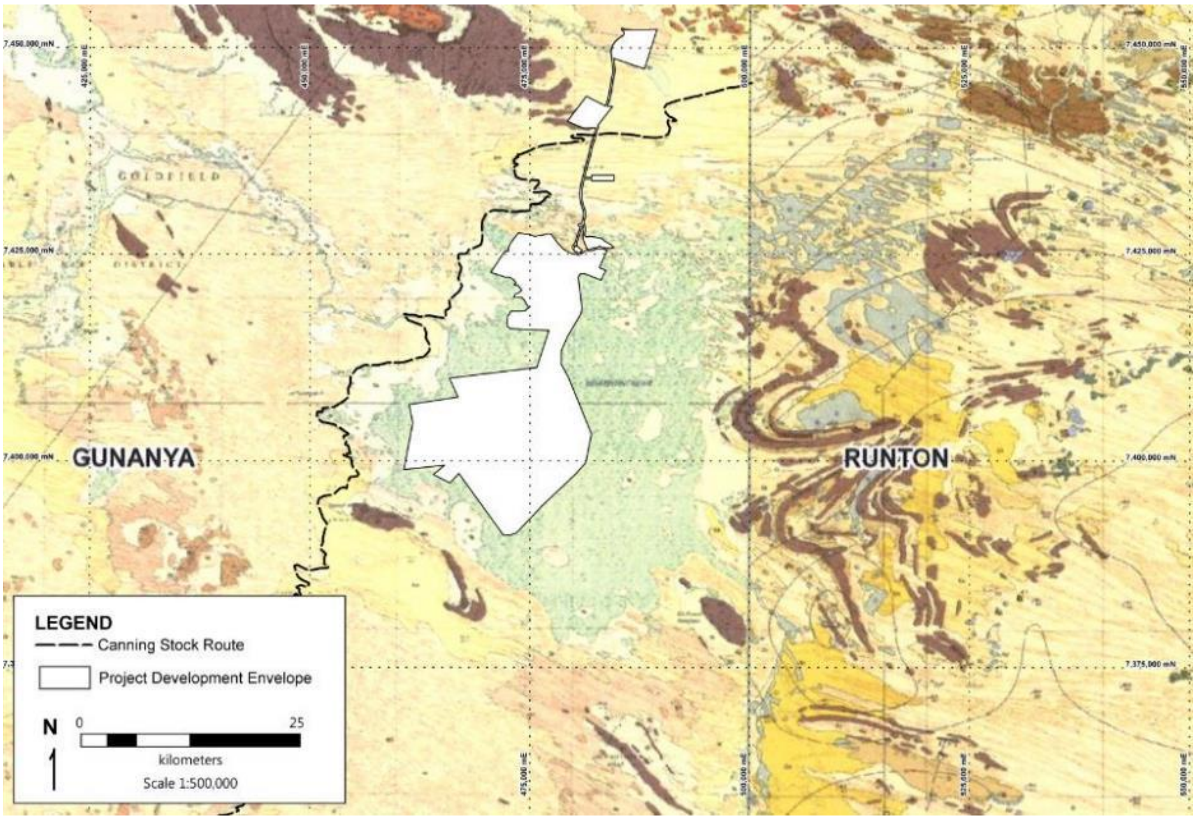
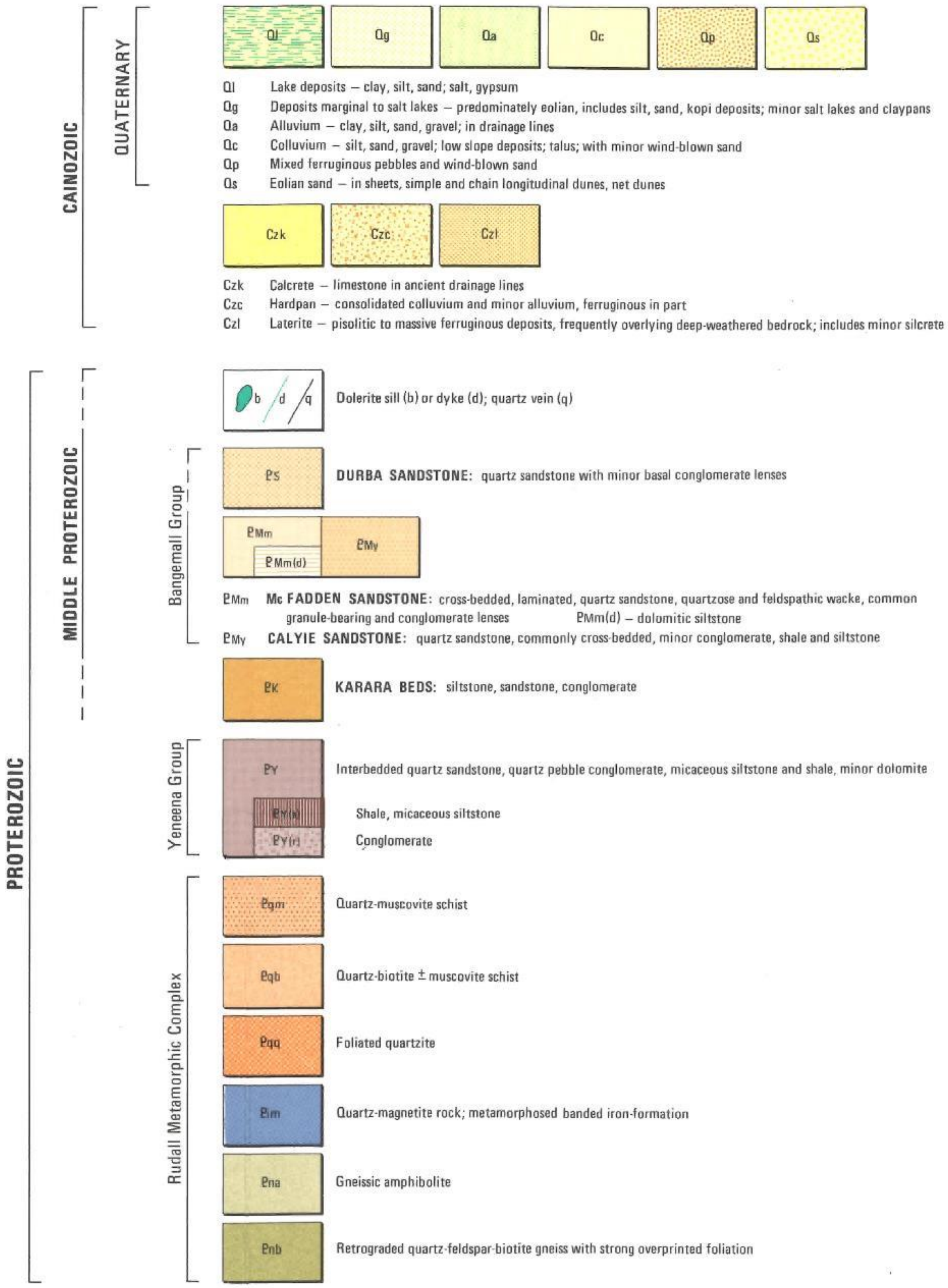


Figure 2-24: Geological map legend



The stratigraphy beneath and adjacent to the Lake Disappointment playa reported in published literature has been generally confirmed by Reward's exploration programs. As shown in Figure 2-25 through Figure 2-27, subsurface conditions beneath the Lake Disappointment playa comprise windblown silty or clayey sands, interspersed with—and underlain by—clayey/silty lake sediment (lacustrine) deposits, with occasional sandy lenses. The combined thickness of the aeolian sand and the lacustrine deposits generally does not exceed about 10 m, except where relatively narrow channels have been incised into the underlying sedimentary bedrock.

Figure 2-25: Geological section lines, showing geoprobe (GP) and bore (LDDH) locations

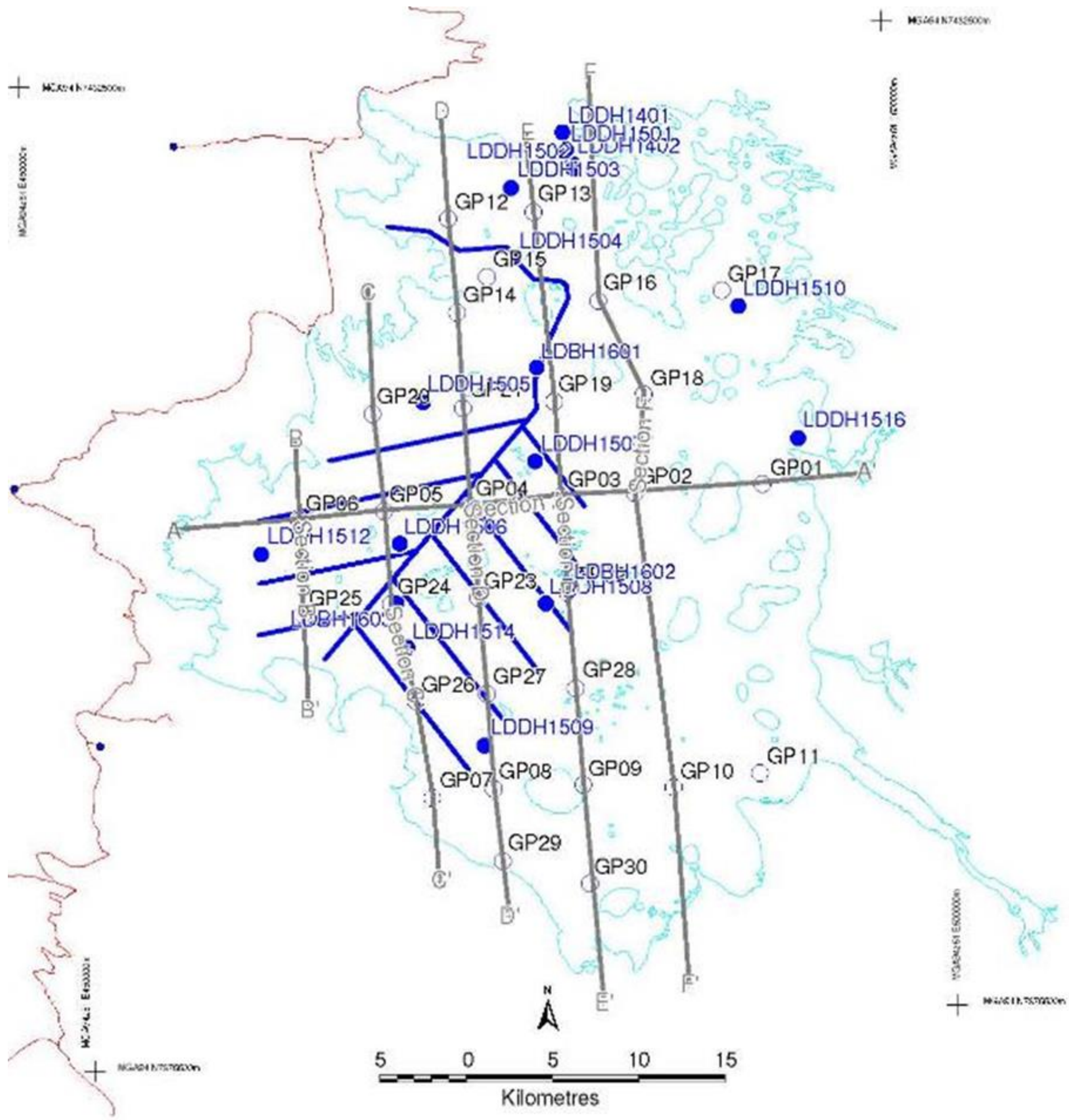


Figure 2-26: North-south cross-sections – Lake Disappointment playa (Reward drilling records)

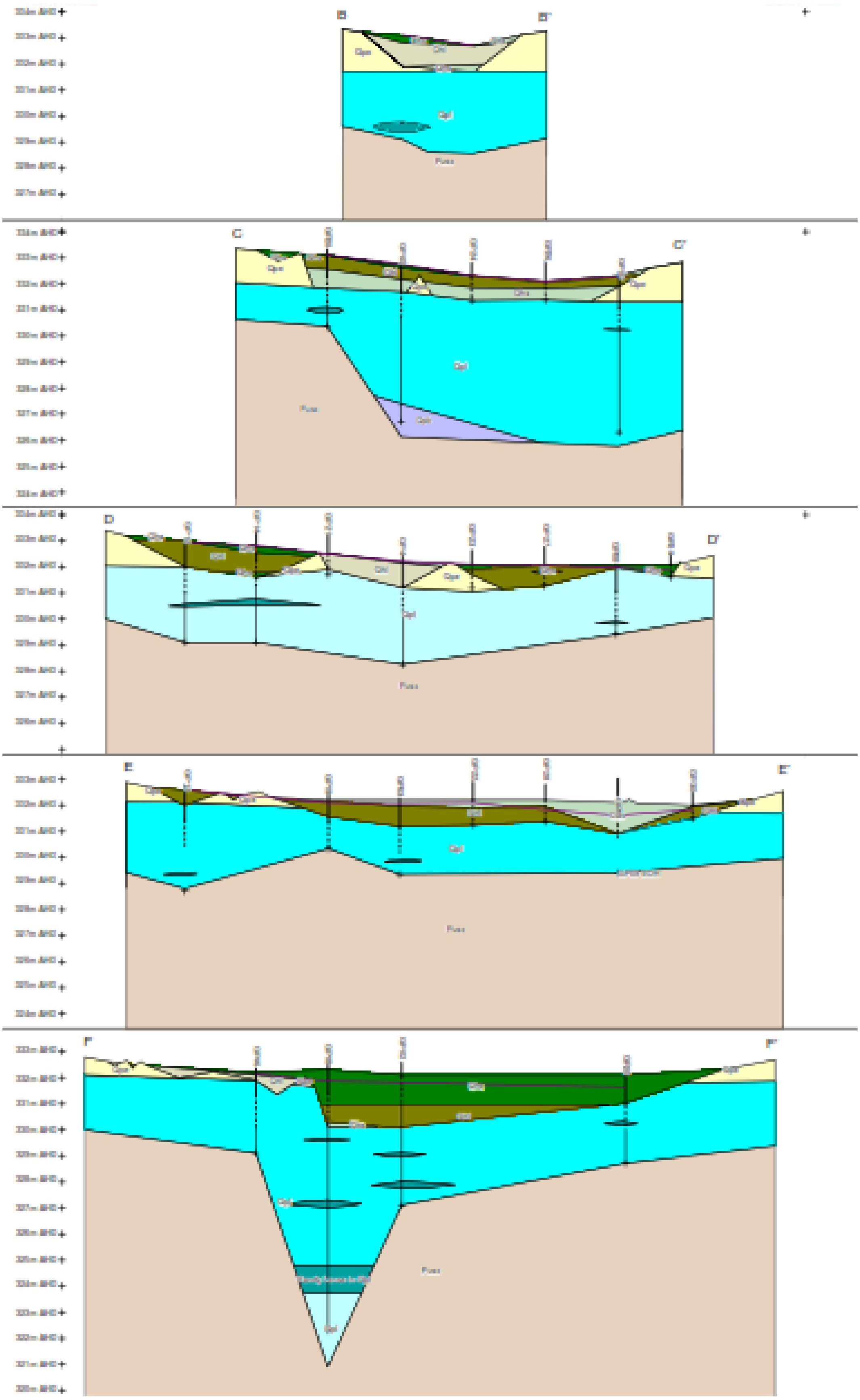
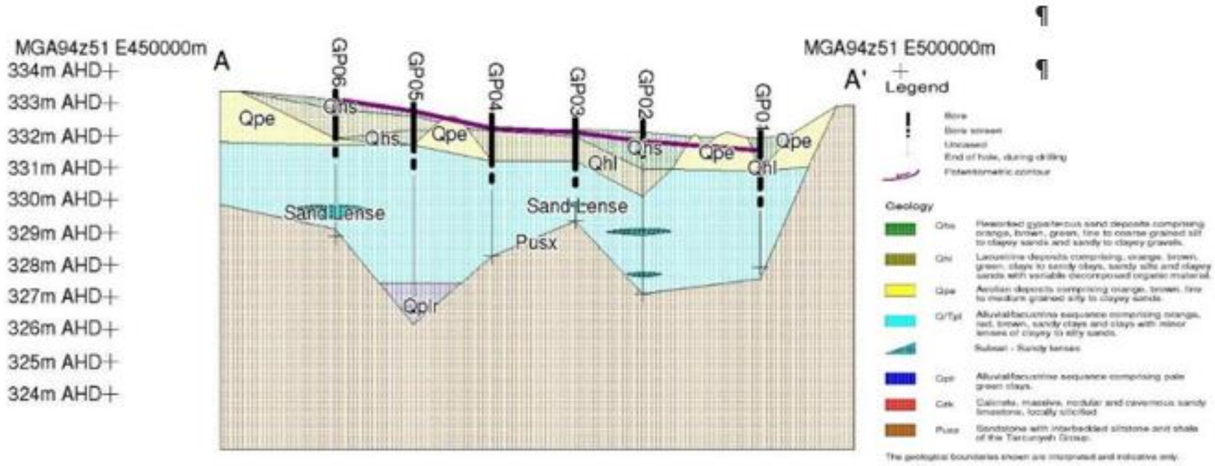


Figure 2-27: East-west cross-section through playa, with geological legend



Note: Letters (A-A′) correspond to section lines shown on Figure 2-25

2.6.2 Soils and land systems

Land systems

The project access road traverses a variety of land systems (Figure 2-28), but the dominant land systems intersected by the proposed disturbance footprint for the Lake Disappointment project are Land System AB44 (sandy plains with occasional claypans and scattered sandstone hills) and Land System SV9 (bare salt pans) (Table 2–4).

Figure 2-28: Land systems of the Lake Disappointment project and surrounds

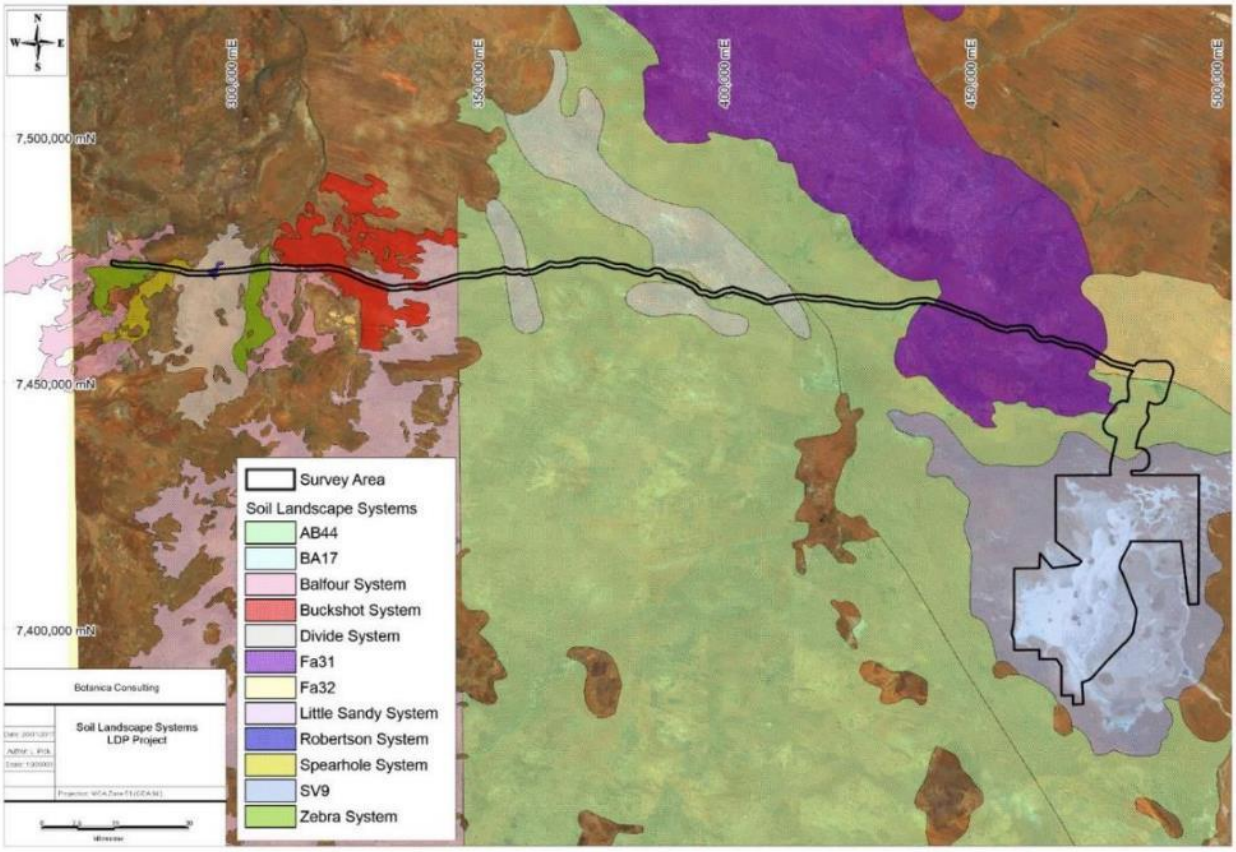


Table 2–4: Land systems present in Lake Disappointment project locality

Name	Description
Balfour	Shale, gravel and clay plains supporting *Eremophila*-cassia shrublands, tussock grasslands and halophytic shrublands
Divide	Gently undulating sandplains with minor dunes, supporting hard spinifex hummock grasslands with numerous shrubs
Robertson	Hills and ranges of sedimentary rocks supporting hard spinifex grasslands
Spearhole	Gently undulating gravelly hardpan plains and dissected slopes supporting groved mulga shrublands and hard spinifex
Zebra	Hardpan plains with large linear gravelly sand banks supporting acacia tall shrublands with soft and hard spinifex
AB44	Plains with variable, but usually high, proportion of longitudinal sand dunes, and with some clay pans; scattered sandstone hills and laterite residuals are fairly common
BA17	Flat-topped, but sometimes steep-sided, hills with extensive areas of bare rock-sandstones and other sedimentary rocks, but including some volcanics
Buckshot	Gravelly sandplains and occasional sand dunes supporting shrubby hard spinifex grasslands
Little Sandy	Sandplains with linear and reticulate dunes supporting shrubby hard and soft spinifex grasslands
FA31	Rugged ranges with extensive areas of bare rock largely on metamorphics and granites but with inclusions of sandstones and conglomerates
FA32	Low ranges and hills largely on metamorphics and granites but with some inclusions of sandstones and conglomerates; extensive areas of bare rock; transgressed by dunes in places and flanked by small plains
SV9	Salt lakes, salt pans, and clay pans mostly devoid of true soils

Note: Soil land systems as described in Tille (2006)

Soil and sediment properties

A range of investigations have been completed to characterise the chemical, physical and geotechnical properties of soils at a local scale (Pendragon Environmental Solutions 2014, Appendices G1, G2 and G10).

Sediments of the Lake Disappointment playa typically comprise a thin (0.1–0.2 m) layer of fine to coarse grained silty sands interlayered with gypsum salts. These surficial sands and salts are underlain by a low to medium plasticity silty clay (Figure 2-29). The shallow lake sediments are generally low in strength, but become denser and stronger below a depth of about 0.8 m to 1 m.

Soils in the sand plains and dunes surrounding the playa consist of loose, fine to medium grained sand or silty sand (topsoil), overlying a fine to medium grained light reddish brown silty sand which becomes denser with increasing depth. A typical cross-section in the riparian zone is illustrated in Figure 2-30.

Figure 2-29: Soil profile showing salt crust and clayey subsoil – Lake Disappointment playa

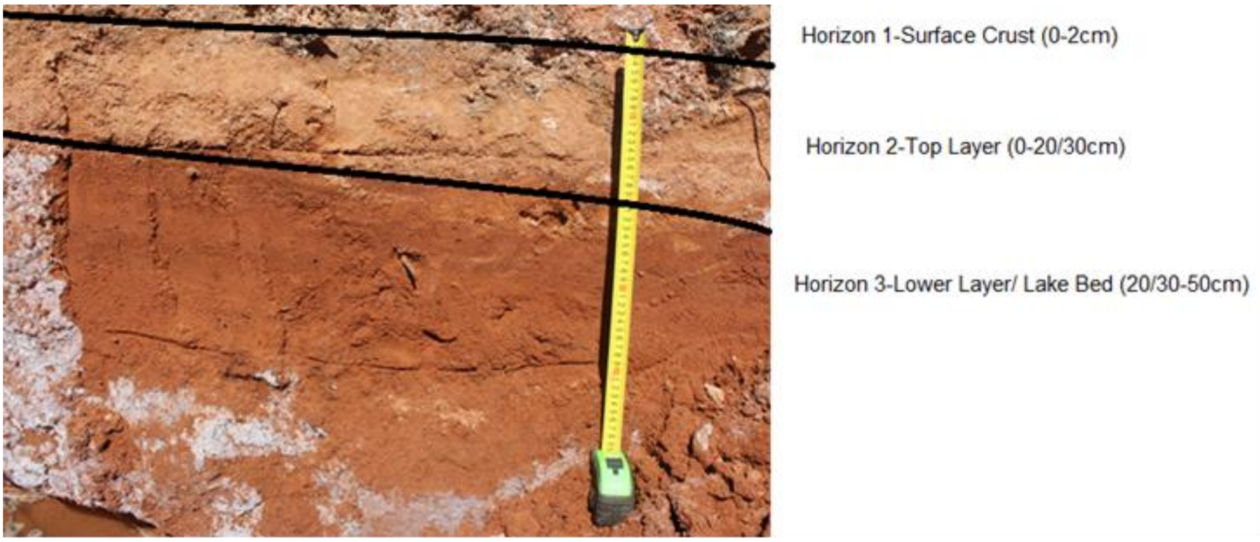
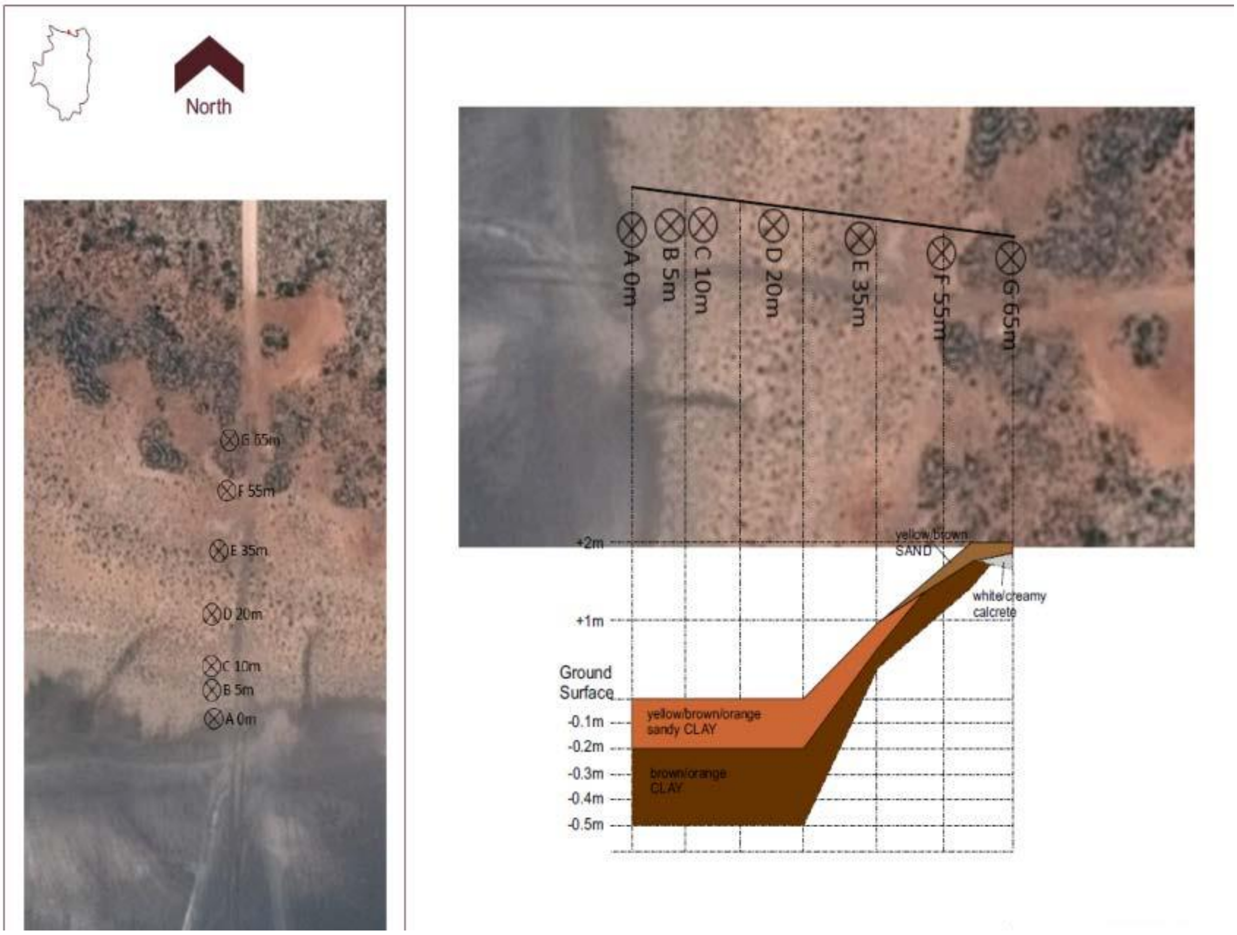
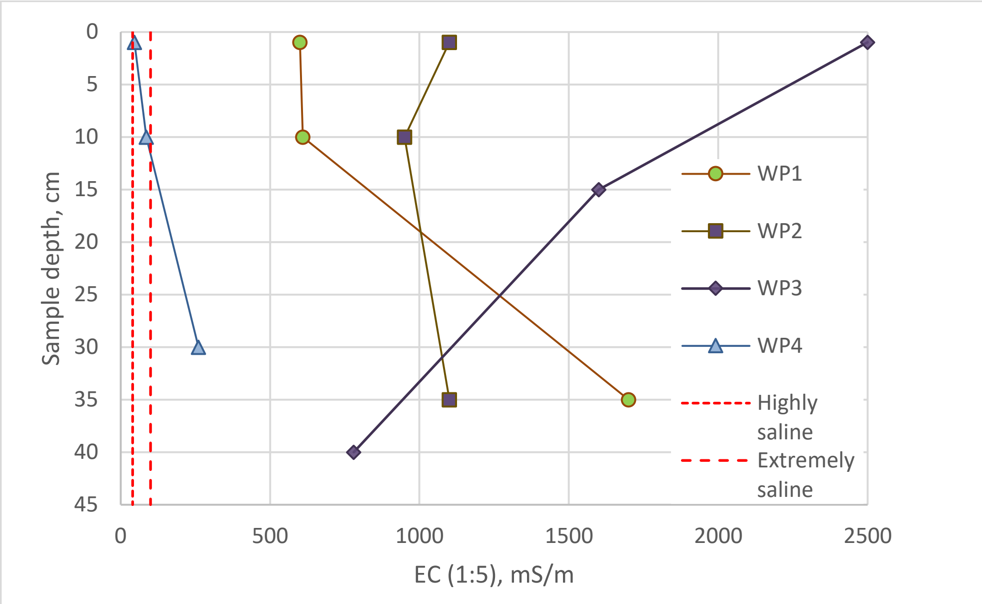


Figure 2-30: Soil transect – riparian zone characterisation (Appendix G3)



The soils in the riparian zone and playa sediments are consistently neutral to alkaline in reaction and are very saline. In riparian zone soils, there is no consistent trend in salinity with depth in the zone accessed by plant roots (Figure 2-31).

Figure 2-31: Shallow soil salinity – Lake Disappointment riparian zone



The soils of the Lake Disappointment region typically have moderate to low organic content, are low in nutrients and have low cation exchange capacities, as would be expected in predominantly sandy soils (Appendix D3). Concentrations of trace metals are unremarkable. Plants roots are generally concentrated in the upper 0.2 m of the soil profile and are rarely evident below at depth of 0.3 m in either the playa sediments or in the sandier dune soils of the riparian zone (Figure 2-32).

Figure 2-32: Soil profiles showing rooting depths on the playa (left) and dune soils (right)

Acid sulfate soil risk

The Lake Disappointment playa is shown in the Australian National Acid Sulfate Soil Risk Map (http://www.asris.csiro.au/themes/AcidSulfateSoils.html, Figure 2-33) as an area with a high probability, but very low confidence, of the presence of acid sulfate soils (ASS). To provide more certainty around the risk of acid sulfate soils in the project area, Reward commissioned baseline assessments in accordance with methods recommended by the Department of Water and Environment Regulation (DWER) (DER, 2015).

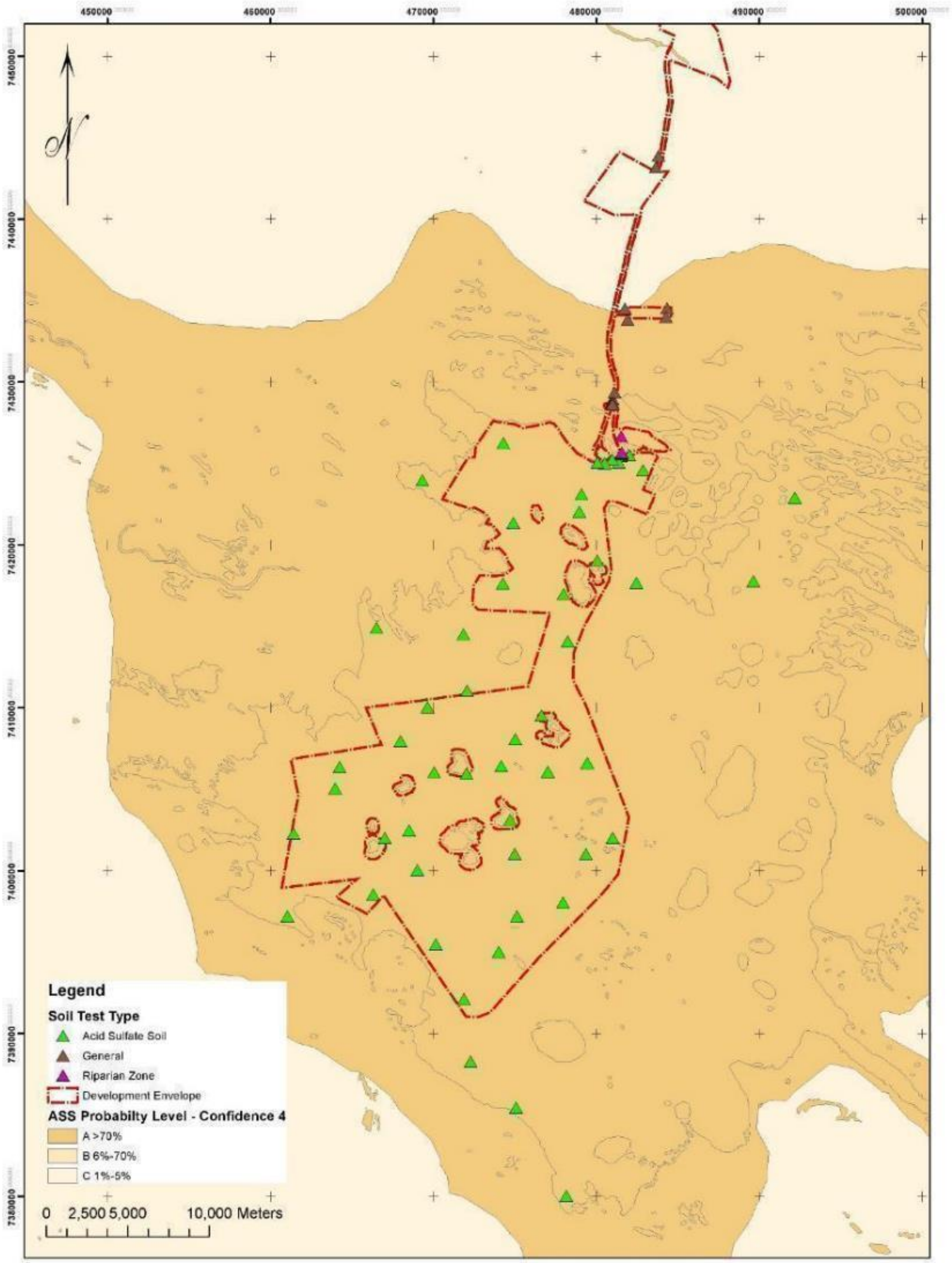
A total of 102 samples of lake sediments from 39 locations and 22 samples of dark, fine-grained sediments, provisionally described as 'monosulfidic black oozes' (MBOs)[4], were obtained during several sampling events (Figure 2-33). These samples were initially analysed for field pHs. Subsequently 61 sediments, including 17 inferred MBOs, were subjected to further analysis using the suspension peroxide oxidation combined acidity and sulfur (SPOCAS) method to ascertain their potential to generate acidity. A number of samples of the MBOs were also analysed for acid volatile sulfur (AVS). Concentrations of heavy metals were determined on laboratory leachates prepared from samples of the MBOs. An additional 15 samples (plus three replicates) were subsequently tested for chromium reducible sulfur, pH and organic matter. Additionally, three bulk samples of inferred MBOs from trench excavations were subjected to incubation testing to assess their behaviour over time. Laboratory results and additional discussion of the testing programs are provided in Appendix G.

In March 2018, Reward conducted additional characterisation of sediments and playa water samples recovered from a trial brine trench which had been established at Lake Disappointment in October 2017. The purpose of this work was to take account of new guidelines released by the Australian Government Department of Agriculture and Water Resources (Sullivan et al. 2017) in August 2017 (after Reward had completed its baseline assessment of playa sediments). The locations from which trench sediment samples were recovered are shown in Figure 2-34.

A summary of the testing conducted by Reward is provided in Table 2–5. This work was subsequently reviewed by an independent specialist, Galt Environmental (Appendix G1).

[4] MBOs are materials high in iron sulfides that form in organic-rich, low-oxygen environments. They are of environmental concern because they can react with oxygen and release acidity and metals when exposed to air.

Figure 2-33: Soil sampling locations, superimposed over ASRIS risk map



Note: ASRIS data sourced from http://www.asris.csiro.au/mapping/viewer.htm

Figure 2-34: Locations of trial trench sediment samples (March 2018)

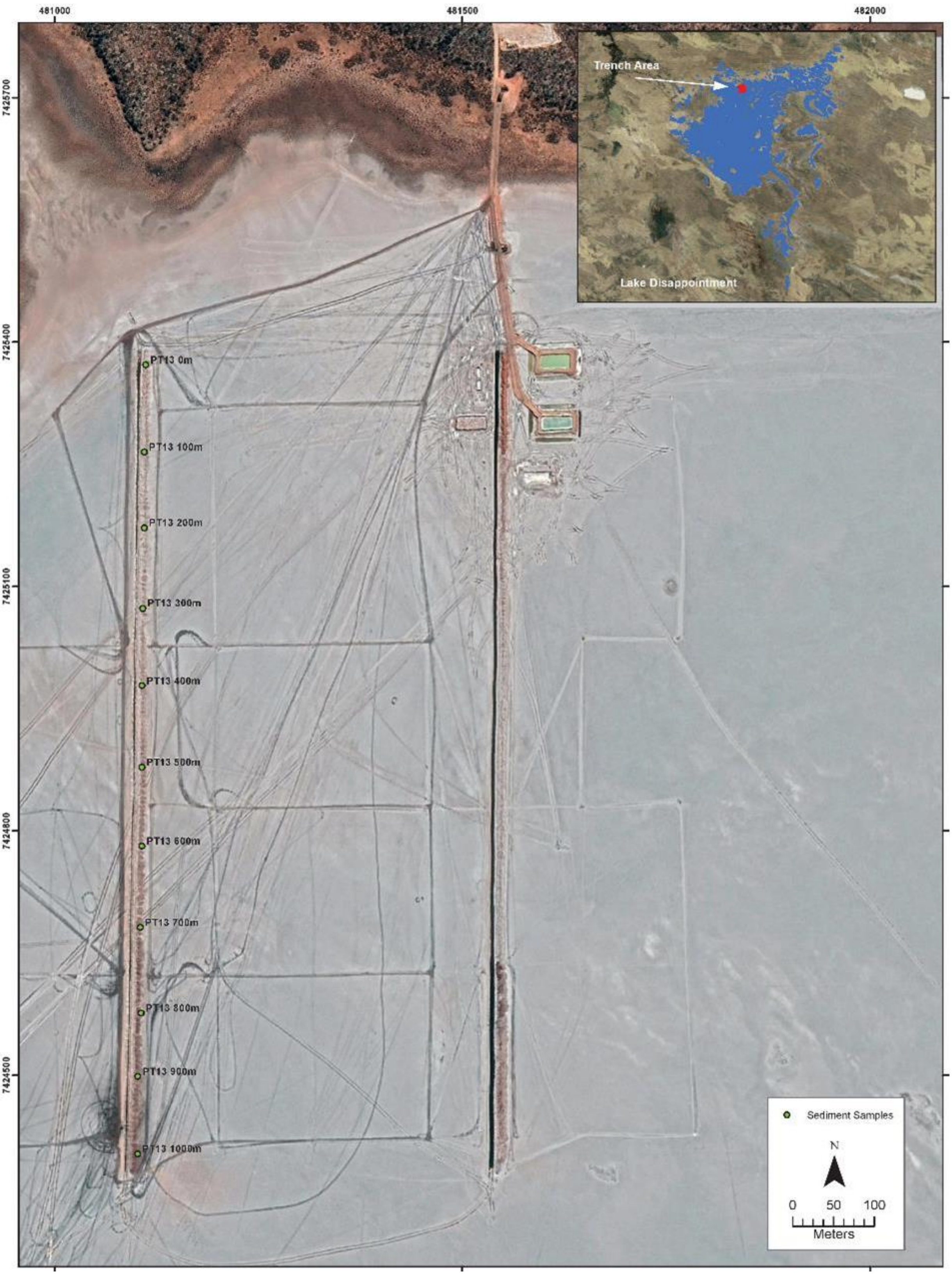


Table 2–5: Soil testing program – acid sulfate soil assessment

Date	Lab report No	Testing completed
5 & 8 May 2015	EP1503424	58 sediment samples tested for pH_F and pH_{FOX}
	EP1503613	37 sediment samples selected (from previous 58) for SPOCAS testing
13 May 2015	EP1510121	10 inferred MBO samples tested for SPOCAS, AVS, metals
	EP1510119	SPOCAS testing
28 July 2015	EP1512437	7 inferred MBO samples tested for SPOCAS, AVS, metals
	EP1513284	Major and trace metal testing in DI water leachate
4 December 2015	EP1516756	49 sediment samples tested for pH_F and pH_{FOX}
	EP1600473	24 sediment samples selected (from previous 49) for SPOCAS testing
	EP1516755	5 inferred MBO samples tested for SPOCAS, AVS, metals
	EP1517110	3 inferred MBO samples analysed for total organic carbon
9 March 2016	EP1602579, EP1602950, EP1603245, EP1603512, EP1603713, EP1604017, EP1604205	3 bulk inferred MBO samples subjected to 9 week incubation testing
6 October 2016	EP1609409	15 samples tested for pH, chromium reducible S, organic carbon
22 March 2018	208454	14 samples of sediment from trial trenches tested for SPOCAS suite, CRS, AVS, metals and organic carbon; 5 trench water samples tested for pH, EC, major cations and anions and dissolved metals

The key findings of Reward's initial lake sediment testing program were:

- Lake sediment samples (including inferred MBOs) had field pH values ranging from pH 5.6 to pH 8.5. All values were well above the recommended assessment criterion of pH 4.0 (Figure 2-35 and Figure 2-36).
- Oxidised (pH_{FOX}) values for lake sediments (including inferred MBOs) ranged from pH 3.5 to pH 8.5, averaging approximately pH 6.2. The oxidised field pH of all samples was above the recommended assessment criterion of pH 3.0.
- Samples identified as MBOs tended to have lower oxidised pH values (pH_{FOX}), but their field pH values were not conspicuously different to those of other sediments (Figure 2-37).
- There was no clear trend in field pH of sediment with increasing depth (Figure 2-38). Samples showing a tendency towards lower pH when subjected to chemical oxidation were more common at very shallow depth (Figure 2-39).

- Bulk samples of inferred MBO material incubated over a nine-week period showed no clear trend towards a reduction in pH. The pHs observed during the incubation trial did not fall below recommended assessment criteria (Figure 2-40).
- All sediments tested (including inferred MBOs) recorded no 'actual acidity' or 'titrable peroxide acidity' above the analytical limit of reporting (0.005% S), indicating that the sediment's buffering/acid-neutralising capacity exceeds (or equals) the potential acidity from oxidation of sulphides (if any are present).

Figure 2-35: pH frequency and cumulative pH probability – non-MBO sediments

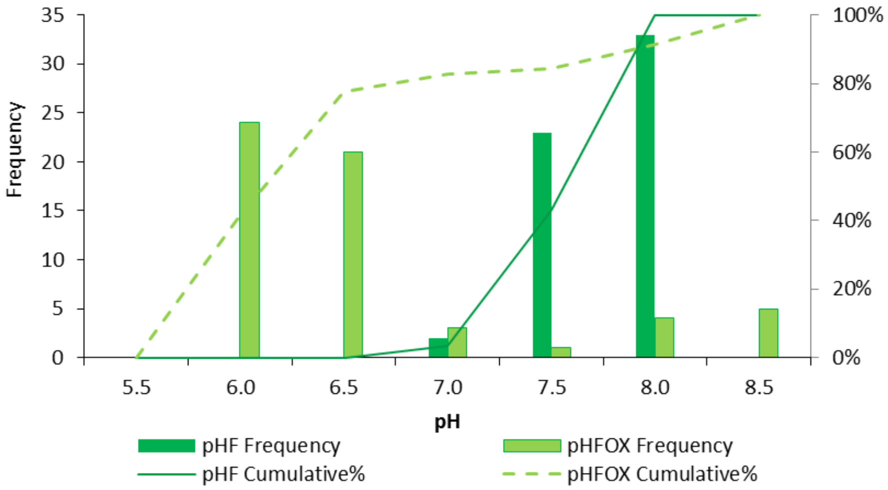


Figure 2-36: pH frequency and cumulative pH probability – inferred-MBO sediments

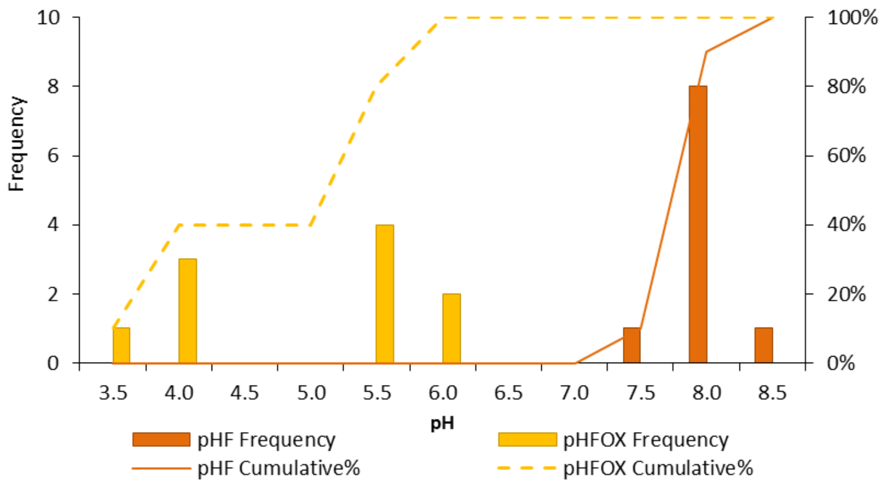


Figure 2-37: Oxidised field pH (pH_{FOX}) vs field pH, showing acid sulfate soil criteria

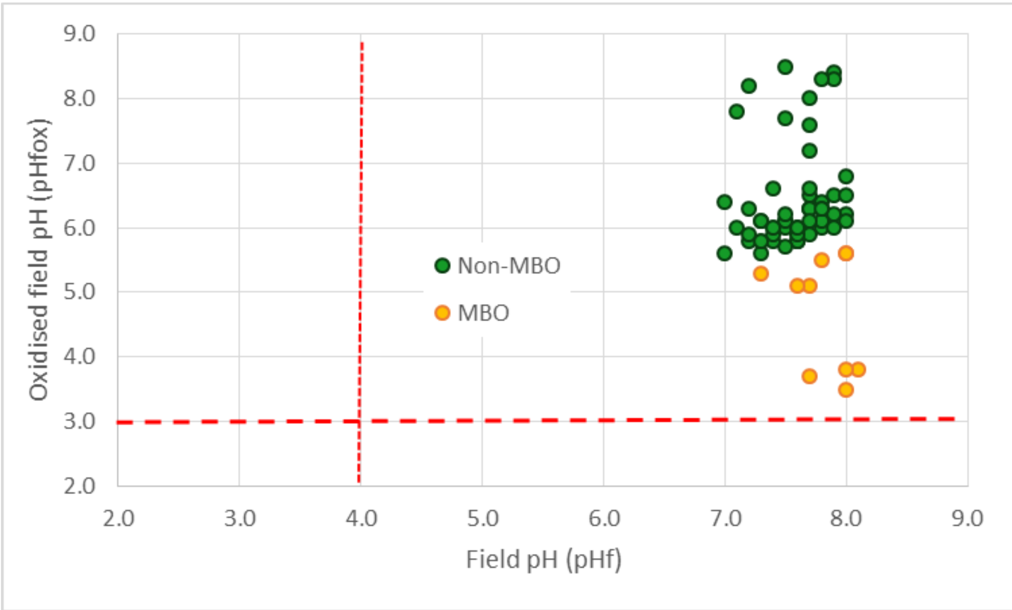


Figure 2-38: Field pH variation with depth (pH of trench water shown for comparison)

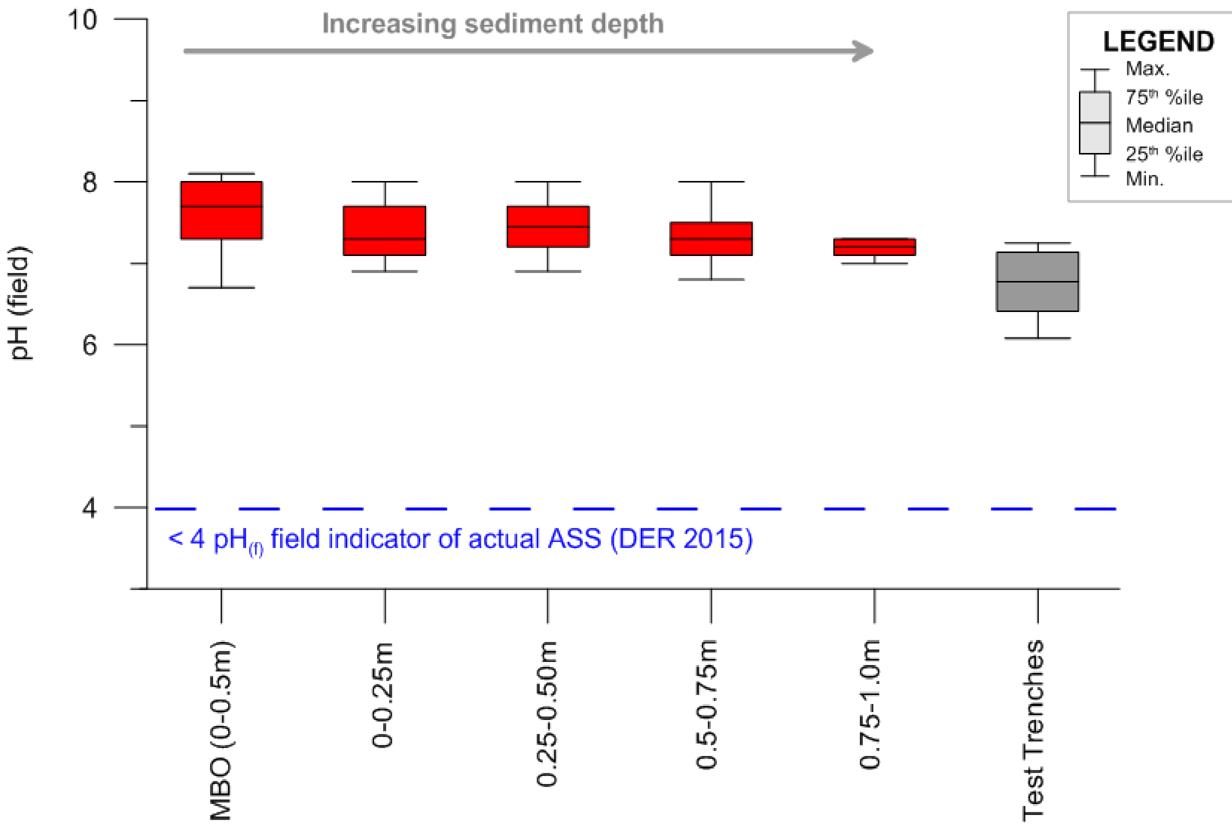


Figure 2-39: Oxidised pH variation with depth (pH of trench water shown for comparison)

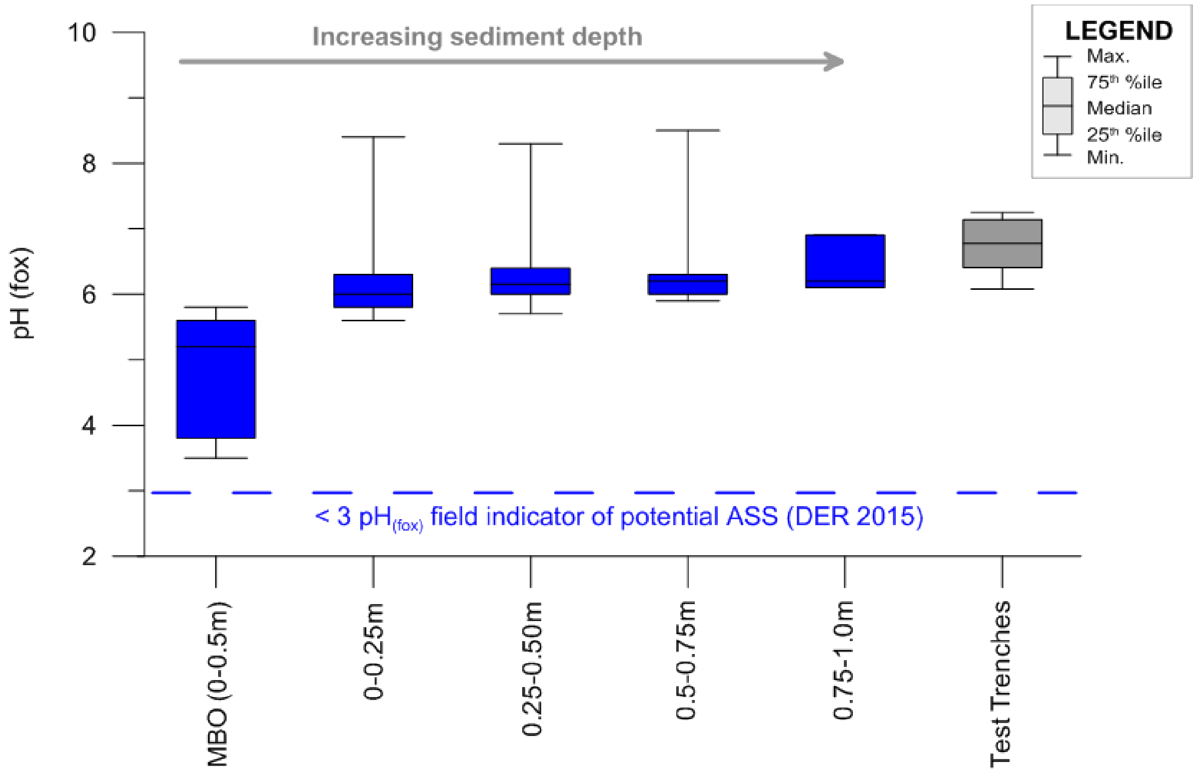
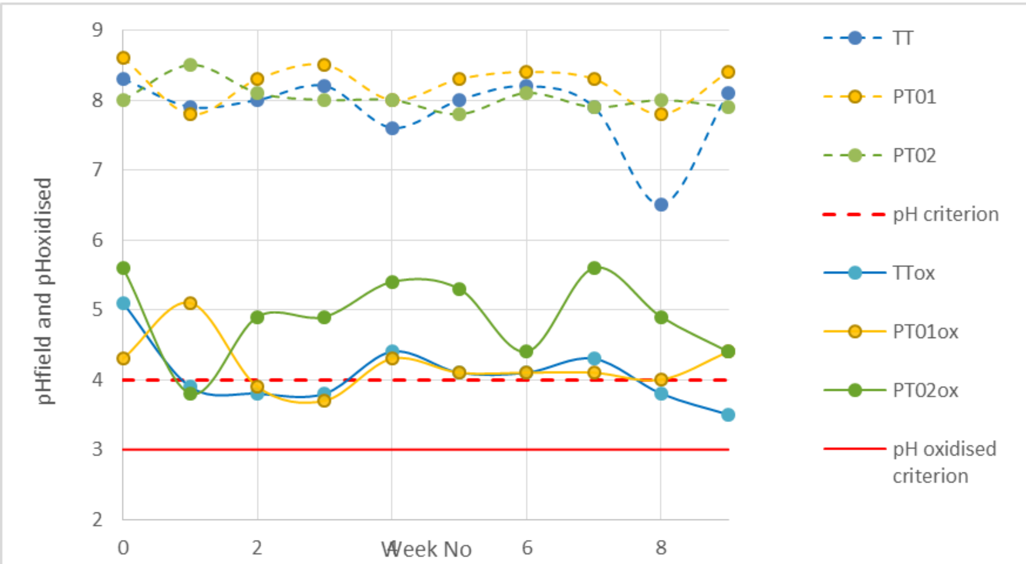


Figure 2-40: MBO incubation test results – oxidised and non-oxidised pH values



Following discussions with the Department of Environment Regulation (DER, now DWER), further analytical assessments were carried out on the inferred MBOs, including measurements of AVS and heavy metals in laboratory prepared leachates. Selected samples were also tested for chromium-reducible sulfur (CRS) and organic carbon, to check for possible over-estimation of sulfur risk. It is known that some of the standard tests used in acid-sulfate soil analyses are unreliable in the presence of high concentrations of gypsum and/or organic matter. The mineralogy of the sediments was also characterised by conducting X-ray diffraction analysis on the bulk inferred-MBO samples used in incubation trials. The results of this additional work are summarised as follows:

- Inferred-MBO samples were found to contain relatively low percentages of AVS, ranging from 0.01% S to 0.09%.
- Organic carbon concentrations in the inferred-MBO samples ranged from less than 0.5% to 1.4%, and averaged approximately 0.63%.
- Only one of 18 inferred-MBO samples tested for CRS (an indicator of the presence of sulphide minerals) contained CRS above the analytical limit of reporting of 0.005 mg/kg. The sample in which reducible sulfur was detected contained a concentration of 0.012% S.
- None of the metals analysed in the inferred-MBO samples (arsenic, cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, nickel, selenium, zinc) exceeded low level sediment quality guideline concentrations recommended by the CSIRO (Simpson et al. 2013). In the cases of arsenic, cadmium, lead, selenium and mercury, no sample contained total metal concentrations above the analytical limit of reporting.
- Water leachable metals were consistently low, with the exception of zinc. The concentrations of zinc in samples leached with deionised water ranged from 0.031 mg/L to 0.068 mg/L, averaging 0.042 mg/L. As there are no standard water quality criteria applicable to saline inland water bodies, Reward commissioned a specialist ecotoxicological assessment to evaluate the possible implications of water-soluble metals mobilised in fresh water (e.g. rainfall) in contact with lake sediments (Appendix G7). Results of the ecotoxicological assessment are described in Section 4.4.

Mineralogical testing of bulk inferred-MBO samples confirmed the presence of gypsum and other sulfate-salts and the absence of any significant quantities of oxidisable sulphide minerals. The X-ray diffraction testing showed that the sediment chiefly comprised quartz, sodium chloride (halite) salt and gypsum (Table 2–6).

MBOs were not identified in any sediment sample recovered from the trial brine trench in March 2018, six months after excavation. Laboratory analysis found no evidence of acid generating material in sediments from the trial trench. Water samples from the trenches exhibited no evidence of acidification as the result of MBO mobilisation. Results of laboratory testing on trench sediments and water are provided in Appendix G5.

Overall, the results of baseline investigations on sediments of the Lake Disappointment playa and on spoil from trial brine trenches indicate a low risk of impacts associated with acid sulfate soils. The samples tested—including those provisionally classified as MBOs—contain no actual acidity and have a significant acid neutralising capacity. They are also low in trace metals, when compared with sediment quality criteria recommended by the CSIRO (Simpson et al. 2013). Where materials having the visual appearance of MBOs are present, they exist in very thin, discontinuous layers (typically less than 40 mm, and averaging approximately 6 mm) and are surrounded by non-MBO sediments with substantial neutralising capacity. The independent review of acid sulfate soil risk (Appendix G1) also concluded that acid sulfate soil risk at Lake Disappointment is low.

Table 2–6: Mineral composition of inferred-MBO sediment

Mineral ID	Chemical formula	Mass %		
		TTMBO	PT01 MBO	PT02 MBO
Alpha quartz	SiO_2	72	19	68
Halite	NaCl	9	45	22
Gypsum	$CaSO_4{\bullet}2(H_2O)$	6	25	0
Bassanite	$2CaSO_4{\bullet}(H_2O)$	7	3	0
Glauberite	$Na_2Ca(SO_4)_2$	*3	*4	*4
Clay mineral		0	0	<1
Kaolinite	$Al_2Si_2O_5(OH)_4$	0	<1	3
Serpentine		0	1	<1
Clinochlore	$(Mg,Fe^{++})_5Al(Si_3Al)O_{10}(OH)_8$	0	1	1
Mica		<1	<1	1
K-feldspar - rutile - titanite	TiO_2-$CaTiSiO_5$	2	<1	1
Sodic and/or calcic plagioclase		*1	0	<1
Sylvite	KCl	<1	1	0

Note: * Mass percentage may be slightly underestimated

2.6.3 Biogeographic context

The proposed Lake Disappointment Potash Project lies within the Fortescue Botanical District and Keartland Botanical District of WA. The Fortescue Botanical District consists of predominantly tree and shrub-steppe communities with *Eucalyptus* trees, *Acacia* shrubs and *Triodia* species. Some mulga occurs in valleys and there are short-grass plains on alluvia (Beard 1990). The Keartland Botanical District consists predominantly of shrub steppes of *Acacia* and *Grevillea*, and *Triodia* spp. on dunes and swales. Patches of desert oak and mulga also occur within the area (Beard 1990).

Based on the Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (DotEE, 2012), the Lake Disappointment project is located within the Pilbara Bioregion and Little Sandy Desert Bioregion of WA (Figure 2-41). These IBRA Regions are further divided into subregions:

- Chichester (PIL1) and Fortescue Plains (PIL2) subregion of the Pilbara Bioregion[5]; and
- Rudall (LSD1) and Trainor (LSD2) subregion of the Little Sandy Desert Bioregion[5, 6].

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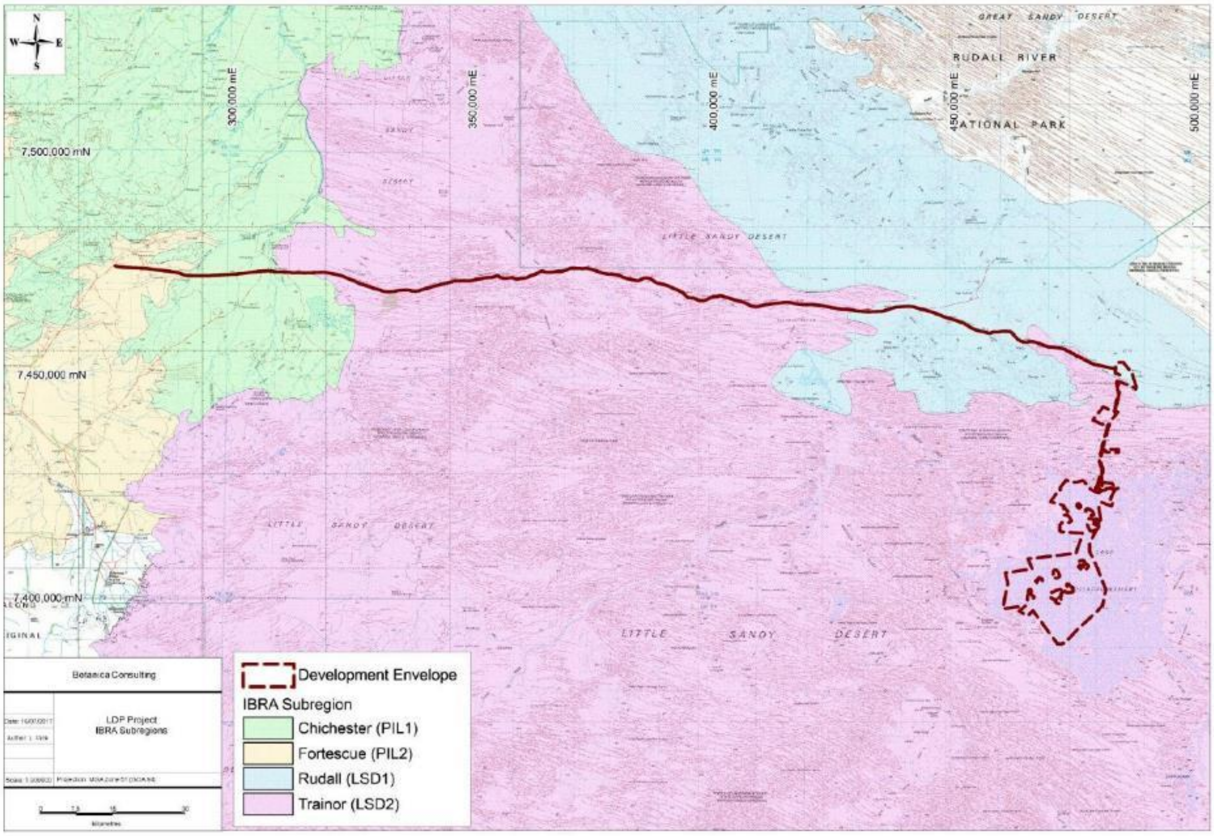
[5] Subregions traversed by the proposed access/haul road
[6] Subregions intersected by the proposed mine operations area

The vegetation of the Rudall subregion typically comprises sparse shrub-steppe over spinifex (*Triodia basedowii*) on stony hills, with river gum communities and bunch grasslands on alluvial deposits in and associated with ranges (Kendrick, 2001a). The vegetation of the Trainor subregion is characterised by shrub steppe of *Acacia*, *Aluta maisonneuvei* and *Grevillea* over spinifex (*Triodia schinzii*) on sandy surfaces. Vegetation also includes sparse shrub-steppe over *Triodia basedowii* on stony hills, with *Eucalyptus* and coolibah communities and bunch grasslands on alluvial deposits and drainage lines associated with ranges (Cowan & Kendrick 2001).

Figure 2-41: IBRA bioregions and subregions (with development envelope)



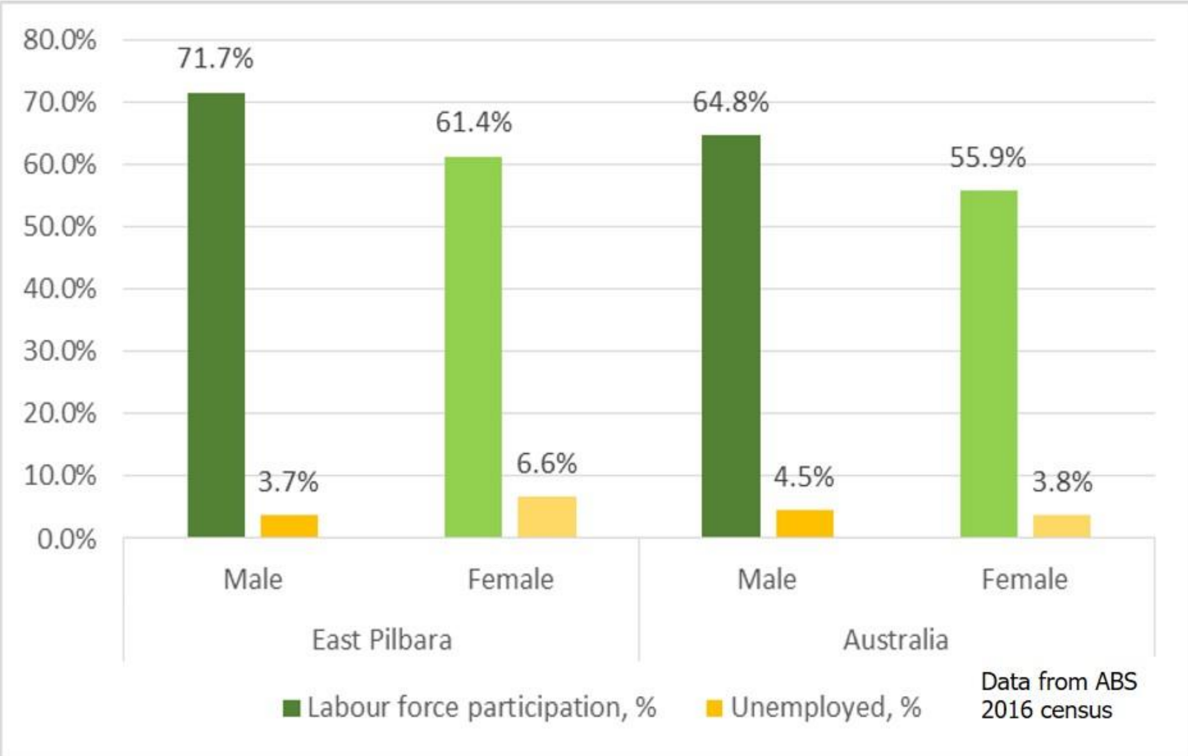
2.6.4 Social and cultural setting

Lake Disappointment lies partly within the Shire of East Pilbara and partly within the Shire of Meekatharra. Effectively all support infrastructure for the Lake Disappointment Potash Project will be developed in the Shire of East Pilbara. The shire covers an area of approximately 380,000 km^2 and has an estimated total population of around 25,055 people (not including fly-in fly-out workers) (ABS 2016). At the 2016 census, approximately 18% of the shire population identified as Aboriginal or Torres Strait Islander people.

In 2016, the mining sector was by far the largest employer in the East Pilbara area, accounting for over 40% of employed people (compared with 1.66% employment in the mining sector for Australia as a whole). The next largest employment sectors in the East Pilbara in 2016 were transport, postal and warehousing (6.3%), health care and social assistance (6.0%) and construction (5.5%). In 2016, the unemployment rate in the shire was less than 4% for male workers (compared to 4.5% for Australia as a whole), but over 6.5% for female workers (compared to 3.8% for Australia as a whole). The labour force participation rate in East

Pilbara was higher for both men and women than comparable participation rates for Australia as a whole (Figure 2-42).

Figure 2-42: Labour force participation and unemployment – East Pilbara 2016

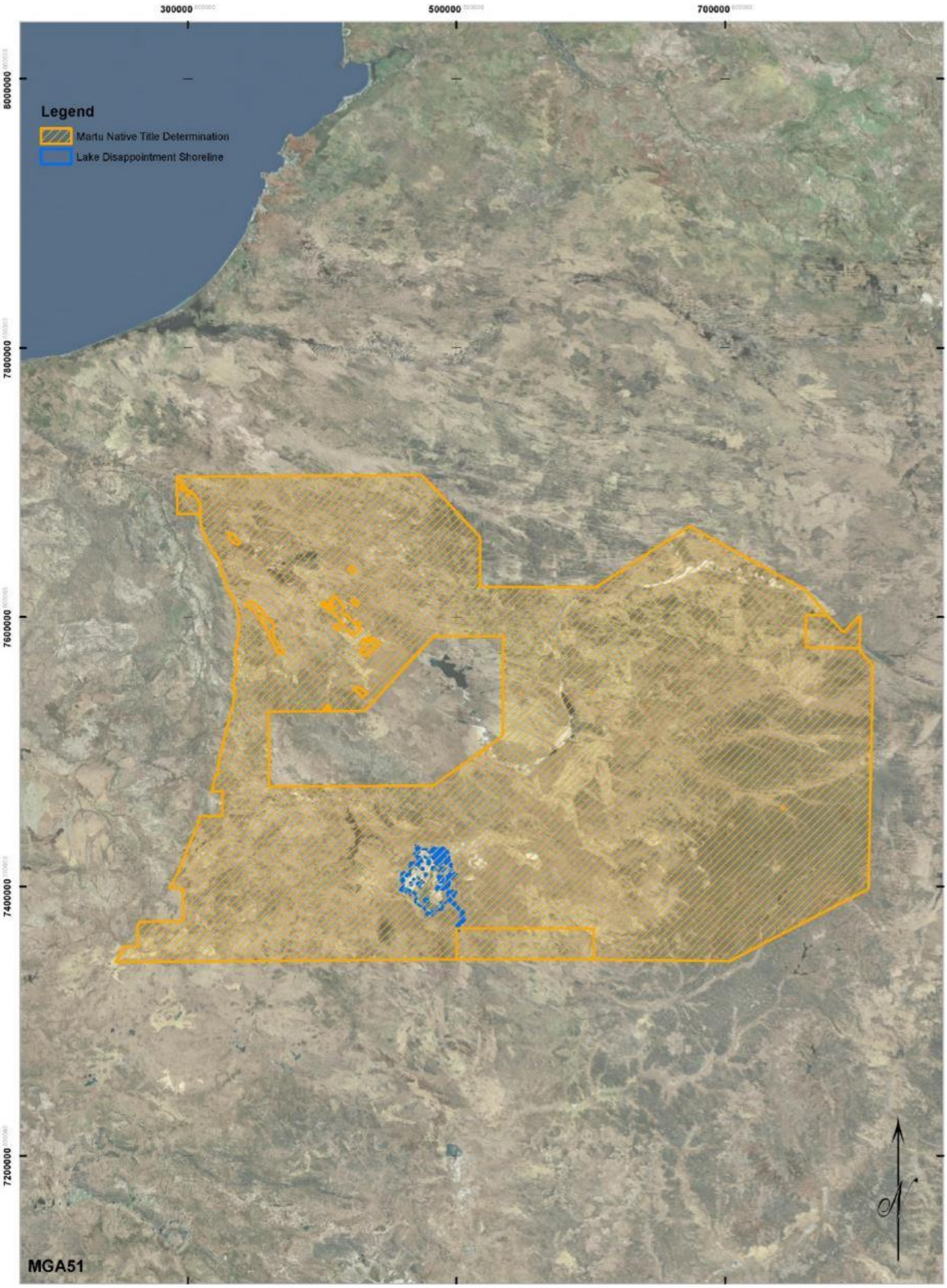


2.6.5 Land tenure and land uses

Land tenure in the project area is predominantly held by Aboriginal Traditional Owners. Pastoral leasehold land occurs to a very limited extent. Nearly the whole of the Lake Disappointment proposal (except for a very minor section of the proposed site access road) is located within the determined Native Title claim area held by the Martu People (Figure 2-43).

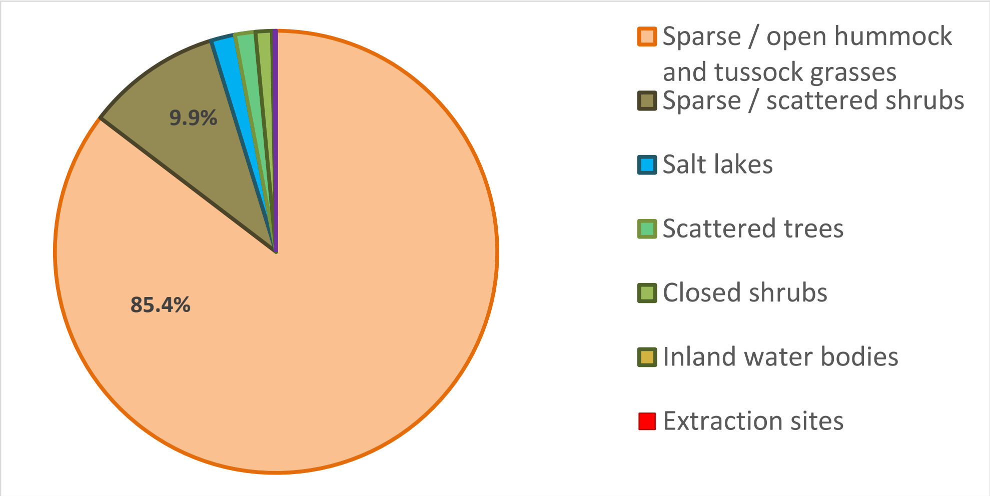
The proposal traverses land covered by the Shire of East Pilbara Town Planning Scheme No. 4 and Pastoral and Mining under layout plan LP2; accordingly, the proposal is not inconsistent with the objectives of the respective planning schemes.

Figure 2-43: Martu Native Title area (WCD2013/002)



At the time of the most recent comprehensive rangelands survey in 2008, it was estimated that only about 2% of the Little Sandy Desert bioregion (in which the project lies) is grazed. Land is mainly used for customary Aboriginal purposes and ecosystem services. Although mining and mineral exploration are by far the largest contributors to the regional economy, the proportion of land affected by mining disturbance is small (less than 0.05% of the Shire of East Pilbara) (Figure 2-44).

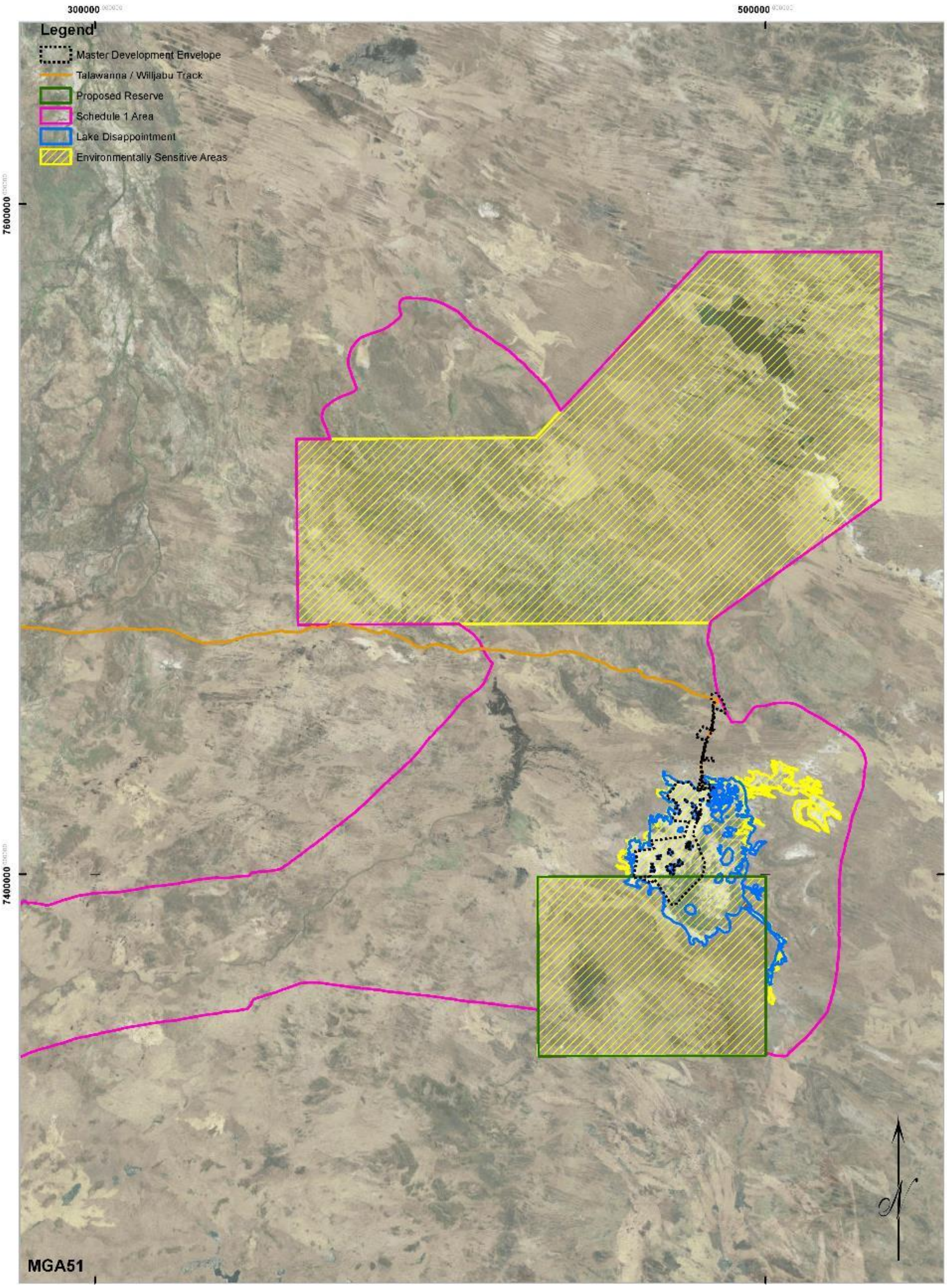
Figure 2-44: East Pilbara land cover (ABS 2008)



The extent of reserved land in the East Pilbara is relatively high: in 2014, some 6,442,200 ha, or approximately 16.5% of the land area of the Shire of East Pilbara, was protected in National Parks, Indigenous Protected Areas or other conservation reserves. However, the distribution of reserved land is uneven: 37.32% of the Little Sandy Desert Subregion 1 is reserved, while only 1.4% of Little Sandy Desert Subregion 2 is formally protected. The Lake Disappointment project area lies near the boundary of LSD1 and LSD2 (Figure 2-41).

Karlamilyi National Park (formerly Rudall River National Park), Western Australia's largest National Park, lies approximately 40 km north of the location proposed by Reward for its potash processing facility (Figure 2-45). The park encompasses more than 1.5 million hectares and is managed by the DBCA. The park includes the Lake Dora (Rudall River) System, a Nationally Important Wetland. The area encompassed by the Karlamilyi National Park is not included in the land granted to the Martu Traditional Owners under Native Title determination WCD2013/002.

Figure 2-45: Special land categories near Lake Disappointment



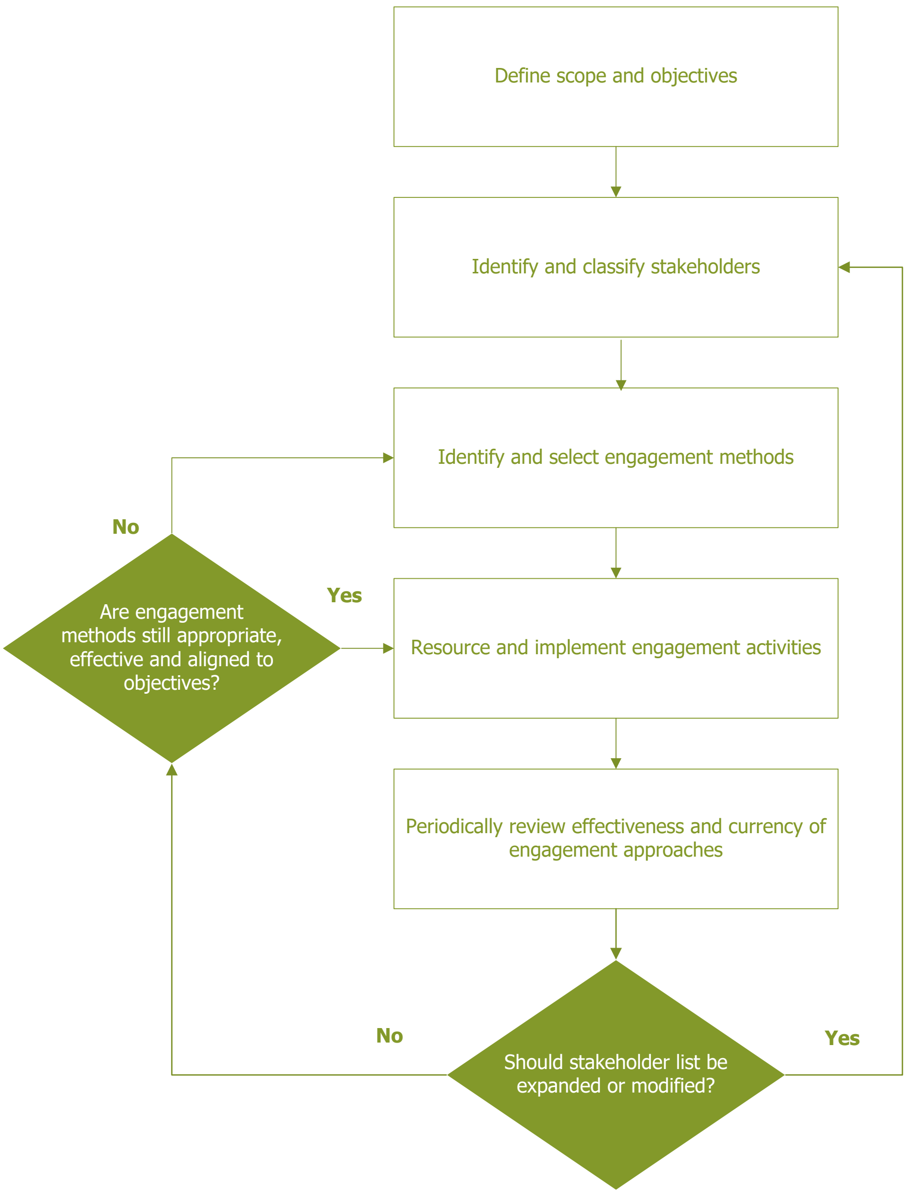
3 STAKEHOLDER ENGAGEMENT

3.1 Stakeholder engagement process

The process adopted by Reward for stakeholder engagement is illustrated diagrammatically in Figure 3-1. The overarching engagement objectives identified by Reward for the Lake Disappointment project include:

- Provide information
- Satisfy statutory requirements
- Establish and maintain relationships
- Identify concerns/issues
- Obtain input into options identification/project design.

Figure 3-1: Stakeholder engagement process



Throughout its stakeholder engagement activities, Reward has consciously chosen to adopt methods involving direct communications with stakeholders, avoiding working through third parties where practicable. This approach was selected as a matter of respect (i.e. to convey a sense of equal standing between stakeholders and the proponent) and also to support the objective of establishing an enduring and constructive relationship between the Company and stakeholders.

A range of consultation methods were used, ranging from relatively informal one-on-one verbal communications to very formal, documented legal negotiations. For the convenience of stakeholders, much of the engagement activity was conducted in regional locations near the proposed project location. Reward has deliberately emphasised engagement with stakeholders in regional areas, as these individuals, communities and organisations are more likely to be directly affected by project implementation (or by refusal of project consents).

Reward has and will continue to undertake a proactive communication, engagement and consultation program with its stakeholders, government and the broader Pilbara community. Reward has engaged stakeholders in the planning process, in the interests of achieving a collaborative approach and to ensure that local knowledge and conditions are considered in the design and management of Lake Disappointment Potash Project.

Initial stakeholder consultation commenced in 2006 with the introduction of the project to the Martu Traditional Owner group and visits to the Lake Disappointment site. A land access agreement was executed and exploration activities undertaken resulting in the definition of a significant resource of SOP in Lake Disappointment in 2007.

Subsequent engagement with the Martu Traditional Owners via the Western Desert Lands Aboriginal Corporation (WDLAC) resulted in execution of an ILUA in 2012 setting out the terms and conditions applicable to development of the Lake Disappointment Potash Project from the Martu People's perspective.

Following execution of the ILUA, Reward proceeded with further exploration and the developmental aspects of the project which led to communications with other stakeholders potentially involved in the project development.

3.2 Identification of stakeholders

Reward's stakeholders are those people and organisations who have an impact on, or who are impacted by, the project's development, operations and activities. Reward has defined 'external stakeholders' as people or organisations who have one or more of the following characteristics:

- Are affected by or affect a particular issue;
- Are responsible for managing or responding to issues;
- Have knowledge needed to develop good solutions or strategies; or
- Have the ability and resources to either block or implement solutions.

'Key stakeholders' are those external stakeholders whose approval and/or input is essential for the project to be implemented and achieve its full set of objectives. They include:

- Traditional Owners (Martu People)
- Local government (Shire of East Pilbara)

- State regulators and statutory authorities:
  - EPA
  - DMIRS
  - DBCA
  - DWER
  - Department of Planning, Lands and Heritage (DPLH, formerly DAA)
  - Department of Primary Industries and Regional Development (DPIRD, formerly DAFWA)
- Australian Government Department of the Environment and Energy.

These and other stakeholders identified as having or likely to have an interest or role in the social and/or environmental impact of the project are listed in Table 3–1.

Reward acknowledges conservation groups, individual researchers, regional service providers and the general public as stakeholders in the project. The Company has engaged with such groups and individuals where the opportunity has arisen. For these stakeholders, Reward has generally taken the approach that the Environmental Impact Assessment processes administered by the OEPA (now part of DWER) provides an adequate framework within which to elicit feedback on aspects of the Lake Disappointment proposal of specific interest to those stakeholders.

Project shareholders, investors, employees and customers have not been included as key stakeholders for the purpose of the stakeholder consultation on environmental aspects of the project, although they are clearly key stakeholders for the overall project development.

Table 3–1: Stakeholders of Lake Disappointment Potash Project

Stakeholder category	Organisation	Key interests
Tradition owners and representative bodies	Martu People (WDLAC) Niyiyaparli People (YMAC)	• Access to and use of Traditional Owner land; Native Title rights • Cultural heritage values • Indigenous rangers • Employment, business opportunities • Land management (weeds, feral animals, fire) • Water abstraction and use and impacts
Local government, Port authorities	Shire of East Pilbara Pilbara Ports Authority Mid West Ports Authority	• Use of public roads and infrastructure • Use of Port Hedland facilities • Use of Geraldton Port facilities • Employment, business opportunities • Compliance with port environmental licence conditions

Stakeholder category	Organisation	Key interests
State government	Office of the Environmental (OEPA) Protection Authority	• Administers Part IV of the EP Act Environmental Impact Assessment
	Department of Planning, Lands and Heritage (DPLH formerly DAA)	• Administers *Aboriginal Heritage Act 1972* • Aboriginal heritage and cultural, ethnographic and archaeological sites
	Department of Mines, Industry Regulation and Safety (DMIRS formerly DMP)	• Administers the *Mining Act 1978*, *Mines Safety and Inspection Act 1994*, *Mining Rehabilitation Fund Act 2012* • Tenement conditions • Mining proposals, programs of work • Mine closure planning and mining rehabilitation fund • Safety in the resources sector
State government	Department of Water and Environment Regulation (DWER formerly DOW and DER)	• Administers RIWI Act, *Contaminated Sites Act 2003*, Part V of the EP Act, including industry regulation and licensing • Pollution control and waste management • Inland water quality and water allocation
	Department of Biodiversity, Conservation and Attractions (DBCA formerly DPaW)	• Administers *Wildlife Conservation Act 1950* (WC Act) and *Biodiversity Conservation Act 2016* • Flora, fauna and habitat conservation • Management of conservation reserves and other protected areas
	Department of Health	• Environmental health, building and planning compliance
	Main Roads Western Australia	• Use of public roads (Great Northern Highway etc.)
	Department of Transport Department of Primary Industries and Regional Development Pilbara Ports Authority Pilbara Development Commission Pilbara Regional Council	• Transport policies, road safety, vehicle licencing • Royalties for Regions funding, remote area service delivery • Management and use of Port of Port Hedland • Business development – Pilbara region • Planning advice and assistance for project developers in the Pilbara region

Stakeholder category	Organisation	Key interests
Australian Government	Department of the Environment and Energy (DotEE)	• Administers EPBC Act • Environmental impact assessments for Matters of National Environmental Significance
Emergency services	Department of Fire & Emergency Services (DFES) Royal Flying Doctor Service	• Emergency response & management (fire, cyclone, road accidents, etc.) • Remote area health care and medical emergency services
Pastoralists	Balfour Downs Station Ethel Creek Station	• Project interaction with pastoral activities • Land management (weeds, feral animals, fire) • Access road management • Water abstraction and use and impacts • Post mining land use
Non-government organisations, including environmental interest groups	Australian Conservation Foundation Australian Wildlife Conservancy Birdlife Australia Conservation Council of Western Australia (CCWA) The Wilderness Society Wildflower Society of Western Australia WWF Australia	• Impacts on flora and fauna, particularly species of conservation significance • Impacts of water abstraction and use • National heritage values • Visual amenity of mine site area • Impacts on tourism • Post mining land use and rehabilitation

3.3 Stakeholder consultation

A summary of stakeholder consultation conducted to date is provided in Appendix C. In accordance with EPA guidelines, generic discussions with decision-making authorities are not included in the table.

Engagement with stakeholders will continue throughout the project assessment and permitting phase and into the construction and operational stages of the project. This ERD provides a wide range of stakeholders with an opportunity to provide comment on the proposal. Reward's responses to stakeholder submissions will be documented in the final ERD.

Prior to the commencement of any on-ground works, Reward proposes to implement a Community and Stakeholder Engagement Program, which would include the establishment of a Community Environmental Consultative Committee (subject to interest from local stakeholders). The purpose of this engagement program would be to ensure effective communications between project operators and stakeholders, so that the Company can be made aware of any project-related issues of concern to the community and so that stakeholders have access to timely and accurate information about the project. The engagement program will include establishment of:

- An environmental consultative committee to meet four-monthly with Reward;
- A stakeholder consultation register that documents stakeholder communications (emails, meetings, correspondence, telephone calls), noting issues raised and any actions items or commitments made by Reward in response to stakeholder comments;
- A project website, providing the general public with project updates and reporting on environmental performance and compliance matters; and
- A program of occasional events to consolidate Reward's position in the East Pilbara community (may include participation/sponsorship of community events, presentations to local government or communities, site visits, collaboration with visiting scientists).

A summary of ongoing stakeholder consultation to be undertaken by Reward is provided in Table 3–2.

Table 3–2: Proposed ongoing consultation

Stakeholder	Consultation requirements
Martu People/Western Desert Lands Aboriginal Corporation	Pre-commencement heritage surveys; cultural awareness training for project participants; advice on 'caring for country' work; input to rehabilitation and closure planning; regular review of compliance with ILUA, consultation during construction & operations phase regarding business and employment opportunities
East Pilbara community	Ongoing consultation during construction and operations phases concerning business and employment opportunities; general project updates; notifications of road works and other project-related activities
EPA/OEPA	Statutory reporting post-assessment
DBCA	Consultation concerning environmental management plans and monitoring regimes; biodiversity offsets; project traffic along Talawana Track where it traverses Karlamilyi National Park
DMIRS	Land access/tenure for mining and related infrastructure; mining proposal; mine closure & rehabilitation planning and implementation; statutory reporting
DWER	Permitting of 'prescribed activities'; authorisation to take groundwater; statutory reporting
Shire of East Pilbara	Use, maintenance and upgrade of road infrastructure; communicate as required regarding activities administered by the shire (building permits, sanitation/waste management)
Environmental and conservation groups	Engagement on: biodiversity offsets, environmental compliance and performance, biodiversity research, closure and rehabilitation design & implementation

4 ENVIRONMENTAL PRINCIPLES AND FACTORS

4.1 Environmental protection and management principles

The object of the EP Act is to protect the environment of Western Australia, having regard principles listed in Section 4A of the Act. Similar principles of environmental protection are also identified in Section 3A and Section 391 of the Australian Government EPBC Act. The EPBC Act includes an additional principle that stipulates that:

> *'decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations'.*

Table 4–1 summarises how Reward has considered these principles in the design and proposed management of the Lake Disappointment Potash Project.

Table 4–1: Environmental protection principles (EP Act)

Environmental principle	Application to Lake Disappointment project
Precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of this precautionary principle, decisions should be guided by: a) Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and b) An assessment of the risk-weighted consequences of various options	Reward has used a risk-based approach in scoping environmental investigations and in the assessment of project options. Where a screening level of assessment identified the potential for serious or irreversible adverse impacts, or where significant knowledge gaps were identified, Reward commissioned specialist investigations to reduce uncertainty and provide an objective basis upon which to assess project impacts. Where appropriate, more than one investigation was completed in order to provide multiple lines of evidence for the assessment of potential impacts. Independent reviews have been conducted where impacts assessment was technically complex or potentially contentious. • Level 2 flora and fauna surveys undertaken for both the mine development area and the Talawana Track (access/haul road) • Surface water investigations were completed to assess potential impacts of development on hydrological processes • Groundwater investigations were completed for brine abstraction from playa sediments • Groundwater investigations were carried out to assess potential impacts of abstracting water from the proposed Cory and Northern process water borefields • Investigation of potential acid sulfate soils was completed, along with ecotoxicological assessment of potential impacts of project implementation on invertebrate and vertebrate fauna • Targeted investigations (root architecture, seasonal plant response to water availability, vegetation health surveys) were completed to inform assessment of potential project impacts on groundwater dependent vegetation (if present) • Subterranean fauna investigations were carried out to assess potential impacts of water abstraction from the Cory and Northern Borefields

Environmental principle	Application to Lake Disappointment project
	• Targeted studies of vertebrate and invertebrate lake biota were carried out over two wet seasons to characterise the wetland values of Lake Disappointment • Heritage surveys were carried out in consultation with Traditional Owners to identify culturally significant places before implementing exploration activities. Further surveys are proposed within the project development envelope prior to the commencement of ground-disturbing works. Where investigations identified the potential for significant adverse environmental impacts, the project design was modified to avoid or reduce potential adverse impacts, where reasonably practicable. Management measures have been developed to further reduce the risk of serious or irreversible harm to the environment.
Principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Reward has considered the possible impacts of its proposal both during construction and operations and long after project completion. The Company has committed to the implementation of a mine closure and rehabilitation plan to achieve acceptable environmental outcomes in the post-closure period. The definition of closure criteria will be developed in consultation with key stakeholders, especially the Traditional Owners of the Lake Disappointment area.
Principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Reward has resourced detailed biological studies of the project area, starting in October 2012. Surveys of flora and fauna were undertaken over a significantly larger area than is proposed to be disturbed, in order to provide contextual information for understanding of the ecological context of predicted impacts. Both direct and indirect impacts have been considered. A range of management and monitoring strategies have been developed to enable verification of the measures proposed by Reward to limit impacts on biological diversity and ecological integrity.
Principles relating to improved valuation, pricing and incentive mechanisms a) Environmental factors should be included in the valuation of assets and services. b) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. c) The users of goods and services should pay prices based on the full life cycle costs of providing goods and	Reward is mindful of its obligations under the *Mining Act 1978*, the EP Act and the *Contaminated Sites Act 2003* to minimise environmental harm and pollution and to rectify adverse impacts associated with project implementation so that at project completion the land formerly used for mining is left in a safe, stable and non-polluting condition, capable of supporting beneficial uses (including ecosystem support). The preliminary estimates of mine rehabilitation and closure costs will be reviewed on a regular basis and the results of these cost reviews will inform the Company's provisioning practices. Reward acknowledges that such costs form part of its production costs. Reward has sought to link commercial goals with environmental goals, to provide strong incentives to achieve target outcomes. During detailed design and project implementation, the project will actively seek to: • Minimise use of petroleum-based fuels

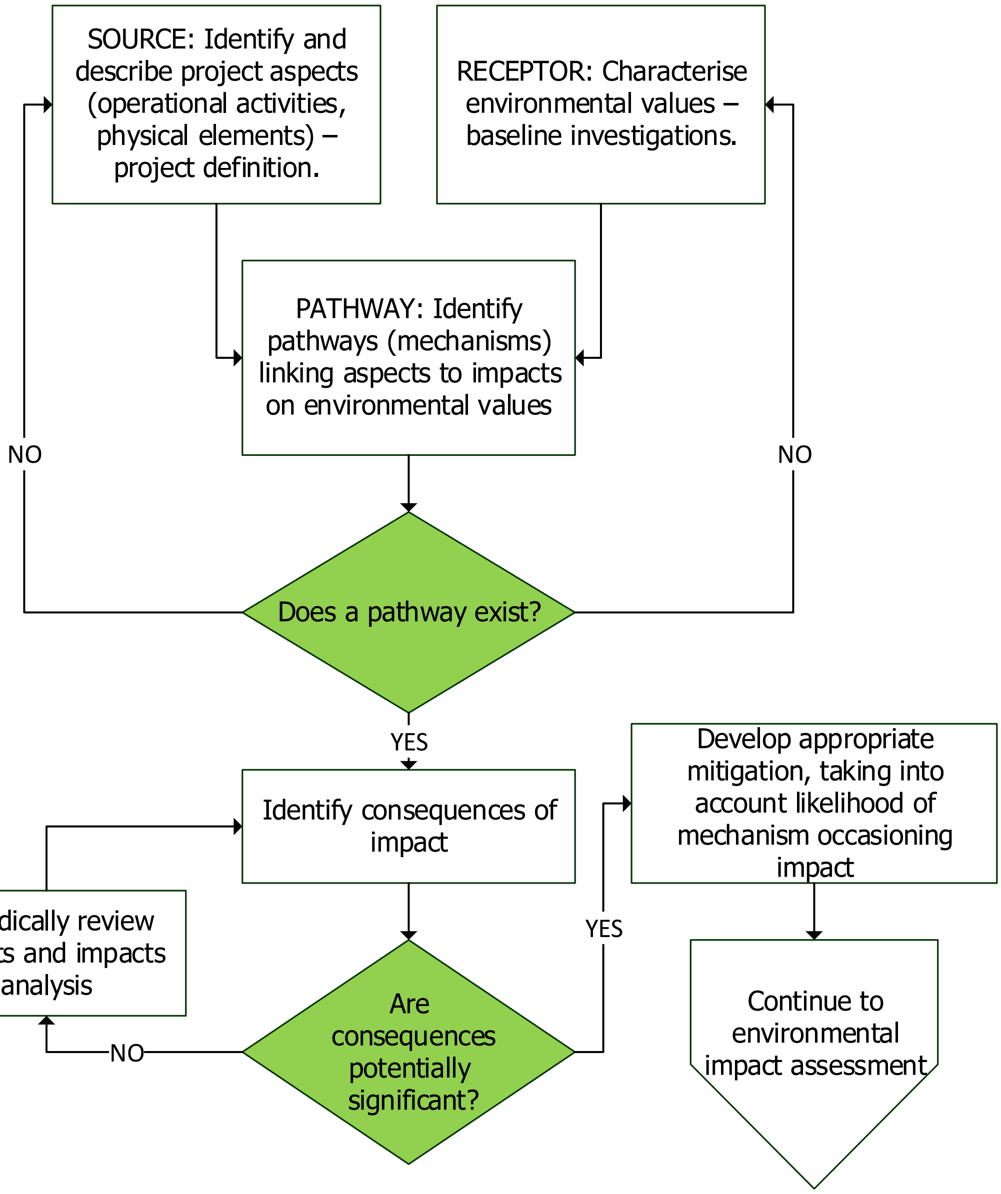
Environmental principle	Application to Lake Disappointment project
services, including the use of natural resources and assets and the ultimate disposal of any wastes. d) Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	• Minimise use of low salinity water • Minimise land disturbance, especially in or near areas identified as having higher ecological or cultural values. These metrics will be monitored throughout project implementation, including during procurement, construction, operations and closure.
Principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Reward will implement the waste hierarchy of: • Avoid • Reduce • Reuse • Recycle • Recover • Treat • Dispose. Examples that will be adopted during project implementation include: • Recycling of end brine from the process plant to improve efficiency of SOP recovery • Periodic refurbishment of halite ponds and disposal of halite byproduct in dedicated stockpiles to minimise the footprint required for halite storage • Re-use of topsoil and cleared vegetation to rehabilitate areas disturbed during project implementation • Disposal of putrescible wastes in a purpose-built onsite landfill • Importing chemicals and fuels in bulk and requiring return of packaging to suppliers where practicable.

4.1.1 Assessment framework

Reward has used a risk-based framework to assess potential impacts of project implementation on key environmental factors nominated by the EPA. To assess potential impacts, Reward used an iterative source-pathway-receptor conceptual framework (Figure 4-1) aligned with the approach recommended in EPA's EAG 9 significance framework (EPA 2015). Details of the risk events considered by Reward are presented in Appendix L2.

The assessment framework used in this ERD took into account EPA objectives for factors nominated as 'key factors' for the Lake Disappointment proposal, as set out in the approved project scoping document (Appendix A) and described in EPA's *Statement of Environmental Principles, Factors and Objectives* (EPA, 2016j).

Figure 4-1: Source-pathway-receptor logic used in impact assessment



The EPA identified the following 'preliminary key environmental factors' for the Lake Disappointment Potash Project:

- Flora and vegetation
- Terrestrial fauna
- Subterranean fauna
- Hydrological processes
- Inland waters environmental quality

- Heritage
- Offsets
- Rehabilitation and decommissioning.

Guidelines released in December 2016 have slightly modified some of the key factors used by the EPA in its impact assessment framework. Accordingly, this ERD has addressed heritage considerations under the heading 'Social surroundings'. Offsets and rehabilitation and decommissioning are no longer considered as standalone factors. Instead, offsets and rehabilitation are discussed where relevant and appropriate under the other key factor headings.

4.1.2 Reward environmental management framework

Reward's environmental management framework has evolved from a Conservation Management Plan (CMP) developed in consultation with the then Department of Parks and Wildlife (DPaW) and DMIRS to guide exploration activities near Lake Disappointment. The CMP is a risk-based management tool used to avoid and mitigate adverse impacts on flora, fauna and vegetation. It was developed to reflect recommendations in draft guidelines issued by the (then) Department of Environment and Conservation (DEC) in 2010 and is structured around the plan-do-check-act model that underpins the current Australian standard for environmental management systems (AS/NZS ISO 14001:2016).

As the project moves into detailed design and construction, the CMP will be replaced initially by a Construction Environmental Management Plan (CEMP) and subsequently by an Operational Environmental Management Plan (OEMP). The purpose of all the environmental management plans is to provide strategic management frameworks for delivering the objectives set out in Reward's environmental policy, a copy of which is provided in Appendix L1. The overarching environmental strategies articulated in the CEMP and the OEMP will be supported by the implementation of specific subplans, as follows:

- Water management plan (and groundwater operating strategies approved by DWER)
- Fauna management plan
- Subterranean fauna management plan
- Flora and vegetation management plan
- Mine closure and rehabilitation plan
- Cultural heritage management plan
- Compliance management plan.

These subplans, and the subordinate management tools associated with them (procedures, forms, checklists, etc), will provide a practical and verifiable system to guide environmental practices to deliver the environmental commitments made in this ERD (Table 4–2) and to achieve compliance with legally binding conditions imposed through the Ministerial Statement and other regulatory instruments.

Environmental management plans for fauna management and subterranean fauna management were required under the ESD approved for the Lake Disappointment project. Reward has prepared draft management plans for terrestrial fauna and subterranean fauna using templates developed by the EPA. The draft plans are presented in Appendices L3 and L4. A draft mine closure plan is provided in Appendix K. Table 4–2 summarises the key management and mitigation measures under each environmental factor described in Sections 4.2 through 4.8.

Table 4–2: Summary of environmental factors, objectives and commitments

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
Flora and vegetation			
To protect flora and vegetation so that biological diversity and ecological integrity are maintained	Each of the 14 vegetation types in the survey area retains more than 99% of its original pre-European extent. Vegetation condition ratings range from 'poor' to 'very good'. One introduced species, *Cenchrus ciliaris* (buffel grass), was identified in six vegetation types within the survey area. No threatened flora species, vegetation assemblages or ecological communities recognised under the EPBC Act were recorded during baseline surveys of the Lake Disappointment project area. No Threatened Ecological Communities (TEC) or Threatened Flora listed under the EP Act and WC Act have been recorded within the project development envelope or the proposed disturbance footprint. No Priority Ecological Communities (PEC) as listed by the DPaW (now DBCA) were recorded within the development envelope/disturbance footprint. Two vegetation type were identified as being of possible conservation significance: Heath of mixed *Tecticornia* spp. on salt lake edge (CD-CSSF1), and	No material impact to the extent of any vegetation type at either local or regional scale as a result of proposed clearing. No conservation significant *Tecticornia* have been recorded within the project's proposed disturbance footprint and very few have been recorded in the project development envelope, compared to the number recorded outside the project envelope during baseline surveys. Project implementation will not significantly impact occurrence of conservation-significant *Tecticornia* species (less than 0.5% loss of local population of novel or priority *Tecticornia*). There is no evidence of groundwater dependent vegetation presence in the zone of influence of water abstraction from the proposed Cory Borefield. *Eucalyptus* woodland near the McKay Creek and associated McKay Creek delta is assumed to have some degree of water inflow dependence.	Disturbance of vegetation will be minimised by siting project infrastructure on existing disturbed areas and/or on unvegetated areas, to the extent that this is compatible with other environmental requirements. During detailed design, the project layout will be systematically reviewed to check for opportunities to consolidate the disturbance footprint so as to further reduce vegetation clearing. An internal clearing permit system will be implemented to ensure that clearing occurs only in approved locations. All staff and contractors will be required to participate in an environmental induction which will include information about requirements for protection of flora and vegetation. Pre-clearance targeted surveys for novel/Priority listed *Tecticornia* species will be conducted in those riparian zones of the playa which cannot be avoided. A minimum 200 m buffer zone would be established between the nearest lake edge vegetation and any on-playa project infrastructure. Track upgrades at the McKay Creek crossing will be designed to maintain natural surface water flow regimes. No water would be abstracted from the McKay Creek or from the shallow unconfined aquifer immediately underlying the creek bed. Proposed groundwater abstraction from the Northern Borefield would draw brackish water from a confined aquifer. Vehicle and equipment hygiene procedures will be implemented to control the risk of introducing and/or spreading weeds and soil borne diseases. Compliance with the weed hygiene procedures will be audited, especially during the construction phase of the project. Vehicles will not be permitted to leave designated access tracks or cleared areas. Machinery and vehicles undertaking clearing activities will be fitted with firefighting equipment and staff and contractors will be trained in fire response.

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
	Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline (OD-EW1)		Mosaic burns will be conducted as required (in consultation with DBCA and Traditional Owners) to limit fire risk. Firefighting equipment will be maintained at the site and emergency personnel trained will be trained in fire response. A Mine Closure and Rehabilitation Plan conforming to DMIRS and EPA requirements will be implemented. Progressive rehabilitation will be undertaken as land becomes available. Progress on rehabilitation will be reported annually in the project's annual environmental report.

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
Hydrological processes			
To maintain the hydrological regimes of surface water so that environmental values are protected	**Surface hydrology** Lake Disappointment is an internally draining ephemeral salt lake with a total area of approximately 150,000 ha. It is listed in the Directory of Important Wetlands in Australia. Savory Creek (an ephemeral watercourse) is one of 48 Western Australian rivers classified as 'wild rivers'. McKay Creek, an ephemeral creekline arising in McKay Range, runs from west to east, discharging seasonally into a delta approximately 23 km north of the Lake Disappointment playa. There is no evidence of hydraulic connection between McKay Creek and the Lake Disappointment playa. The Lake Disappointment playa surface is dry most of the time. Wetting events mostly occur in summer (January to March). Wetting events sufficient to cause ponding on the playa surface occur infrequently. During wetting events, water deeper than 0.1 m is rarely present on the playa surface for more than about 2 months in any given year. However, when infrequent, longer duration wetting events do occur they are important to the breeding cycle of a number of conservation significant bird species.	The most significant risk to hydrological processes arises from the possibility that the establishment of on-playa infrastructure (trenches, causeways, ponds, halite stockpiles) could alter the depth, duration, or distribution of surface water on the playa during periodic wetting events. Brine abstraction from on-playa trenches will result in localised groundwater drawdown. This has some potential to reduce the amount of water available for surface ponding and/or to affect root-zone water relations of riparian	**Surface hydrology** Engineering measures (bypass drains, channels and bunds, culverts, and floodways) will be used to maintain unimpeded flow of surface water across the on-playa operational areas so that flood depths, durations and wetting patterns are not significantly altered. A 2000 m floodway (gap) in the linear trench system will be provided to accommodate substantial streamflow from the Savory Creek feeding into the central playa channel. A network of shallow piezometers and/or measuring staves will be established to enable monitoring of ponded water depths in areas surrounding the brine collection trench system. A minimum 200 m buffer zone will be established between the nearest lake edge

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
	Hypersaline groundwater The hypersaline brines targeted by the Lake Disappointment Potash Project lie within a layer of alluvial/lacustrine sediments overlying older basement rock. Water enters the playa sediments from rainfall, surface water runoff and groundwater discharge from surrounding areas and is lost from the playa by evaporation. Recharge from infiltration of rainfall and surface water runoff are likely to be considerably greater (an order of magnitude in average years) than recharge by subsurface flows from surrounding areas. The depth to groundwater beneath the playa is typically in the order of 0 m to 0.5 m below the playa surface. The water level beneath the playa is relatively stable with fluctuations over the annual cycle in the order of 0.5 m. **Brackish groundwater** The fresh-to-brackish water that would be abstracted from the proposed Cory Borefield will target the Coolbro (Gunanya) Sandstone fractured rock aquifer. The proposed Northern Borefield will target the deeper units of the Tertiary sequence of sands, clays and sandy clays above the basement rock. The depth to groundwater in the proposed borefield locations north is typically in the order of 13 m below ground level at the end of the dry season. Groundwater levels can rise to depths as shallow as 6 m below ground level during the wet season. The groundwater flow direction in the proposed borefields is from the north-west to the south-east, although localised transient reversals of flow gradients may occasionally occur in response to heavy rainfall events. The groundwater table typically is a subdued reflection of the local topography. The nearest groundwater bore to the proposed Cory and Northern Borefields is Georgia Bore, located approximately 20 km to the north east of the proposed Cory Borefield. It is fitted with a hand pump and is reportedly used by travellers along the Talawana Track and Canning Stock Route.	vegetation around the playa edge. Groundwater abstraction from the proposed borefields has the potential to reduce available subterranean fauna habitat. There is no groundwater dependent vegetation in proximity to the Cory Borefield and, accordingly, impacts on vegetation are unlikely. The riparian vegetation along McKay Creek and in the McKay Creek delta is inferred to be inflow dependent. The health of vegetation could be affected groundwater abstraction results in reduced water levels in the shallow unconfined aquifer. No impacts on existing human groundwater users are likely, given the distance between the proposed borefields and the nearest existing groundwater bore.	vegetation and any on-playa project infrastructure. No water would be abstracted from McKay Creek or from the shallow unconfined aquifer immediately underlying the creekbed. Culverts or floodways will be installed at all ephemeral creek crossings to maintain wet season flow along watercourses. **Groundwater hydrology** Production bores in the Northern Borefield will be screened only in the confined aquifer. Monitoring bores will be provided in both the confined and superficial aquifers. The borefield water abstraction networks will be designed and operated to limit groundwater drawdown in locations where stygofauna species of restricted distribution have been identified. Groundwater monitoring networks will be established and maintained, as required, under the borefield operating strategies. Reward will implement an adaptive management approach to limit groundwater drawdown. Hydrogeological models will be reviewed and updated at least 3-yearly after commencement of borefield operations.

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
Inland water quality			
To maintain the hydrological regimes of groundwater so that environmental values are protected	There are no permanent surface water bodies anywhere in the Lake Disappointment project development envelope, although there are limited areas of shallow ponded water at the mouth of Savory Creek. During the summer wet season, rainfall and runoff pond on the playa surface and in surrounding claypans. The quality of the ponded water on the playa is strongly influenced by the salt crust that covers the playa. Except for brief periods after large rainfall events, water ponded on the playa is typically hypersaline (>200,000 mg/L TDS). The seasonal ponds that form in the clay pans surrounding the main playa are typically much fresher (and consequently more turbid), with salinities generally less than 1000 mg/L TDS. Groundwater beneath the Lake Disappointment playa is nearly ten times as salty as seawater, with a median total dissolved solids concentration of approximately 326,000 mg/L. The playa groundwater has no noticeable enrichment in trace metals, including uranium and thorium. Groundwater in the proposed Cory and Northern Borefields is brackish to saline, with total dissolved solids typically ranging from slightly under 1000 mg/L to approximately 5000 mg/L. Background concentrations of uranium and thorium in groundwater beneath the proposed borefields are low.	Acidification of shallow groundwater beneath the playa as a result of brine abstraction and/or excavation of shallow sediments Increased salinity of water in playa as a result of seepage from evaporation ponds, runoff from halite stockpiles or flood incursion into on-playa infrastructure Increased turbidity of playa water resulting from sediment disturbance during project development Contamination of groundwater as a result of spillage during transport, dispensing, storage or use of hydrocarbon fuels/reagent Contamination of groundwater resulting from treatment or disposal of septic wastes Contamination of groundwater resulting from disposal of putrescible wastes	Site drainage works will be designed and constructed to prevent scouring associated with concentrated surface flows. Appropriately engineered culverts, floodways and bypass structures will be provided where off-playa works traverse drainage lines Earthworks will be carried out primarily during the dry season, when the risk of large rainfall events entraining stockpiled soils is low. Reward will implement a sediment screening procedure to guide handling of materials during establishment of on-playa infrastructure. Routine monitoring of shallow groundwater quality will be conducted surrounding the brine trench network under Reward's groundwater operating strategy. Brine ponds will be designed and constructed to minimise seepage losses and prevent overtopping. A perimeter bund will be provided around the halite stockpiles to reduce the risk of stormwater incursion during major flood events. Diesel fuel and emissions reduction fluid will be stored in self-bunded tanks. All hydrocarbon and chemical storages will be designed and constructed in accordance with relevant requirements of Australian standards AS 1940 and AS 1692. Hydrocarbon spill kits will be provided at workshops, maintenance and refuelling locations, and any location where fuel is stored or handled in bulk. Employees will be trained in the use of spill kits. An incident reporting procedure, including reporting of hydrocarbon or chemical spills, will be implemented and maintained. No waste treatment or disposal facility will be sited within the 1-in-100 year flood zone. Sewage treatment facilities and the putrescible landfill will be constructed, operated and maintained in accordance with the DWER and Department of Health/local government approval conditions.

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
Terrestrial fauna			
To protect terrestrial fauna so that biological diversity and ecological integrity are maintained	Several significant species occur at Lake Disappointment and its surrounds. Some have significance because of their rarity, others have significance because of their use of, or association with, the Lake Disappointment playa. Night parrot calls have been recorded in the project area near Lake Disappointment. A single bilby was recorded by Reward personnel on the Talawana Track. Although no evidence of a significant Bilby population has been detected during baseline surveys, Reward has assumed that Bilbies may be present. Lake Disappointment ground geckos and Lake Disappointment dragons (both Priority 1 species) inhabit riparian vegetation surround the Lake Disappointment playa. No evidence of significant populations of crest-tailed mulgara (*Dasycercus cristicauda*), brush-tailed mulgara (*Dasycercus blythi*), or great desert skinks (*Liopholis kintorei)* has been recorded during baseline surveys, although the possible presence of these species has been assumed, as some suitable habitat occurs within the project development envelope. During baseline surveys, 7 species listed under the EPBC Act, as well as one 'otherwise significant' waterbird species (the banded stilt), have been recorded at or near Lake Disappointment. The Lake Disappointment/Savory Creek system has national value for migratory shorebirds on one criterion, namely that more than 0.1% of the flyway population of a species is present for at least part of the year. An estimated 0.4% of the flyway population of the sharp-tailed sandpiper was present at Lake Disappointment in March 2017.	Habitat clearing causes injury, death or disturbance of conservation significant fauna species Altered hydrology on-playa disrupts breeding or feeding cycles of migratory birds Vehicle strike causes injury or death of native fauna Project activities result in increase in introduced predators or herbivores, causing impact to native fauna Fauna entrapment leads to injury or death Putrescible water or fresh water impoundments attract pest animals Altered fire regime impacts native fauna or fauna habitat	Reward will implement and maintain a Fauna Management Plan (FMP). A structured program to address data deficiencies (as described in the FMP) will be implemented to support adaptive management of fauna. A program to reduce numbers of feral predators, introduced herbivores and other animal pests will be implemented for the life of the project. All areas scheduled for vegetation clearing will be clearly demarcated prior to clearing. Areas which have the potential to contain conservation significant fauna will be searched by a suitably qualified and experienced person within four weeks of the proposed vegetation clearing. If night parrots calls are identified, then a thorough search of the area will be undertaken to determine whether Night parrot nests are present. If nests are present, then all habitat within 500 m of the nest will quarantined until the chicks have fledged. Where practicable, areas containing bilbies will be quarantined with a 500m exclusion zone until they have left the area. Where required, bilby, great desert skink and mulgara will be captured and relocated. No access will be permitted to islands used for breeding by banded stilts and gull-billed terns. A 200 m exclusion zone will be maintained around all islands and between any on-playa infrastructure and the riparian zone (except at the main access causeway). To avoid disturbance to breeding waterbirds, all anthropogenic activity on Lake Disappointment will cease when more than 150 mm of rainfall in less than a week has been recorded at the Reward weather station. Activity on the lake will only resume once banded stilts and gull-billed terns have fledged and left site or died. Access to putrescible waste and fresh water pondage will be carefully controlled to prevent the establishment and proliferation of silver gulls. If necessary, a culling program will be implemented to control silver gulls. Vehicle speed limits will be established and enforced to reduce risk of fauna strike.

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
Subterranean fauna			
To protect subterranean fauna so that biological diversity and ecological integrity are maintained	Potential subterranean fauna habitats in the vicinity of the Lake Disappointment project include: shallow, unconfined alluvial and colluvial sediments; unconfined fractured sandstone systems and confined fractured rock aquifers. The sediments beneath the Lake Disappointment playa are generally considered unsuitable to support subterranean fauna. Potential stygofauna habitat in the Northern Borefield consists of the upper aquifer in surficial alluvial and colluvial deposits, which likely extends beyond the proposed borefield in association with McKay Creek. Results from the two proposed borefields suggest that the Cory Borefield (and possibly the wider Gunanya Sandstone) contains a modest stygofauna community, while the Northern Borefield is less prospective. The documented stygofauna community at Lake Disappointment is modest compared with many areas of the Pilbara and Yilgarn. Baseline characterisation of subterranean fauna in the general project area has concluded that the stygofauna community at Lake Disappointment is not notably speciose. A considerable proportion of stygofauna species in the Lake Disappointment area are known to be widespread and have been recorded elsewhere; some specimens collected during baseline studies appear to belong to new species that have not been recorded elsewhere. Based on available hydrogeological information, it is considered likely that all six new species have at least locally extensive ranges around Lake Disappointment.	The main threat to subterranean fauna from project implementation is the potential loss of subterranean fauna habitat as a result of groundwater abstraction from the proposed process water borefields. No overlapping or additive effects of drawdown are expected to result from interaction of groundwater abstraction from the two proposed borefields. No cumulative effects on subterranean fauna populations from groundwater use by other users is likely, as there are no other significant water users in the district So far, four subfauna species are known only from locations inside the proposed borefields and/or inside the areas of drawdown predicted by hydrogeological modelling. These species are: *Atopobathynella* sp. B27 and *Dussartstenocaris* sp. B08 in the Cory Borefield and *Enchytraeidae* sp. B18 (LD) and *Enchytraeidae* sp. B19 in the Northern Borefield. The actual distributions of both *Atopobathynella* sp. B27 and *Dussartstenocaris* sp. B08 are considered to be greater than shown by field survey because of (a) the likely connectivity of available stygofauna habitat throughout the Gunanya Sandstone, and (b) the locally extensive ranges of other stygofauna species recorded during survey. The two enchytraeid species (*Enchytraeidae* sp. B18 (LD) and *Enchytraeidae* sp. B19) known only from in and around the Northern Borefield are probably more widespread than shown by collections to date. The connectivity of suitable habitat outside the Northern Borefield has been demonstrated by both hydrogeology and the ranges of other species. Irrespective of species' ranges, information in the borefield hydrogeological assessment suggests that minimal drawdown of primary stygofauna habitat will occur in the unconfined upper aquifer associated with McKay Creek. Therefore, the level of impact of groundwater abstraction on stygofauna is likely to be low.	Reward will establish a distributed production bore network with some redundancy so that selected bores can be temporarily shut off if unacceptable drawdown effects become apparent during borefield operation. Production bores in the Northern Borefield will be screened only in the deeper confined aquifer, to avoid producing groundwater drawdown in the more prospective shallow groundwater aquifer associated with McKay Creek. Operation and monitoring of both the Cory and the Northern Borefields will be in accordance with groundwater operating strategies approved by the DWER. The operating strategies will include specific trigger values to support an adaptive management framework aimed at minimising impacts on subterranean fauna habitat. Groundwater models will be reviewed and updated at least 3-yearly based on input of actual groundwater monitoring and abstraction data. This will allow comparison of predicted and actual groundwater drawdowns and will enable the stygofauna impact

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
			management strategies to be updated.

Environmental factor & EPA objective	Summary of existing environmental values	Potential impacts	Key commitments in this ERD
Social surroundings (heritage)			
To protect social surroundings from significant harm	Lake Disappointment lies in the north-western part of the Western Desert lands traditionally occupied by the Martu people. The whole of the Lake Disappointment proposal is located within the determined Native Title claim area held by the Martu People (WCD2013/002). In addition to supporting customary uses such as foraging and hunting, parts of the Lake Disappointment area have significant spiritual/religious values for the Traditional Owners. Lake Disappointment itself and parts of the surrounding area are registered with the DPLH as a 'ceremonial/mythological' site. Other registered heritage sites and/or their buffers intersect the Talawana Track. The dune fields and sandy plains surrounding the lake are considered to have relatively low potential for significant archaeological material, due to the absence of surface stone and rocks. A number of artefact scatters have been identified in proximity to ephemeral drainage lines associated with McKay Creek.	The implementation of the Lake Disappointment project has the potential to impact culturally important values by: • Allowing access to areas which, under customary Law, have restricted access • Causing ground disturbance to known or unknown Aboriginal heritage sites • Limiting access to land required by Traditional Owners for customary purposes	Reward will continue to implement and to work in accordance with the ILUA agreed with the Martu Traditional Owners in December 2012 (Lake Disappointment Project Mining and Indigenous Land Use, WI2012/009). Reward will continue to respect and enforce heritage exclusion areas defined by the Martu Traditional Owners. Additional heritage surveys will be conducted as part of detailed planning for upgrade of the Talawana Track. If required, Section 18 approvals will be sought under the *Aboriginal Heritage Act 1972*. Reward will establish an operations Aboriginal heritage management framework, developed in consultation with Traditional Owners. Management requirements for specific heritage places and sites will be addressed in a Cultural Heritage Management Plan (CHMP). The plan will be prepared in close consultation with Traditional Owners.

4.2 Key factor 1A: Hydrological processes – surface water

4.2.1 EPA objectives

To maintain the hydrological regimes of surface water so that environmental values are protected.

4.2.2 Policy and guidance

Table 4–3: Relevant policies, guidelines & standards – hydrological processes (surface water)

Environmental factor	Relevant policies, guidelines, and standards
Hydrological processes (surface water)	EPA, 2016c. *Environmental factor guidelines – hydrological processes*. DOW, 2009a. *Wild rivers in Western Australia – about wild rivers*. Water notes WN37.

4.2.3 Receiving environment

This Section provides an overview of surface hydrology in the Lake Disappointment area. The information presented in this Section draws on baseline studies commissioned by Reward (Table 4–4). Copies of the baseline technical studies are appended to this ERD.

Table 4–4: Summary of studies conducted to inform assessment of hydrological impacts

Study reference	Description
Appendix E7: Bennelongia Environmental Consultants, 2016. Ecological Character of Lake Disappointment	Preliminary assessment of the biological character of Lake Disappointment, and its surrounds, with focus on aquatic fauna
Appendix H1: SRK Consulting, 2018. Lake Disappointment Pond Persistence Modelling	Stochastic modelling to evaluate potential for brine extraction to cause changes to the frequency, duration or extent of surface water ponding on the Lake Disappointment playa
Appendix H2: Hydrobiology 2017. Memorandum: Lake Disappointment 2017 Flooding Hydrology Calculations	Uses satellite imagery and topographic data to establish correlation between ground elevation and wetting frequency on-playa surface
Appendix H3: Knight Piésold 2017. Lake Disappointment Hydrological Study	Surface water assessment provides a description of the surface water environment around Lake Disappointment, evaluates the potential impacts of project infrastructure on surface flow patterns on the playa, assesses potential impacts of flooding events on the project infrastructure, and provides design recommendation for mitigation of flood effects. The report includes information on: extent of surrounding catchment areas; surface water inflow into Lake Disappointment; frequency, magnitude and duration of flooding events; and storm flood levels.
Appendix H4: Pendragon Environmental Solutions, 2016. Hydrological (Surface Water) Investigation and Assessment	Hydrological (surface water) investigation to ascertain if proposed on-lake infrastructure will interfere with the hydrological functionality of Lake Disappointment

Study reference	Description
Appendix I5: Global Groundwater. 2017. Lake Disappointment – Hydrogeological Assessment of the Impact of Brine Extraction on the Lake Fringe	Hydrogeological modelling and estimation of potential groundwater drawdowns arising from abstraction of up to 63 GL/a of brine from shallow trenches at Lake Disappointment, assuming a 10-year 'no-recharge' scenario

Lake Disappointment is an ephemeral salt lake located at the lowest point of the Little Sandy Desert, approximately 340 km east of Newman. It is the dominant surface water feature in the region, with a surface area of approximately 150,000 ha[7] (1500 km^2). Aside from the large surface area of the playa, the various claypans, riparian communities, and dunefields in the surrounding area can be considered as part of the Lake Disappointment system. In the early Tertiary period[8], Lake Disappointment was part of a larger and more extensive drainage system which drained north-easterly into the Percival Palaeoriver and then, finally, north-westerly into the Indian Ocean (van de Graaff et al. 1977). Following tectonic events in the Miocene epoch (~23 million years ago) the drainage to the north was cut off, so that all surface flow within the area surrounding the Lake Disappointment playa now flows towards the playa.

Lake Disappointment (and the associated Savory Creek system) is listed in the Directory of Important Wetlands in Australia (Environment Australia 2001), based on the following two criteria:

- It is a good example of a wetland type occurring in a biogeographic region in Australia; and
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail (more likely the former, as the playa would be dry under drought conditions).

The Lake Disappointment system is classified as a 'category B wetland', based on the following two criteria:

- Seasonal and irregular rivers and streams (B2)
- Seasonal/intermittent saline lakes (B8) (Environment Australia 2001).

The seasonal freshwater claypans greater than 8 ha around the Lake Disappointment playa are considered to be 'category B6 wetlands' (seasonal/intermittent freshwater lakes (>8 ha) and/or floodplain lakes) (Environment Australia 2001).

Savory Creek is one of 48 Western Australian rivers classified as 'wild rivers'. 'Wild rivers' are those which have experienced little or no modification as a result of modern human activities. They are mostly located in remote and very sparsely populated areas of the state and generally occur on Crown Land. The former Department of Water (now DWER) defines the boundary of wild rivers by their catchment areas. The DWER aims to manage impacts on wild rivers chiefly by controlling activities along the waterway and the adjoining banks; however, the DWER also considers activities in the catchment that may adversely impact the ecological values of wild rivers, including water quality and flow.

Lake Disappointment is the terminus of a modern internal drainage system, which comprises the southern portion of the larger Sandy Desert Basin catchment. The main surface water features that drain to the lake are Savory Creek from the west, an unnamed drainage system from the south-east

[7] Surface area as given in the Directory of Nationally Important Wetlands entry for Lake Disappointment (last updated 1995)
[8] The Tertiary period of geological time lasted from about 65 million years ago to about 1.8 million years ago.

(corresponding approximately to the path of the ancient Disappointment Palaeoriver (Beard, 2002)) and local runoff from the escarpment to the east of the lake. McKay Creek, an ephemeral creekline arising in McKay Range, runs from west to east, discharging seasonally into a delta approximately 23 km north of the Lake Disappointment playa. There is no evidence of hydraulic connection between McKay Creek and the Lake Disappointment playa.

The playa lake itself lies in a closed drainage basin, with a total topographic catchment area estimated to be 50,654 km^2 (Knight Piésold, 2016, Appendix H3). The topographic catchment consists of two sub-catchments which feed into the lake (Figure 4-2). These are split into:

- A 26,160 km^2 northern catchment, which drains into Lake Disappointment mainly via Savory Creek to the north-west; and
- A southern catchment, with an extent of approximately 24,494 km^2, which drains via the Disappointment Palaeoriver along the eastern margin of the lake (Appendix H4).

All of the off-playa operational areas proposed for the Lake Disappointment project lie within the more northerly of the two subcatchments. None of the works proposed in connection with project implementation will directly affect flows in Savory Creek: no water will be taken from the creek and no infrastructure will be constructed over or near the creek. The location where Savory Creek discharges into Lake Disappointment is an exclusion area formally recognised under an ILUA established between Reward and the Martu Traditional Owners.

Although the two subcatchments contributing runoff to the Lake Disappointment playa are similar in area, the Savory Creek catchment is thought to exert the stronger influence on lake hydrology. About three-quarters of the external catchment flow entering Lake Disappointment is estimated to arise from inputs from the Savory Creek part of the contributing catchment (Appendix H3). The remainder of surface flow into the playa is from flow from the southern catchment (the Disappointment Palaeoriver catchment) and from various minor ephemeral drainage lines. Baseline hydrological studies of the project area have concluded that the part of the catchment that actually contributes flow to the playa (the 'zone of influence') is considerably smaller than the topographic catchment. The catchment that actively contributes surface runoff to Lake Disappointment (the 'contributing catchment') is estimated to be approximately 3,090 km^2 (309,000 ha) in area (Appendix H3). The relative sizes of the topographic catchment, the contributing catchment, the lake surface and the proposed on-playa disturbance footprint are illustrated in Figure 4-3.

Figure 4-2: Lake Disappointment surface catchments

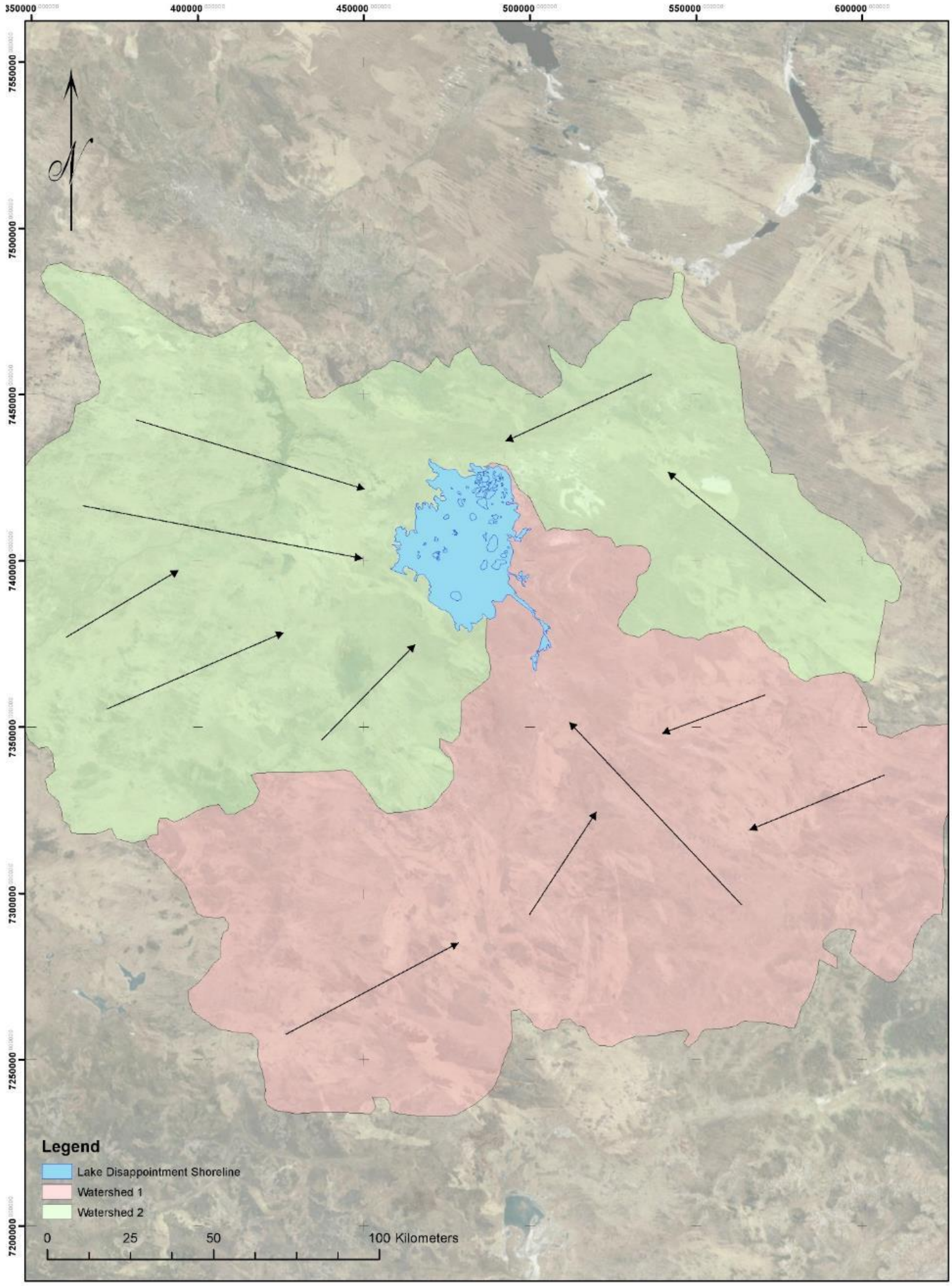
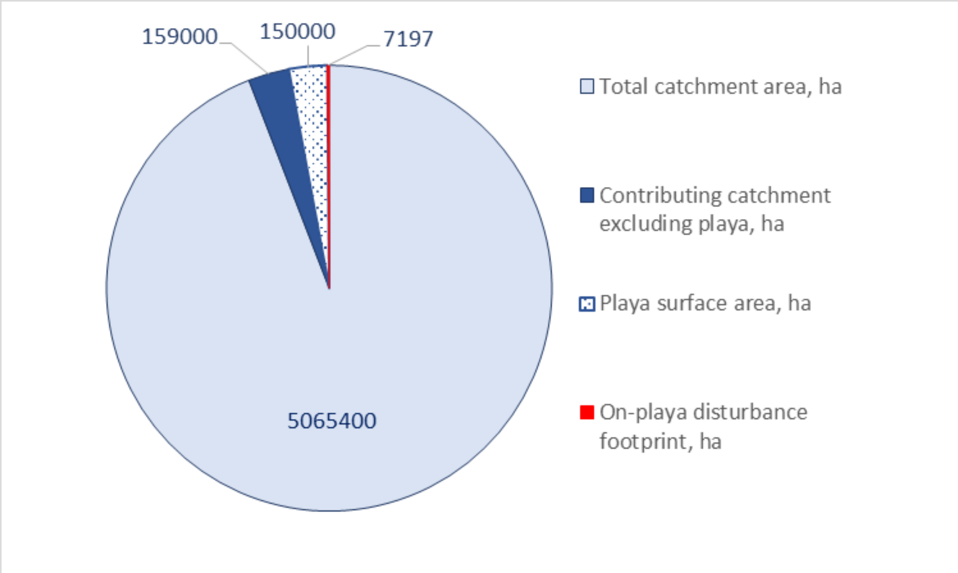
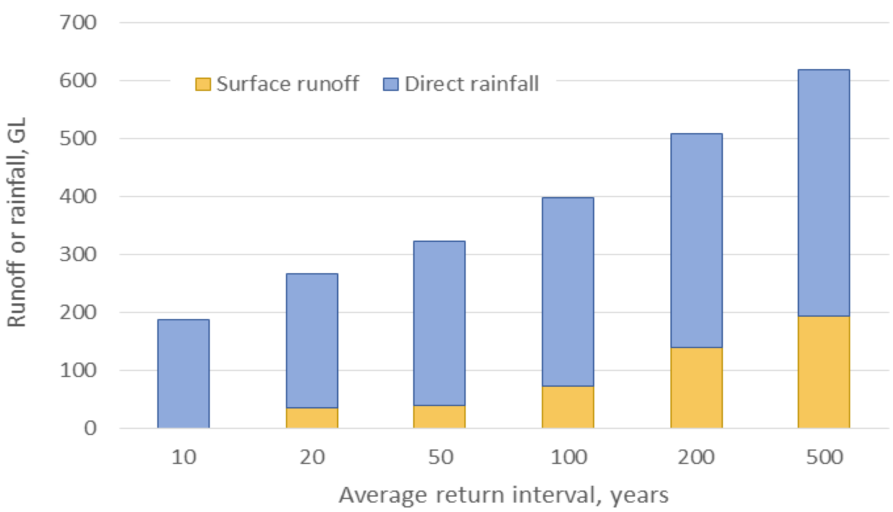


Figure 4-3: Relative sizes of catchments and proposed on-playa footprint



Surface water runoff from the surrounding catchment is—intermittently—a significant contributor to the Lake Disappointment playa. This is supported by the form of the lake, which displays large deltas associated with the some of the main creeklines (Appendix I5). Knight Piésold (Appendix H3) estimated that after Cyclone Rusty (which corresponded to about a 1-in-212 year storm event) approximately 139 GL of water entered the lake by streamflow. Lower intensity rainfall is likely to produce less runoff, both in absolute terms and in terms of the percentage of rainfall that ultimately reaches the playa. In most years, however, direct rainfall incident on the playa is a much larger contributor to surface water on the playa than runoff from the surrounding catchment (Figure 4-4).

Figure 4-4: Rainfall and runoff contributions to playa – various return intervals



The Lake Disappointment playa surface is dry most of the time. Wetting events mostly occur in summer (January to March). Wetting events sufficient to cause ponding on the playa surface do not occur every year. It is relatively rare for water deeper than 0.1 m to be present on the lake surface for more than about two months in any given year. For example, a 1-in-20 year flood event (which has about a 5% likelihood of occurring in any given year) results in parts of the playa being ponded to a depth of up to 0.1 m for about 53 days (Table 4–5, Figure 4-5).

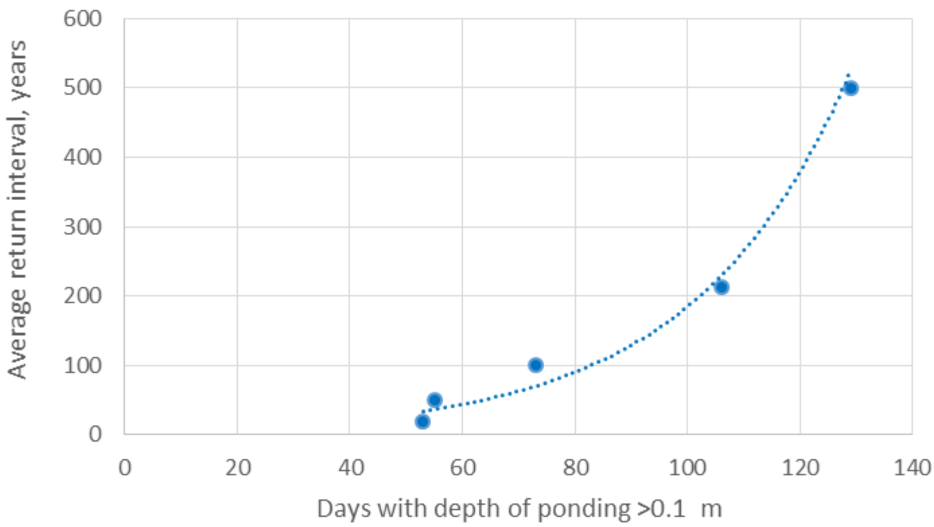
Table 4–5: Ponding duration and estimated flood elevation for various flood events (Appendix H3)

AEP (%)	ARI (years)	Estimated flood elevation (RL m AHD)	No. days depth of ponding >0.1 m
0.2	500	327.83	129
1	100	327.50	73
2	50	327.38	55
4.9	20	327.36	53
Cyclone Rusty	212	327.70	106

Notes: AEP means annual exceedance probability; the likelihood (in percentage) of a flood event of this magnitude occurring in any given year.

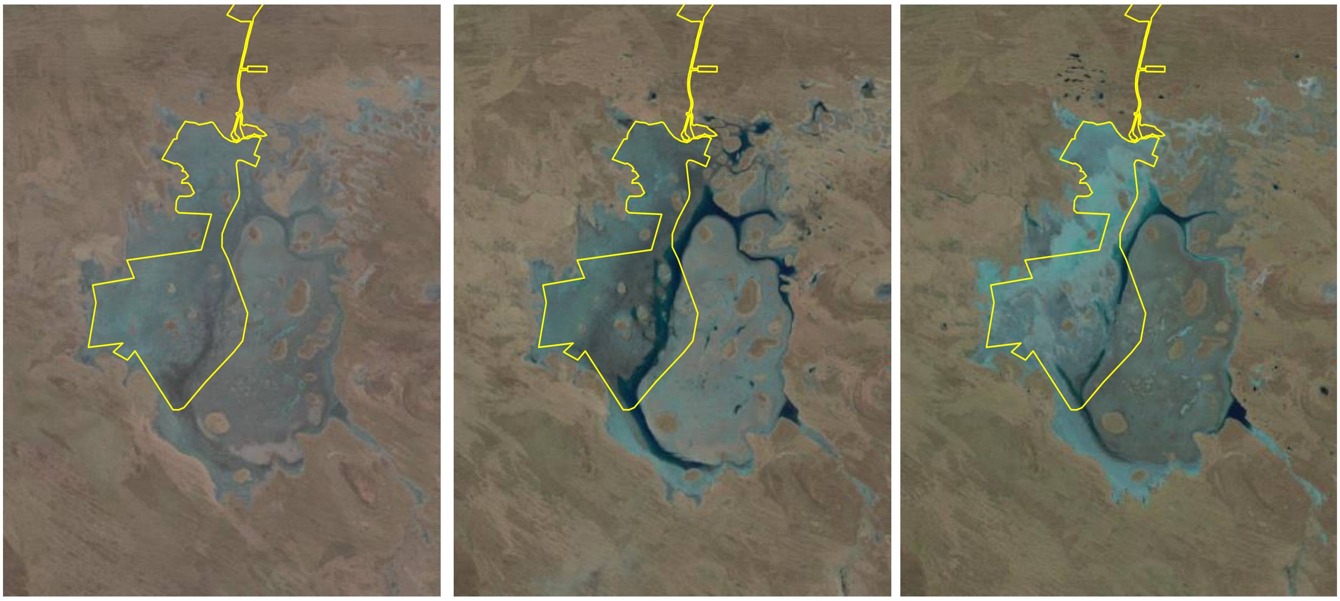
ARI means average recurrence interval; the average frequency of a flood event of this magnitude (1-in-20 years, 1-in-50 years, etc).

Figure 4-5: Ponding duration vs average return interval (plotted values from Appendix H3)



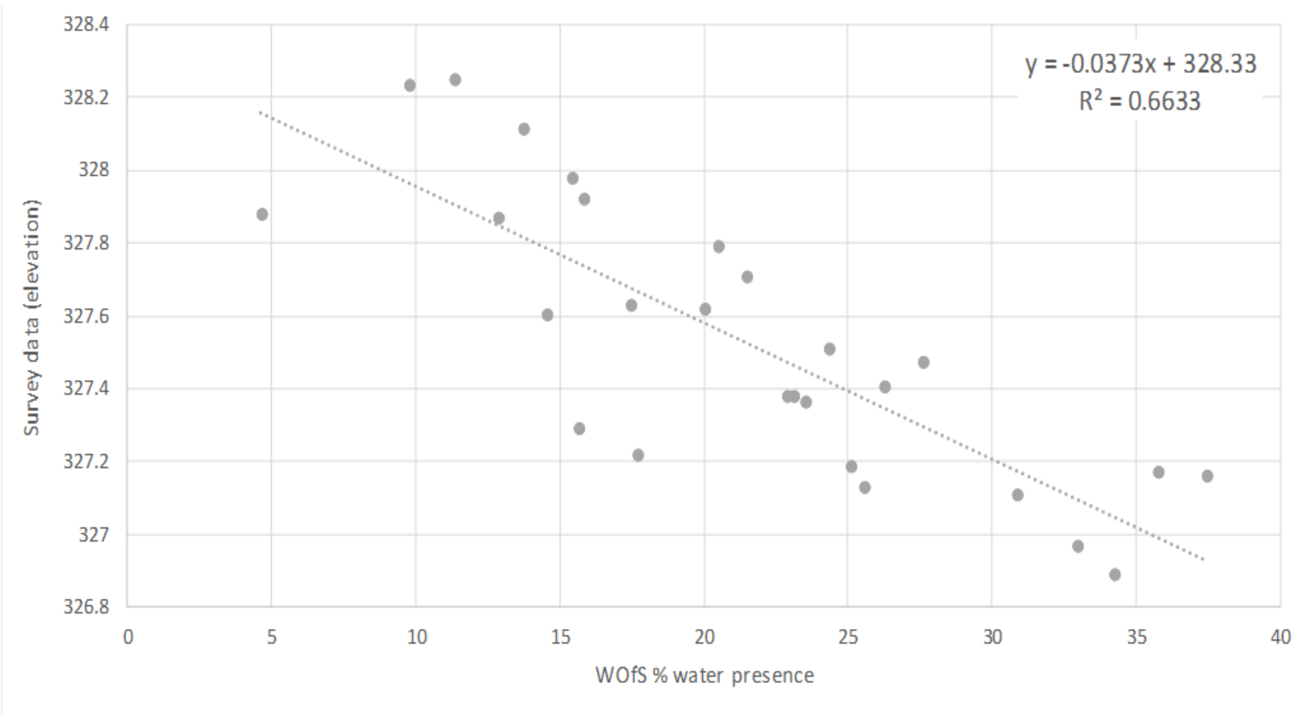
During wetting events, the water depth is not uniform across the playa: there is a deeper channel that runs approximately along the north-south centreline of the playa, and a small number of deeper channels that convey flows from ephemeral drainage lines surrounding the playa (Figure 4-6). An analysis by Hydrobiology (Appendix H2) has used satellite imagery and topographic information to estimate how much of the time various parts of the playa are likely to experience ponding. This analysis has shown that areas with an elevation of 328 m AHD or greater are likely to be wet less than 10% of the time and areas with an elevation of more than 327 m AHD are likely to be wet less than 35% of the time (Figure 4-7). Nearly all of the proposed on-playa evaporation ponds will be established on the higher parts of the playa, at a nominal elevation of RL 327.6 m AHD or greater. Within recent times (those for which satellite imagery is available), areas above RL 327.6 m AHD have experienced wetting less than about 20% of the time. The relationship between surface elevation and wetting frequency is necessarily approximate, because of the difficulty in getting precise topographic information over the flat and highly reflective playa surface.

Figure 4-6: Landsat imagery showing post-wet season inundation at Lake Disappointment



2 May 2010 **18 May 2016** **21 May 2017**

Figure 4-7: Correlation between playa surface elevation and frequency of ponding



4.2.4 Potential impacts

Reward's risk register (Appendix L2) identifies impacts on surface hydrology processes that could result from of project implementation. The register also lists potential impacts on other environmental factors that could occur as a result of alteration in surface hydrology (Table 4–6).

Table 4–6: Excerpt from project risk register – hydrological processes (surface water)

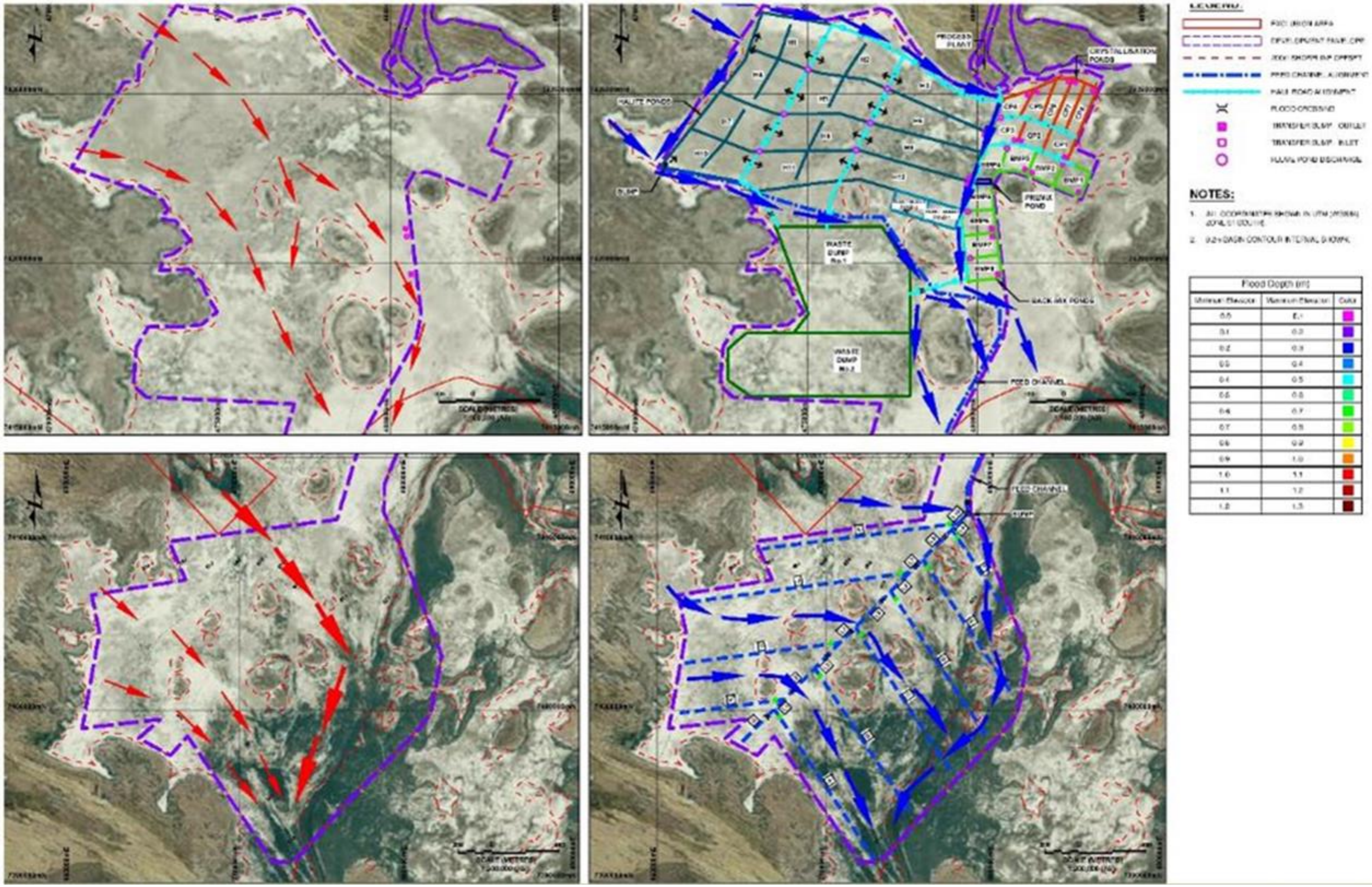
Event description	Potential impact
Extraction of brine results in increased infiltration of surface water on playa	Reduction in the extent, duration or depth of water ponded on playa surface during wet season: potential impacts on biota, especially migratory waterbirds
Establishment of on-playa infrastructure	Alteration and/or obstruction of surface drainage, resulting in modification of frequency, velocity, duration extent of flooding
Establishment of on-playa infrastructure	Potential impacts on vegetation or fauna as a result of modified hydrology (increased submergence or reduced flow to channel system in central playa)
Establishment of on-playa infrastructure	Presence of permanent pondage causes birds or other wildlife to be attracted to area at a time/frequency that differs from the usual pattern
Establishment of linear infrastructure off-playa	Altered flow at drainage line crossings, resulting in backwater effects, reduction in downstream flow, increased erosion/scouring, altered patterns of sediment deposition

One of the most significant risks to hydrological processes (and the environmental factors affected by hydrological processes) arises from the possibility that the establishment and use of on-playa infrastructure (trenches, causeways, ponds, halite stockpiles) could alter flooding regimes in one or more of the following ways:

- Depth of flooding: The development of the Lake Disappointment project includes the construction of a number of ponds and other infrastructure on Lake Disappointment. As such, the lake will lose some water storage capacity, which could—theoretically—increase the flood levels resulting from storm events.
- Distribution of wetting: The infrastructure (in particular the infiltration trenches) will impact the flow patterns on the playa surface.
- Duration of wetting: Establishment of ponds, stockpiles and other barriers to water movement could affect how long water ponds in a particular part of the playa. Abstraction of brine could also give rise to changes in shallow sediment hydrology, leading to reduction in duration of ponding following rainfall events.
- Velocity of flow: The modification of flow patterns could cause localised changes in the rate of water flow, causing erosion or sediment deposition.

The predicted changes in surface water flow that would result from establishment of on-playa infrastructure are illustrated in Figure 4-8.

Figure 4-8: Surface water flows without (red arrows) and with (blue arrows) proposed infrastructure



Note: Weight of arrows in Figure 4-8 indicates relative contribution to flow: surface flows along Savory Creek are by far the largest contributor to surface flow in the northern part of the playa.

Establishment of off-playa infrastructure, including access roads and associated drainage and/or pipelines, is much less likely to interfere with existing hydrological processes. No part of the proposed processing plant site or other support infrastructure (accommodation village, airstrip, borrow pit) lies within the 1-in-100 year flood zone of any watercourse. The existing access tracks, the Willjabu and Talawana Tracks, cross a number of ephemeral watercourses—most notably McKay Creek—and some upgrades of the existing tracks and associated drainage structures are likely to be required to maintain safe access and to accommodate occasional flood events.

4.2.5 Impact assessment

Potential for changed flooding regimes – backwater effects

Flood modelling for Lake Disappointment indicates that following rainfall events that are sufficient to recharge the vadose zones of the playa, the main contributions to ponding from surface influx originate from the Savory Creek system entering the lake off the north-western sector, the southern palaeo river channel and—to a lesser degree—sheet flows off the Runyon Range to the east of the playa. The Savory Creek inflows have the highest potential for streaming over the lake surface to contribute to pond formation in the central parts of the lake.

The central part of the lake is characterised by a shallow depression or ponding zone extending from the southern palaeoriver channel to the northern extents of the lake. When ponding occurs on the surface, it typically fills this shallow channel first. This central ponded area persists for anywhere up to three months (depending upon the magnitude and frequency of rainfall events), until it is exhausted naturally (mainly via evaporation).

The two main surface hydrological processes for consideration are thus:

- Influx of water to the playa via channel flow from the Savory Creek
- Surface water flow across the playa surface to the central north-south channel.

The evaporation pond infrastructure is located on slightly elevated ground in the north-western sector of the playa, above the reach of even substantial flood events. These ponds cover approximately 3.5% of the total playa area. Flood modelling has been conducted to evaluate whether the establishment of evaporation ponds and other on-playa infrastructure (with a maximum total footprint of up to 7197 ha) could result in greater flooding depths on the playa, as a result of the area occupied by project infrastructure or 'backwater effects' due to restriction of surface flows (Appendix H3). Increases in flooding depths can be ecologically important in cases where vegetation is intolerant of submergence. While *Tecticornia* are generally very tolerant of drought and salinity, peer reviewed research has suggested the zonation commonly observed in *Tecticornia*-dominated riparian vegetation communities may relate to differing submergence tolerance between *Tecticornia* species (Konnerup et al. 2015).

In order to assess the potential for indirect impacts on the health of *Tecticornia*-dominated riparian vegetation, changes to surface water ponding depths were assessed by developing a stage storage model of the lake with and without project infrastructure in place (Appendix H3). The stage storage model was then used to estimate the new flood level for 72 hour storms with a range of return intervals. As shown in Table 4–7, the increase in the flood levels when infrastructure is included is very small.

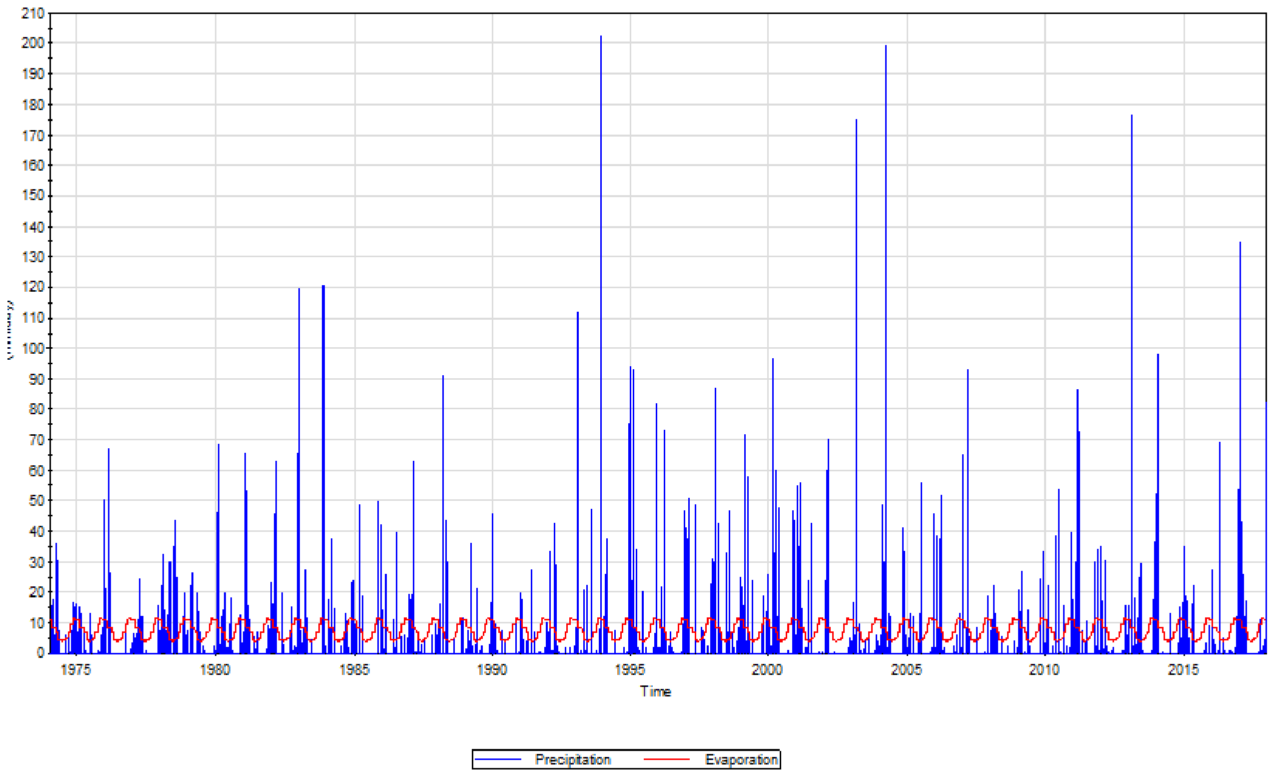
For a 1-in-500 year flood the predicted increase in ponding depth is in the order of 10 mm. For an event delivering flows similar to those recorded during severe tropical Cyclone Rusty in 2013 (corresponding approximately to a 1-in-212 year event), the estimated increase in ponding depth across the playa would be approximately 4 mm, compared to the depth of ponding predicted to occur if there were no project infrastructure present.

Table 4–7: Predicted increases in flood depths post-development

Annual exceedance probability (AEP, %)	Average return interval (ARI, years)	Predicted increase in flood level (m)
4.9	20	0.000
2	50	0.000
1	100	0.000
0.2	500	0.010
Cyclone Rusty	212	0.004

Given that average daily evaporation rates in the Lake Disappointment area typically range between approximately 5 mm/d and 11 mm/d (Figure 4-9), it is unlikely that the predicted minor increases in ponding depth would persist long enough to adversely affect riparian vegetation health.

Figure 4-9: Daily rainfall and evaporation (BOM Telfer Aero), 1974–2017, mm/d



Potential for changed flooding regimes – reduction in ponding duration/extent

Brine extraction from trenches will cause localised reduction in the depth of the groundwater table over parts of the playa and will result in more pore space becoming available for water storage in the unsaturated sediment zone lying above the water table. Concerns have been raised that brine extraction will therefore lead to increased infiltration of water that would normally pond on the playa surface. If this were to occur, then it could result in an associated reduction in either the extent of ponding or the duration of surface ponding on the playa. If the extent or duration of ponding were to change as a result of hydrological changes associated with brine abstraction, this could give rise to indirect impacts on migratory birds, such as the banded stilt.

The banded stilt (*Cladorhynchus leucocephalus*) is an Australian shorebird that has been known to breed on islands located in Lake Disappointment (Figure 4-10). A March 2017 survey by Bennelongia Environmental Consultants (Appendix E3) recorded 94,046 adult birds, 49,321 nests on 10 islands, and 7,388 young chicks on Lake Disappointment. This aligns closely with the 93,455 adult banded stilt population observed at Lake Disappointment in February 2017. Bennelongia estimates that these numbers represent between 25% (based on estimates from Watkins, 1993) and 46% (based on estimates from Wetlands International, 2017) of the entire species' population.

Figure 4-10: Eggs and dead banded stilt (arrow) on island in Lake Disappointment, 3 April 2018

Note: Photo by Bennelongia Environmental Consultants, 2018

Banded stilts require an ephemerally flooded, hypersaline wetland that persists for a minimum of 80–90 days to provide food sources to support successful fledging of young (termed 'recruitment'). Additionally, banded stilts typically nest on islands, and rely on sufficient water depth in ponds to act as physical barriers to prevent predation of their nests. Based on criteria discussed in Appendix E3, a minimum surface water persistence of more than 80 days with a water depth greater than 10 cm is necessary to support a recruitment event.

A deterministic hydrological model was developed using all available information for the Lake Disappointment playa. That is, a model was run using BOM Telfer Aero rainfall data from the period from 1974 to 2017 to estimate how many ponding events would have occurred at Lake Disappointment, and how long the surface water ponding would have persisted, assuming that a similar weather conditions had occurred at Lake Disappointment as those recorded at Telfer Aero. The model was used to estimate daily fluxes of water, ponded water volumes and ultimately to determine the length of pond persistence (Appendix H1). This information was used as the basis for assessing the potential for hydrological changes that could affect recruitment of banded stilts or other migratory waterbirds.

In order to assess pond persistence, three modelled scenarios were developed:

1. Base Case Scenario: Developed to represent current hydrological conditions at Lake Disappointment
2. Scenario 1: Represented the effect of brine abstraction by increasing the depth of the unsaturated zone by a nominal depth of 1.5 m. The specific yield of the lake sediments was also altered to reflect the larger unsaturated zone.
3. Scenario 2: Used identical parameters for the unsaturated zone as Scenario 1 and also reduced the overall runoff reporting to the pond by 20% in order to represent potential interruption of flow due to proposed site infrastructure.

The model results showed that ponding of surface water on Lake Disappointment typically occurs only after rainfall events which deliver rain in the order of 50 mm/d or more. This result is consistent with anecdotal observations at Lake Disappointment. Other model findings include:

- Rainfall events large enough to result in ponding on the playa can occur at any time of year, but mostly occur in the summer wet season, suggesting a high dependency on cyclonic rainfall events.
- An estimated 36 ponding events (rainfall events resulting in ponded water deeper than 10 cm in the central part of Lake Disappointment for any time duration) occurred during the period 1974–2017 (Table 4–8).
- It is likely that six of the ponding events during the period 1974–2017 were of sufficient duration to support successful banded stilt recruitment. One of the recruitment events predicted by the model (in February 2004) has been confirmed by visual observation of birds at Lake Disappointment.
- A further four of the ponding events may have been long enough to support successful banded stilt recruitment.
- Two ponding events observed at Lake Disappointment (in 2015 and 2016) were not predicted by the model and are assumed to be the result of localised storm events that were not experienced at Telfer Aero.

Table 4–8: Modelled ponding duration under existing conditions and modelled scenarios

Event date	Pond persistence (in days)			
	Base case	Scenario 1	Scenario 2	Notes
March 1976	47	-	-	
February 1978	49	-	-	
May 1978*	140	134	97	Likely recruitment event
February 1980	47	45	45	
February 1981	63	52	52	
February 1982	49	48	49	
January 1983	39	-	-	
December 1983	34	-	-	
March 1984	51	-	-	
July 1986	16	-	-	
February 1987	47	-	-	
May 1988*	96	85	85	Potential recruitment event
February 1993	45	-	-	
December 1993	34	34	34	
February 1994	50	-	-	
December 1994	36	-	-	
February 1995*	101	59	59	Potential recruitment event
December 1995	36	36	37	
February 1997	60	55	53	
February 1998	55	53	57	
January 1998*	104	92	61	Potential recruitment event
February 1999*	146	135	134	Likely recruitment event
February 2000*	175	169	169	Likely recruitment event
January 2001	77	73	71	
July 2001	67	-	-	
February 2002	65	64	62	
March 2003	47	48	48	
February 2004*	120	115	115	Documented successful recruitment

Event date	Pond persistence (in days)			
	Base case	Scenario 1	Scenario 2	Notes
March 2006*	146	138	137	Likely recruitment event
March 2007	77	73	73	
February 2011*	118	111	111	Likely recruitment event
January 2012	45	-	-	
February 2013	48	42	42	Nesting noted but no successful recruitment
June 2013*	91	74	73	Potential recruitment event
January 2014	62	50	44	
January 2017	71	70	69	Nesting noted but no successful recruitment

Note: An asterisk (*) indicates ponding events that are large enough to lead to successful fledgling of banded stilts. Ponding events were observed at Lake Disappointment in June 2015 and February 2016, but no lake formation is modelled; this is due to the use of Telfer Aero precipitation data (no rain was recorded at Telfer Aero over those periods).

The model simulations found that brine abstraction does have the potential to change the frequency and magnitude of ponding events. Compared to the 'no development' base case:

- Scenario 1 had 24 pond-forming events, instead of the 36 pond-forming events that were estimated to have occurred under base case conditions between 1974 and 2017.
- The reduction in pond-forming events associated with brine abstraction chiefly related to smaller, short-term precipitation events (<50 mm/d rain) that would not have been sufficiently long to support successful banded stilt recruitment. Larger ponding events were not materially affected, except in two cases:
- the modelled event for February 1995 changed from a ponding duration of 101 days to 59 days under an operational scenario and the modelled event for June 2013 changed from a ponding duration of 91 days to about 74 days under an operational scenario.
- Scenario 2 also had 24 pond-forming events, compared to the 36 pond-forming events that were estimated to have occurred under base case conditions between 1974 and 2017. However under Scenario 2 conditions (with 20% reduced runoff) there was a slight (5–10%) reduction in the duration of ponding after a pond-forming rainfall event.

Overall, the modelling indicates that hydrological changes resulting from brine abstraction are unlikely to change the frequency or duration of flooding events required for successful breeding, nesting and fledging of banded stilts.

Potential for increased erosion/sedimentation

Establishment of on-playa infrastructure has the potential to change surface flow during flood events and potentially to concentrate flow, which could result in increased flow velocities, causing scouring of lake sediments and/or of engineered structures (causeways, bunds). The inflow into Lake Disappointment from Savory Creek is expected to be the largest inflow and is therefore the critical inflow. A hydrologic model was developed using RORB software to represent flows from the

Savory Creek catchment and to generate an indicative estimate of the hydrograph resulting from various (relatively large) design storms (Appendix H3).

The flows predicted from these large storm events are substantial (Table 4–9) and would require specific engineering treatments to convey flow to the deeper sections of the lake without causing unacceptable scouring of bund walls, access causeways or brine supply trenches or damage to the proposed brine collection trenches. Information on drainage design is provided in Section 4.2.6.

Table 4–9: Savory Creek peak flows – various AEPs (Appendix H3)

Storm AEP (%)	Storm ARI (years)	Critical duration (hours)	Peak flow (m^3/s)
4.9	20	30	126
2	50	30	209
1	100	24	386

The potential for changes in erosion or sedimentation rates are chiefly of concern from an operational perspective, rather than from an ecological perspective: the project layout is such that areas susceptible to flow concentration are located outside areas occupied by riparian vegetation and the vegetation is therefore at low risk either from erosion or from increases in sedimentation[9]. The risk of high concentrations of suspended sediment is low in a high salinity environment, as suspended clay and silt particles rapidly settle out of the water column when the water is very saline (Figure 4-11).

Figure 4-11: Trial brine trenches, showing low turbidity of water (Lake Disappointment, Oct 2018)

[9] Reward is aware of only one study which mentions impacts of sedimentation on salt marsh vegetation. That study (Coleman et al. 2017) found that increases in sediment deposition enhanced the survival of a South Australian *Tecticornia* species by counteracting the effect of increases in groundwater levels and mitigating the effect of root waterlogging.

4.2.6 Management and mitigation measures

Management of altered flood regimes – depth and duration of ponding

Hydrological modelling of surface water flows with and without the proposed on-playa infrastructure has concluded that changes in depth of water ponding will not be materially altered by the presence of on-playa infrastructure with the implementation of engineering measures outlined below (Appendix H3). This is in part because the area occupied by the on-playa infrastructure is a small percentage of the playa surface (less than 5%), so that the displacement of flood storage capacity is very small. Additionally, engineering works will be provided to convey flows across or around on-playa infrastructure in order to maintain usual depth and duration of flooding.

Routine monitoring will be carried out during wetting events to confirm modelled flood depths and duration.

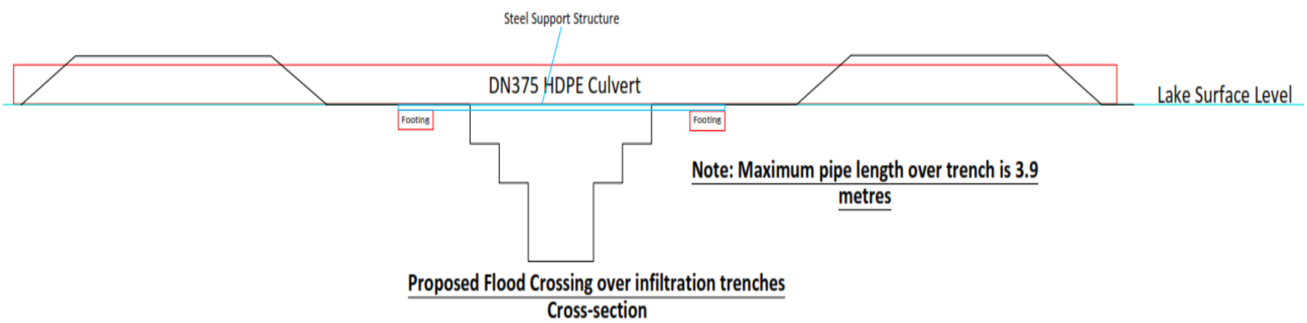
Measures to maintain hydrological connection and prevent erosion

Engineering measures implemented to enable near normal surface water hydrology include the following:

- Floodways or corridors through and around the pond system so that surface water running off the north-west playa shoreline zone can migrate unimpeded to the central pond channel;
- 2,000 m floodway design (gap) in the linear trench system to accommodate substantial stream flow from the Savory Creek feeding into the central pond channel; and
- Surface (including optional submerged) culverts throughout all trench embankments to enable the steady migration of water captured in between embankments (which would otherwise contribute to dam effects) towards the central pond channel.

To maintain hydrological connections, two engineering approaches have been considered. One option is to use culverts or flood crossings to allow surface runoff to steadily migrate across the top of the brine infiltration trenches without entering the trenches (Figure 4-12).

Figure 4-12: Culvert over brine infiltration trench (schematic)



The other option is to establish a floodway (or gap) so that surface water can cross over the trenches towards the main channels near the centre of the playa. This may involve, for example, installing subsurface pipes to convey brine and backfilling the section of trench above the brine collector pipe so that surface water could flow across the backfilled section, towards the central part of the playa. The approximate sizes of the floodway sections required to accommodate surface flow from large storm events are summarised in Table 4–10.

A preliminary assessment has concluded that a combination of the culverted and floodway approaches may be required. In the part of the playa which lies in the flow path of discharge from

Savory Creek, it would be impractical to convey flows using culverts across the top of the trenches, as the flows may be substantial and many culverts would be required. At this location, a better option is to provide floodways at selected locations along the brine infiltration trenches so that flood will not be prevented from reaching the central part of the playa. Reward proposes to implement the engineering measures recommended by Knight Piésold (Appendix H3).

Table 4–10: Infiltration trench gap sizes – various AEPs (Appendix H3)

Storm AEP (%)	Storm ARI (years)	Required floodway length (m)
4.9	20	700
2	50	1200
1	100	2100

Flood events equal to or greater than the 1-in-100 year flood have the potential to breach or overtop the designed trench embankments, enabling fresh water to flood the trench system. The amount of flow that could be retained in the trenches is estimated to be around 0.35 GL (due to the limited storage capacity in the trench system). The amount of water available to then recharge the playa channel system is not materially reduced. Operationally, Reward will have to cease all pond and brine abstraction activities until the natural flood and evaporation processes have occurred, so in effect, the consequence of such flood occurrences on the lake system ecology would therefore be limited.

During the operational phase of the project, Reward would implement and maintain a network of shallow piezometers and/or measuring staves to enable monitoring of ponded water depths in areas surrounding the trench system. This will enable Reward to check the effectiveness of its drainage management system during flood events by measuring (at millimetre scale) the depths of water upstream and downstream of the trenches. Stream gauging will be conducted on Savory Creek (outside the exclusion area) to provide additional information required as input to future surface water models.

In parts of the playa more distant from the Savory Creek mouth, culverts and bunding will be used to convey flow towards and across the infiltration trenches. Appropriately-sized culverts will prevent 'backwater effects', will maintain flow to the deeper channels in the centre of the playa and will ensure that near-shore areas do not become hydraulically isolated from other parts of the playa.

In areas not influenced by the Savory Creek discharge, the height of bunding that would be required to contain and convey flows would be relatively low: the average bund height required to contain the 72-hour 1% AEP storm would be in the order of 0.65 m (Appendix H3). This estimate does not take account of possible seiching or wind effects on water depth. Details of engineering structures required to maintain surface flows would be determined as part of detailed engineering design.

Most of the flow bypass works (including culverts and causeways associated with the trench network) will be decommissioned at project completion: the infiltration trenches will be backfilled and it will no longer be necessary to provide bypassing structures to maintain surface flows.

Measures to protect riparian vegetation

Seasonal variation in inundation is thought to have an important effect on the establishment and persistence of plant communities in the riparian zone of salt lakes (English & Colmer 2011, Konnerup et al. 2015, Purvis et al. 2009). Although vegetation in the riparian zone is generally salt tolerant, different species show widely varying responses to submergence. Sensitivity to submergence in some riparian species, including members of the genus *Tecticornia*, may be greater than sensitivity to drought (Marchesini et al. 2014, Konnerup et al. 2015, Van Etten and Vellekoop 2009). Because of the complexity and variability of the physiological responses of riparian vegetation to inundation, Reward has sought to protect riparian vegetation by establishing a minimum 200 m buffer zone between the nearest lake edge vegetation and any on-playa project infrastructure. Coupled with the engineered drainage measures described above, the buffer zone will help to reduce the likelihood of increased duration or depth of inundation. This will help protect those *Tecticornia* species which may be especially sensitive to the effects of low oxygen conditions and osmotic stress that can develop with prolonged submergence.

Management of flows at drainage line crossings

Reward will upgrade the Talawana Track from the Balfour Downs Road interSection up to and including the Willjabu Track (a distance of approximately 248 km). The purpose of this upgrade is to provide an unsealed road surface suitable for operation of road trains along the alignment. Reward's operating strategy makes provision for occasional interruption of site access. Drainage works will be designed to ensure road availability for at least 330 days per year.

Culverts or flood ways will be installed during construction at all ephemeral creek crossings to maintain flow across the road. The existing crossing at McKay Creek will be upgraded by providing four 900 mm diameter corrugated steel culverts each approximately 17 m long. Erosion protection (rock armouring) will be provided as required. The crossings are designed to overtop at a point adjacent to the culvert(s), mitigating extreme events that could otherwise impede flow and contribute to backwater effects.

4.2.7 Predicted outcomes

Establishment of on-playa infrastructure is unlikely to result in material changes to flooding depths, extent or duration. Extraction of brine is likely to reduce the duration or extent of surface water ponding following smaller storm events (those delivering less than 50 mm/d), but should not materially affect the extent or duration of ponding that results from large storm events. As the successful recruitment of banded stilts relies on larger storm events, brine extraction is not expected to affect banded stilt populations.

A buffer zone of 200 m will be maintained between any on-playa infrastructure and riparian vegetation which could be sensitive to increased inundation. Engineering works will be implemented and maintained to ensure that there is no impediment to surface water flow across the brine collection trench network, so that wet season flows will continue to feed the ecologically important channels near the centre of the playa throughout the operational life of the project. A network of piezometers and/or measuring staves will be established at project commencement to enable ongoing monitoring of playa water depths during inflow events. If the monitoring results indicate that flow from upstream areas is being impeded to an unacceptable degree, additional drainage works will be implemented to maintain flows across or around the on-playa infrastructure. At closure, culverts and bunds associated with the trench network will be removed and trenches will be backfilled to restore flow to approximately the predevelopment condition. Flow diversion structures around the pond structures will be retained at closure.

Surface flows in off-playa areas will be largely unaffected by project implementation. No water will be taken from surface sources and new infrastructure is located out of 1-in-100 year flood zones. Where the existing access roads cross ephemeral creek lines, road upgrade works will include provision of culverts and floodways to prevent backwater effects or flow restriction. Erosion protection will be provided at major crossings, if required to prevent scour or bank erosion.

The residual impacts of project implementation are consistent with EPA's objective of protecting environmental values by maintaining hydrological regimes.

Table 4–11: Summary of impact assessment – hydrological processes (surface water)

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
Brine extraction from trenches	Altered depth, duration, extent or frequency of ponding: impacts on breeding success of migratory birds	Review and update hydrological modelling, incorporating results of local meteorological monitoring and groundwater level data; if drawdown effects are greater than predicted, implement intermittent pumping strategy (cycling between different parts of trench network) Cease on-playa operations following major rainfall events ($\geq$150 mm in under a week) to allow for bird nesting and breeding	Groundwater drawdown records Updated modelling results Operational records (no on-playa operations following major rainfall events) Observations of bird breeding, nesting & recruitment
Establishment of on-playa infrastructure	Altered depth, duration, extent or frequency of flooding Impacts on riparian vegetation health Increased erosion	Maintain exclusion zone at mouth of Savory Creek Implement drainage design (culverts, floodways) to maintain flow across trench network, in consultation with DWER (bed and banks permit, if required) Monitoring of upstream and downstream flood depths and water ponding patterns during and following wetting events Monitoring of health of riparian vegetation	As-built engineering report Surface water monitoring records Meteorological records Vegetation health monitoring results (in annual environmental report)
Establishment of off-playa infrastructure	Obstruction of flow at drainage lines, backwater effects, scouring/erosion Impacts on riparian vegetation health	Implement drainage design (culverts, floodways) to maintain flow along ephemeral watercourses, in consultation with DWER (bed and banks permit, if required) Monitoring of vegetation health along McKay Creek and in McKay Creek delta	As-built engineering reports Vegetation health monitoring results (in annual environmental report) Stream gauge records

4.3 Key factor 1B: Hydrological processes – groundwater

4.3.1 EPA objectives

To maintain the hydrological regimes of groundwater so that environmental values are protected.

4.3.2 Policy and guidance

Table 4–12: Relevant policies, guidelines & standards – hydrological processes (groundwater)

Environmental factor	Relevant policies, guidelines, and standards
Hydrological processes	Barnett et al., 2012. *Australian Groundwater Modelling Guidelines.* DOW, 2009d. Operational policy no. 5.12 – *Hydrogeological reporting associated with a groundwater well licence*. DOW, 2013. *Western Australian water in mining guideline*. EPA, 2016c. *Factor Guidelines – hydrological processes*.

4.3.3 Receiving environment

This Section provides an overview of groundwater hydrology in the Lake Disappointment area. The information presented in this Section draws on baseline studies commissioned by Reward (Table 4–13). Copies of the baseline technical studies are appended to this ERD. Reward commissioned SRK Consulting to conduct an independent review of hydrogeological assessments conducted by others in connection with proposed brine extraction at Lake Disappointment and groundwater extraction from the proposed Cory and Northern Borefields. Copies of SRK's reviews are also appended to this ERD (Appendix I1).

Table 4–13: Summary of investigations - groundwater

Study reference	Description
Appendix D1: Botanica Consulting, 2017. Level 2 Flora & Vegetation Survey - Lake Disappointment Project	Presents results of Level 2 flora and vegetation surveys, including in the proposed borefield areas
Appendix D2: Botanica Consulting, 2017. Lake Disappointment Project - Flora and Vegetation Impact Assessment	Presents an assessment of the potential direct and indirect impacts on flora and vegetation of implementing the Lake Disappointment Potash Project (including impacts associated with modified groundwater hydrology)
Appendix D3: Botanica Consulting, 2017. Soil Characterisation and Assessment on Tecticornia Root Structure of the Lake Disappointment Riparian Zone	Report describes the root architecture of *Tecticornia* plants growing in the riparian zone of Lake Disappointment and summarises information about the physical and chemical properties of soils within the riparian zone
Appendix D6: Hydrobiology, 2017. Memorandum: Lake Disappointment: NDVI, NDWI and ET calculations	Technical memorandum presenting the results of analysis of spectral data to inform an assessment of the likely groundwater dependency of vegetation near Lake Disappointment

Study reference	Description
Appendix F1: Bennelongia Environmental Consultants, 2018. Stygofauna Values at the Lake Disappointment Potash Project	Presents results of a field survey involving collection of 22 samples from nine wells in the proposed borefield and five wells in the surrounding region; the study confirmed the occurrence of stygofauna in the project area: 16 out of 22 samples and 12 out of 14 wells yielded stygofauna; includes preliminary assessment of potential impacts of water abstraction on subterranean fauna values
Appendix F2: Bennelongia Environmental Consultants, 2016. Lake Disappointment - Subterranean Fauna Desktop Assessment	Presents the results of a desktop review conducted to assess the likelihood of subterranean fauna occurring in the project area. Database searches covered a search area of 100 km by 100 km around the project
Appendix F3: Harewood, G, 2016. Stygofauna Survey (Level 1) – Lake Disappointment Potash Project	Presents the results of a reconnaissance level subterranean fauna survey near Lake Disappointment; samples were taken from 6 bores in the proposed production borefields and 2 regional bores.
Appendix I3: Strategic Water Management, 2017. Lake Disappointment - Hydrogeological Assessment of the Impact of Process Water Abstraction from the Cory Borefield, an H2 Level Assessment for 1.5 GL/year	Hydrogeological assessment of the Cory Borefield area; outlines the hydrogeological investigation program and presents the results from the analysis of test pumping and analytical modelling of the capacity to supply 1.5 GL/a from the Gunanya Sandstone fractured rock aquifer
Appendix I4: Strategic Water Management, 2017. Lake Disappointment - Hydrogeological Assessment of the Impact of Process Water Abstraction from the Northern Borefield, an H2 Level Assessment for 2 GL/year	Hydrogeological assessment of the Northern Borefield area; outlines the hydrogeological investigation program and presents the results from the analysis of test pumping, analytical and numerical modelling of the capacity to supply 2 GL/a from the Tertiary aquifer
Appendix I5: Global Groundwater, 2017. Lake Disappointment – Hydrogeological Assessment of the Impact of Brine Extraction on the Lake Fringe	Hydrogeological modelling and estimation of potential groundwater drawdowns arising from abstraction of up to 63 GL/a of brine from shallow trenches at Lake Disappointment, assuming a 10-year 'no-recharge' scenario

Hydrogeological setting

The subsurface stratigraphy at and surrounding Lake Disappointment comprises a variable thickness of Quaternary and Tertiary Age transported material overlying older weathered Neoproterozoic sedimentary basement rock (sandstone, siltstone and shale). A summary the main stratigraphic units is provided in Table 4–14.

Table 4–14: Stratigraphic units in and near Lake Disappointment

Unit	Description	Typical thickness
Aeolian sand (Qpe) and sand plains(Qs)	Longitudinal dunes comprising dark red wind-blown sand and clayey sand; sand comprises iron stained quartz grains. Dunes are orientated approximately east-west; extensive coverage to the north of the playa	Up to 10 m
Quaternary creekline (Qa) and delta deposits (Qw)	Alluvial deposits: silt, sand, and gravel; in drainage channels and on floodplains; colluvial clay, silt, sand, and gravel in distal outwash deposits in poorly drained areas; includes some weakly cemented sandy conglomerate	Up to 5 m
Tertiary sediment (Cz)	Rounded sands and fine gravel in a clay and silt matrix; weakly cemented in places to form a vuggy conglomerate	Up to 26 m
Tertiary sediment (Cz)	Sandy, silty clays, green brown dense and indurated	Up to 50 m
Tertiary sediment (Cz)	Clayey sands with some sandy zones and locally weathered bedrock	Up to 20 m
Upper lake bed (Qh)	Can be highly permeable: permeability is dominated by interconnected porosity of thin gypsum beds	Up to 5 m
Lower lake bed (Q/Tpl)	Mostly low permeability clay with rare thin, disconnected zones of gypsum with development of secondary porosity	Up to 30 m
Weathered basement rock (PUsx and PUu)	Interbedded sequence of fine to medium grained sandstones (with local beds of conglomerate and grit), finely laminated siltstone and shale	Up to 90 m
Weathered basement rock (PUw)	Mostly clays and silts with some permeable sand sections	

Beneath the Lake Disappointment playa, a thick layer of alluvial/lacustrine sediments overlies the basement rock. External to the playa, relatively recent aeolian sands can directly overlie the basement fractured rock system, but in some locations there is a layer of older alluvial sands, clays and sandy clays between the recent aeolian sediments and the Proterozoic basement (Figure 4-13). Geological logs from within the McKay Creek catchment indicate a secondary period of deposition during the Quaternary era where the fluvial sediments are deposited within the older Tertiary alluvial layers (Figure 4-14).

The hypersaline brines targeted by the Lake Disappointment Potash Project lie within the alluvial/lacustrine sediments. The fresh-to-brackish water that would be abstracted from the proposed Cory Borefield will target the Gunanya sandstone fractured rock aquifer (Figure 4-13), while the proposed Northern Borefield will target the deeper units of the Tertiary sequence of sands, clays and sandy clays above the basement rock (Figure 4-14).

Figure 4-13: Conceptual hydrogeological setting of Cory Borefield

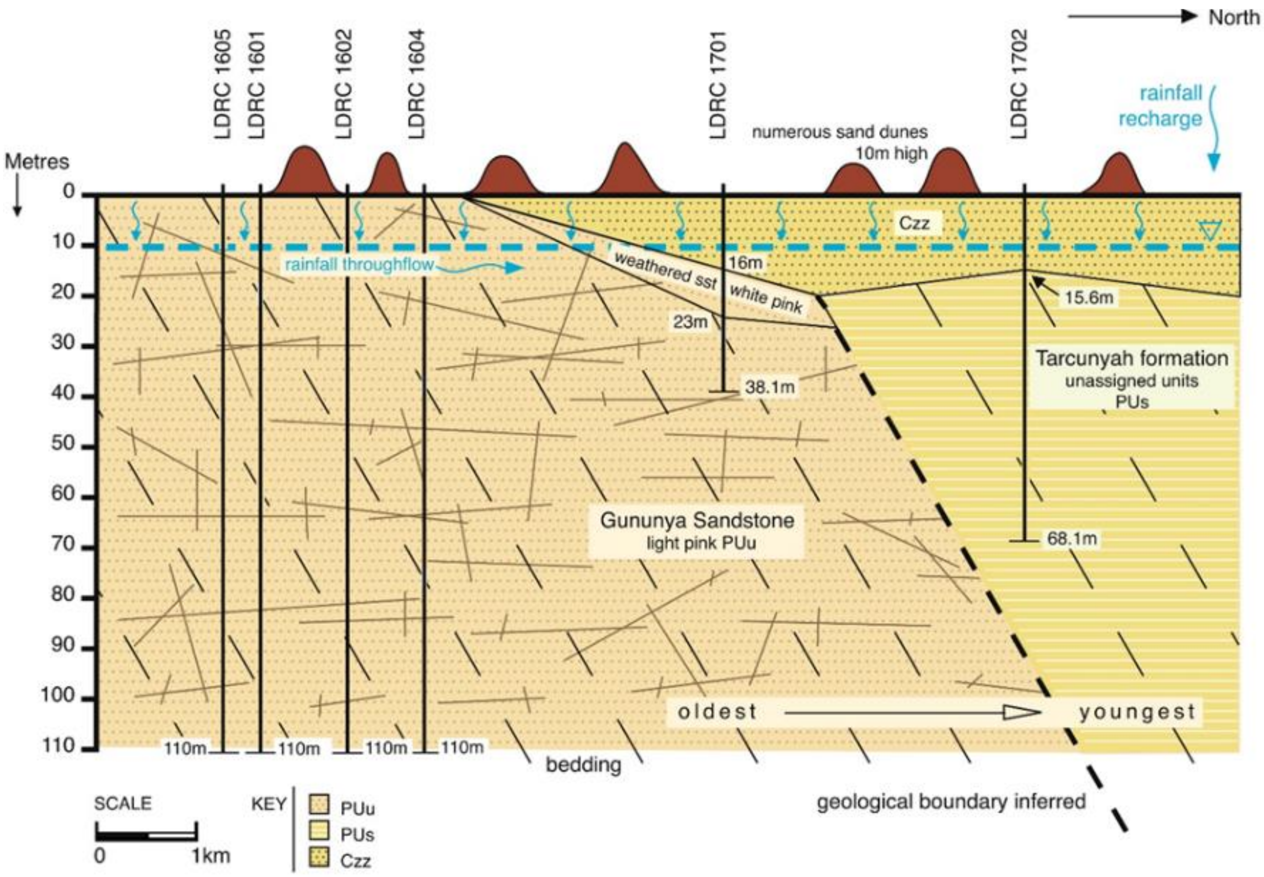
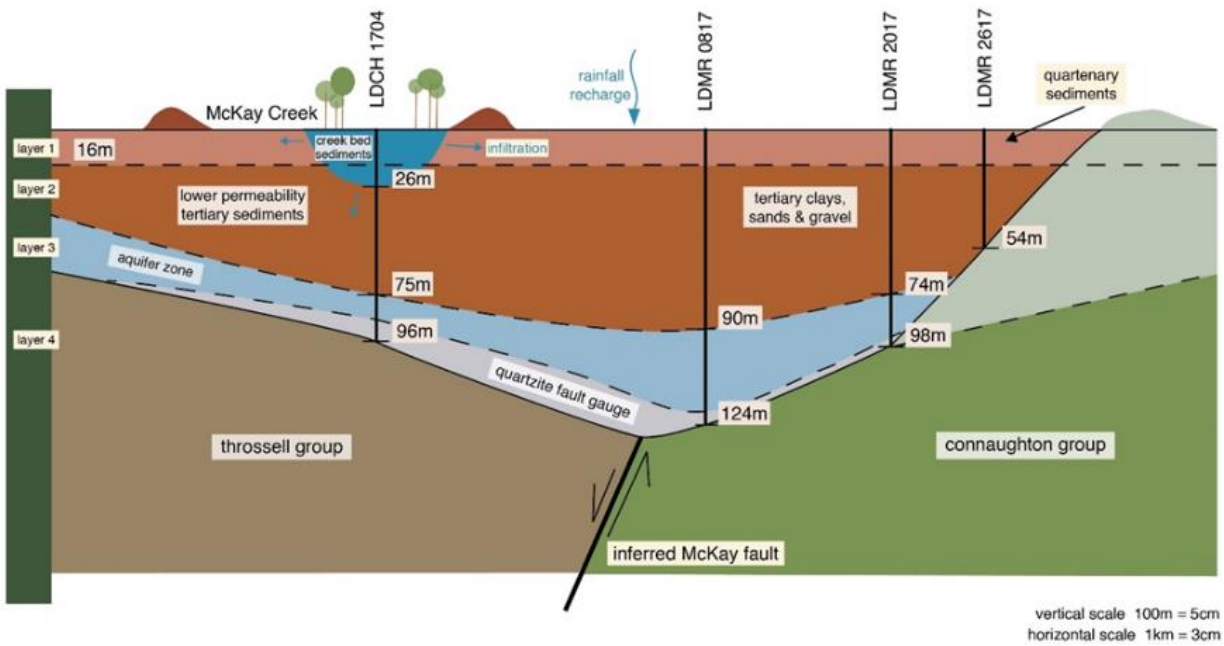


Figure 4-14: Conceptual hydrogeological setting of Northern Borefield



Hydrological processes

Water enters the lake sediments from rainfall, surface water runoff and groundwater discharge from surrounding areas. Water is lost from the lake by evaporation. Groundwater inflows to the sediments beneath the playa from the surrounding groundwater catchment to the west, south and east are estimated to contribute in the order of 17.5 GL annually. Groundwater recharge from infiltration of rainfall and surface water runoff from surrounding areas are likely to be considerably greater (by an order of magnitude in average years).

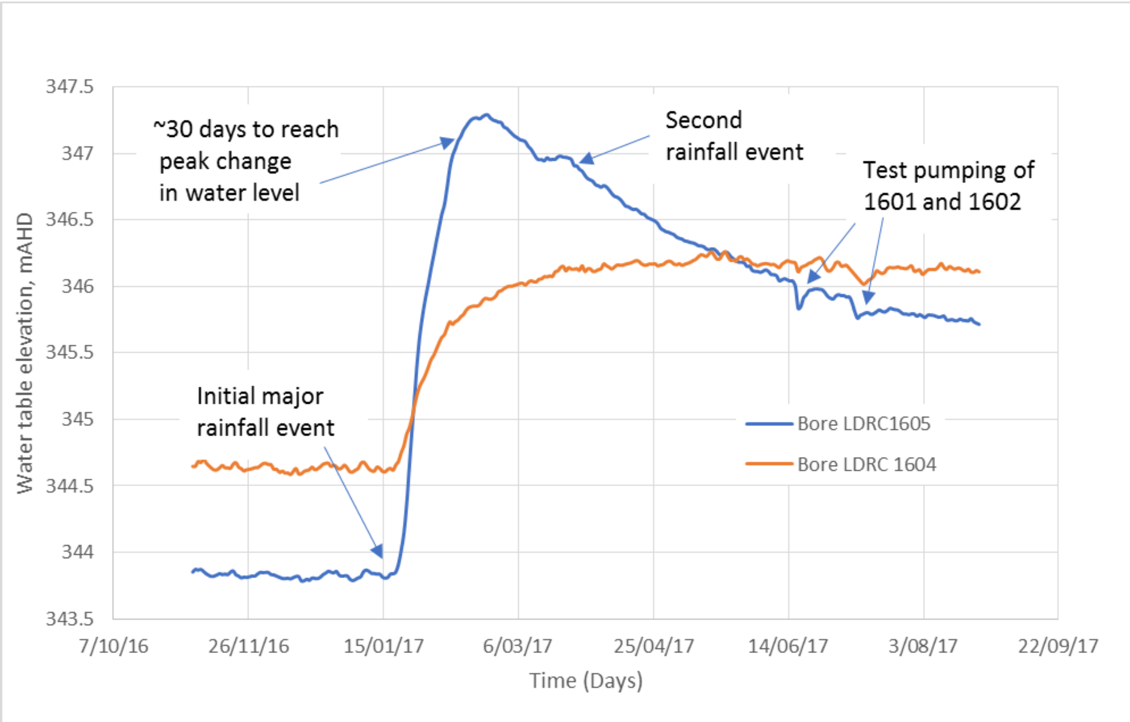
The depth to groundwater beneath the playa is very shallow: typically in the order of 0 m to 0.5 m below the playa surface. The water level beneath the playa is relatively stable with fluctuations over the annual cycle in the order of 0.5 m. The stability of the groundwater levels indicates that the depth to which evaporation can remove water from the lake is relatively shallow and probably less than 1 m below the playa surface and also that evaporative water losses are approximately equal to groundwater inflow. During dry periods, the groundwater levels remain relatively constant (i.e. they do not continuously decline through the dry season), but following a rainfall event groundwater levels can respond quickly and rise by up to about 0.5 m.

The depth to groundwater in the proposed borefield locations north of the Lake Disappointment playa is typically in the order of 13 m below ground level at the end of the dry season. Depending on the duration and magnitude of rainfall events, groundwater levels can rise to depths as shallow as 6 m below ground level during the wet season. The groundwater flow direction in the proposed borefields is from the north-west to the south-east, although localised transient reversals of flow gradients may occasionally occur in response to heavy rainfall events. The groundwater table typically is a subdued reflection of the local topography. Flow gradients are flat, ranging from about 1 in 500 to 1 in 1000.

The Cory Borefield is recharged directly by rainfall and indirectly by water drainage off the McKay Range, 20 km west of the proposed borefields. The superficial aquifer in Northern Borefield area, which overlies and is separated from the target groundwater abstraction zone by a substantial aquiclude, is directly fed by McKay Creek which flows strongly after even moderate rain events.

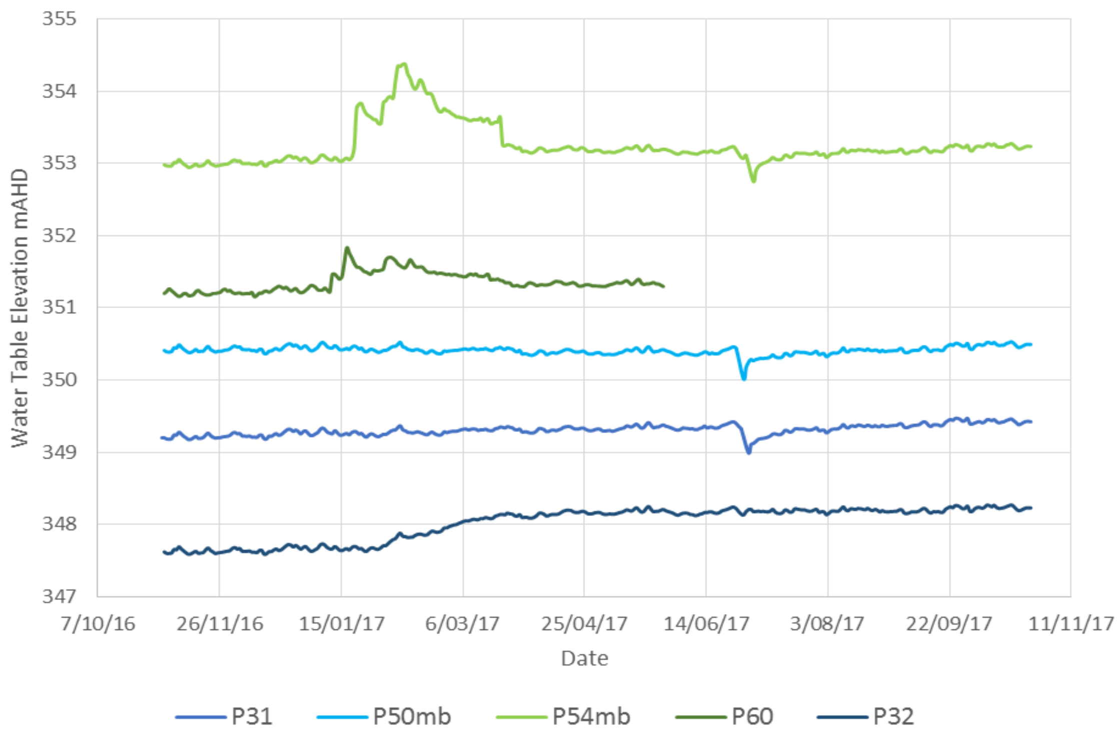
Groundwater responses to large rainfall events are typically rapid. The persistence of changes in groundwater level after a rain event is variable: in some location the increase in water level may persist for many months (Figure 4-15), while at other locations the groundwater levels initially decline quickly, but slow as the hydraulic gradient becomes flatter and the regional water table begin to equalise (Figure 4-16).

Figure 4-15: Water table response to 2017 wet season – proposed Cory Borefield



Areas in very close proximity to incised creek lines, such as the McKay Creek, show distinctive responses which reflect the proximity of the monitoring point to the drainage channel and also the water storage characteristics of the aquifer at a local scale. Monitoring points remote from the influence of drainage channels (e.g. in the sand plains north of McKay Creek) typically show an attenuated recharge response indicative of a diffuse recharge mechanism (Figure 4-16).

Figure 4-16: Water table response (2017) – sand plain within proposed Northern Borefield



Groundwater levels in monitoring points directly in the drainage flow path respond quickly, but also subside quickly after flow along the creek stops (Figure 4-17). Monitoring points in the delta area at the eastern end of McKay Creek respond more slowly, but the increase in groundwater levels is more persistent (Figure 4-18). The ability of the delta area to retain water and the capacity of the shallow aquifer to absorb large volumes provides a buffer against the effects of the dry season providing a local fresh water source all year round. The large eucalyptus trees present in the McKay Creek delta most likely represent an 'inflow dependent' vegetation community that relies on periodic flows along the creek line.

Figure 4-17: Groundwater response: bores close to McKay drainage channel (Northern Borefield)

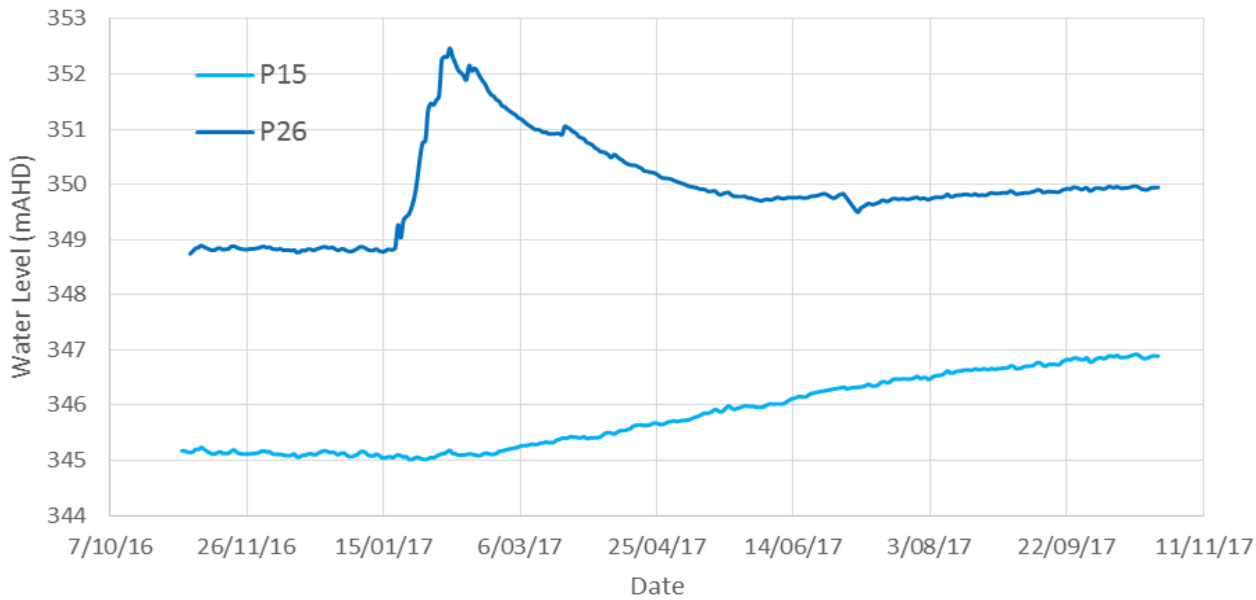
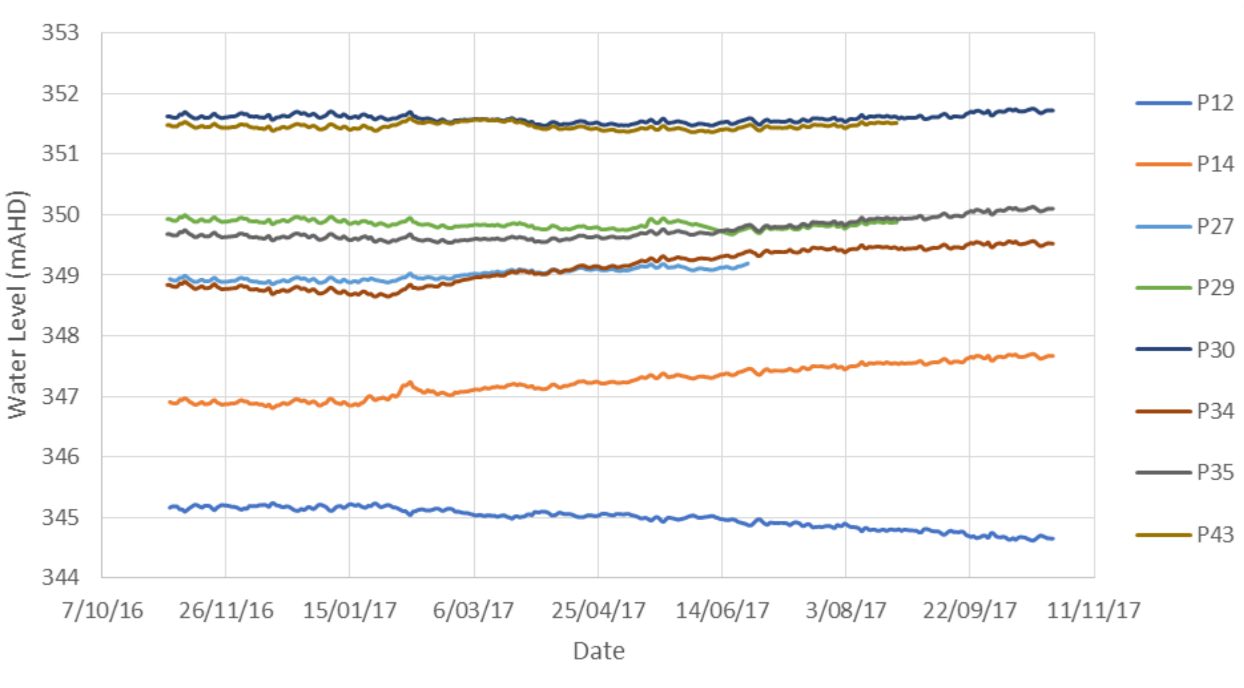


Figure 4-18: Groundwater response: bores not closely associated with McKay drainage channel



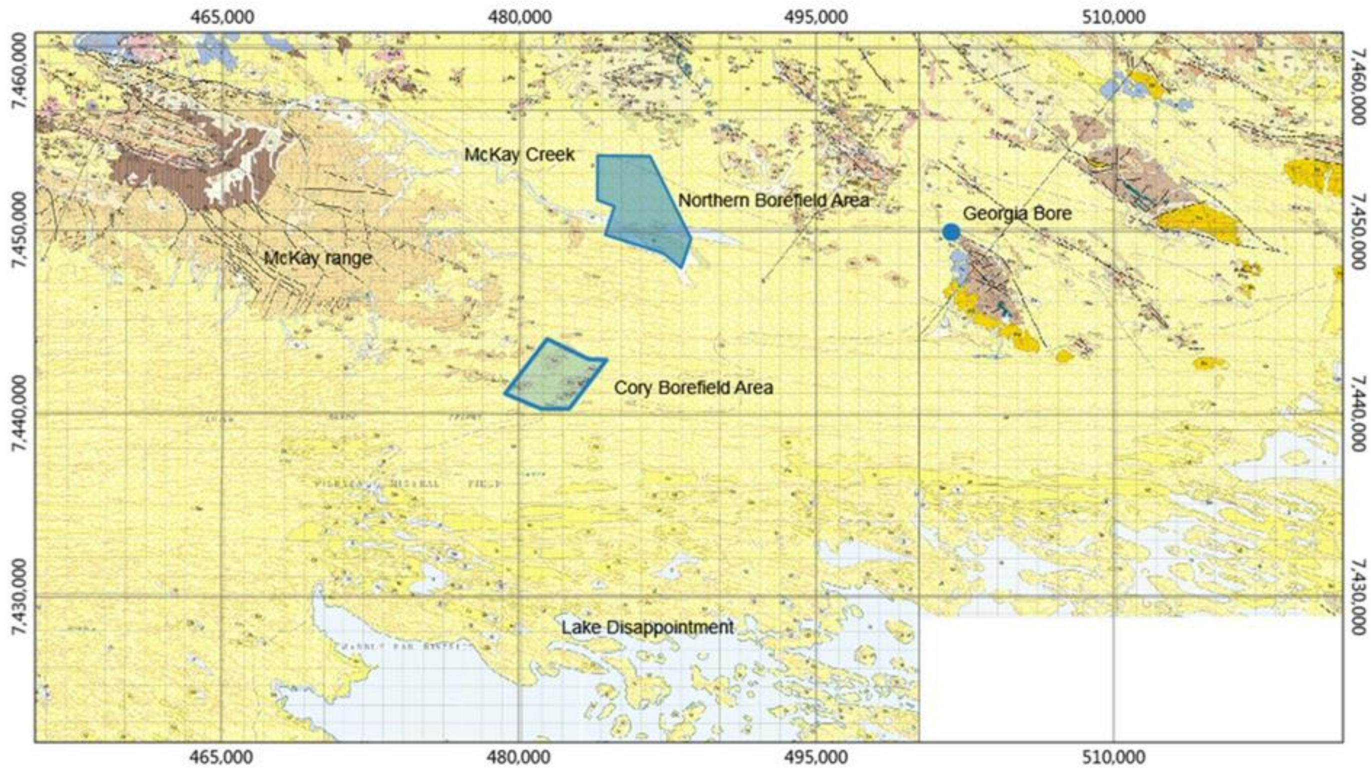
Groundwater users

The only existing groundwater use in the proposed Cory Borefield area is from the Cory Bore itself. Reward holds a groundwater allocation of 90,000 kL/a under groundwater licence GWL182580 to take water from the Cory Bore for use at Reward's exploration camp. The bore is pumped intermittently via a 20 m pipe into a 10,000 litre tank and transferred to the camp via a standpipe and truck operation. The water is processed through a reverse osmosis plant at the site to make it suitable for domestic use. Well 21 is located approximately 5.5 km to the south of the Cory Bore, along the Canning Stock Route. This well has been long abandoned and has partially caved.

Georgia Bore is located approximately 20 km to the north-east of the proposed Cory Borefield (Figure 4-19). CRA Exploration drilled the Georgia Bore in 1990 for an exploration camp water supply. This bore is still functioning and has been fitted with a hand pump. It is reportedly used by travellers along the Talawana Track and Canning Stock Route. The bore was drilled to 35 m depth, the last 20 m being in sandstone of the Throssell group, a fractured rock aquifer in a different geological setting to the aquifers targeted by Reward's proposed Northern Borefield.

There are currently no other water-using activities in the vicinity of the proposed Cory and Northern Borefields. Groundwater use by vegetation and subterranean fauna is discussed in Sections 4.5 and 4.7, respectively.

Figure 4-19: Location of Georgia Bore, relative to proposed borefield



4.3.4 Potential impacts

Potential impacts on groundwater hydrology values—and on other environmental values affected by on groundwater hydrology—are summarised in Table 4–15.

Table 4–15: Excerpt from project risk register – hydrological processes (groundwater)

Event description	Potential impact
Brine abstraction from trenches results in water table drawdown	Adverse impact on health of riparian vegetation
	Loss of subfauna habitat
	Oxidation of shallow sediments results in acidification and mobilisation of metals
	Reduction in water available to other water users
Water abstraction from lower salinity borefields results in water table drawdown	Adverse impact on health of groundwater dependent vegetation
	Loss of subfauna habitat
	Reduction in water available to other water users
Seepage of water from production ponds results in groundwater mounding	Adverse impact on health of riparian vegetation

4.3.5 Impact assessment

Predicted drawdowns from brine abstraction

To simulate the greatest potential impact (worst case scenario), a transient simulation for brine abstraction from the proposed network of trenches on the Lake Disappointment playa was run, assuming that there are no significant rain or surface water inputs to the playa for 10 consecutive years. This scenario is considered highly unlikely (very conservative). After one year of continuous brine abstraction at a rate of 63 GL/a, the groundwater drawdown cone is predicted to extend for a distance of approximately 500 m from the trench centreline (Appendix I5). After 10 years of brine abstraction (assuming no recharge), groundwater drawdown of up to 0.7 m is predicted to occur at a distance of up to 1.7 km from the nearest trench (Figure 4-20 and Figure 4-21).

Areas landward of the playa edge are unlikely to experience groundwater drawdowns of more than 0.3 m, even under the assumption of a 10 year drought. This means that under average climatic conditions, the effects of brine abstraction will not be evident beyond the playa perimeter. The potential for indirect impacts on the health of riparian vegetation, including *Tecticornia*-dominated vegetation communities, is accordingly low.

Figure 4-20: Schematic cross-section – groundwater drawdown near brine trenches

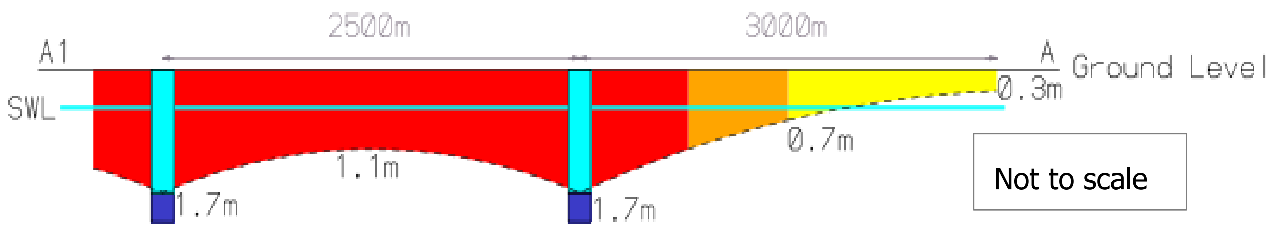
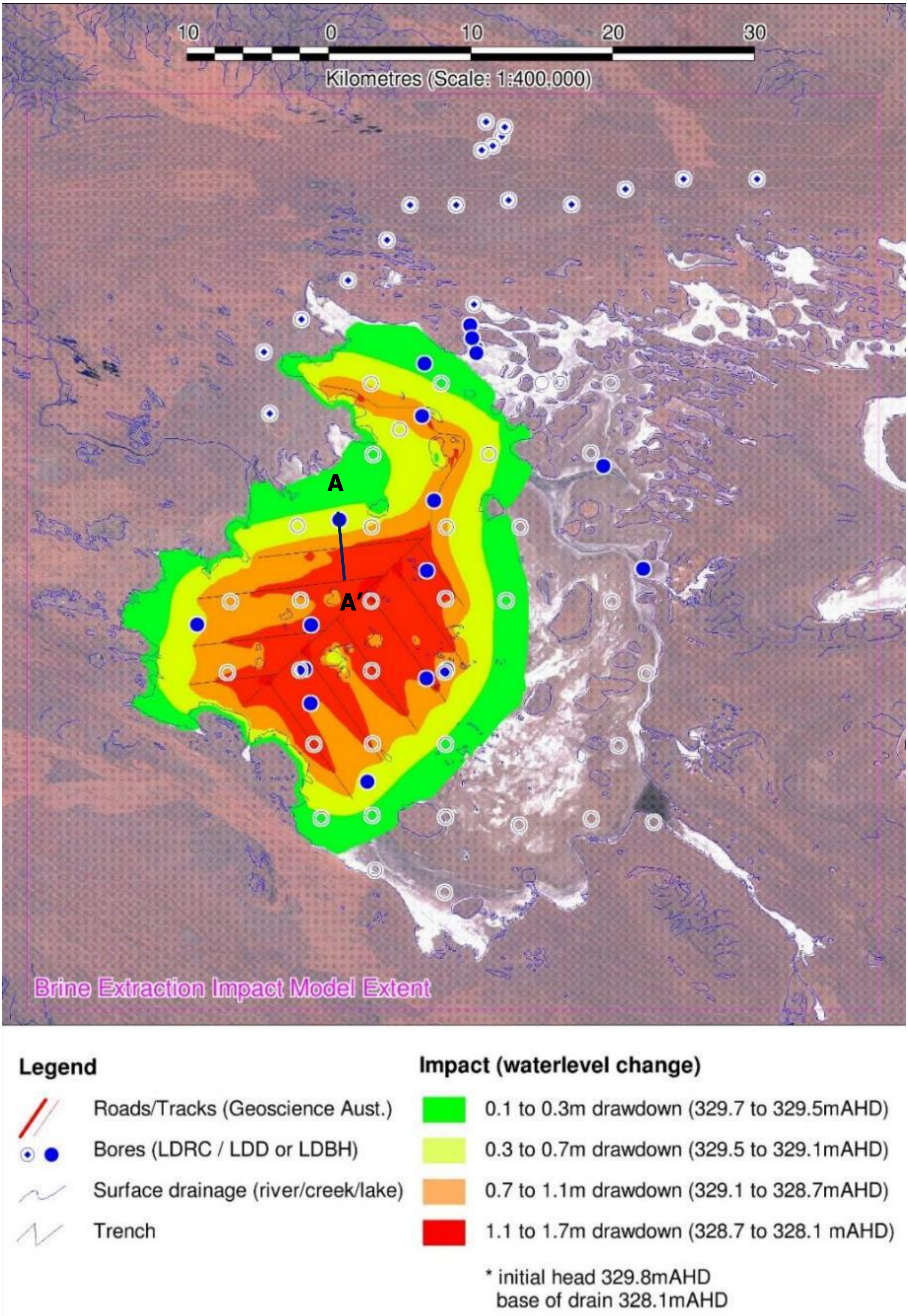
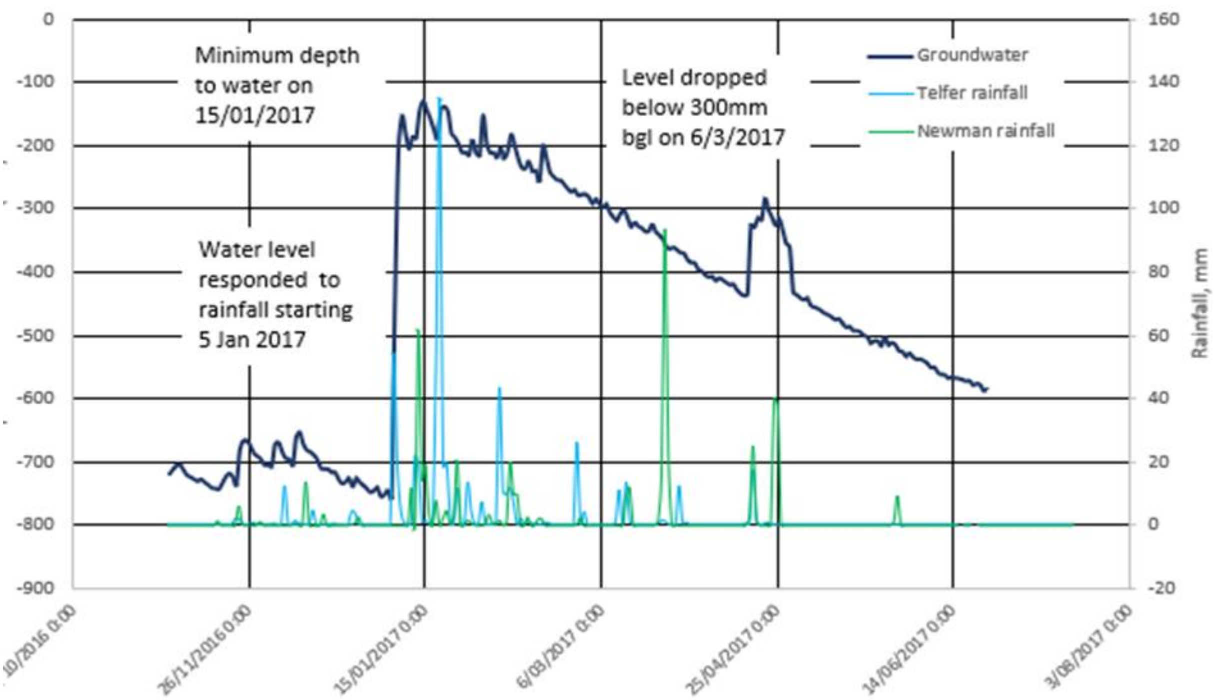


Figure 4-21: Estimated maximum drawdown extent (assumes no recharge for 10 years)



For comparison, the typical variability in groundwater levels in the riparian zone at the north-west corner of the Lake Disappointment playa is shown in Figure 4-22.

Figure 4-22: Groundwater response to 2017 rainfall events (51K 471323mE, 7426684mN)

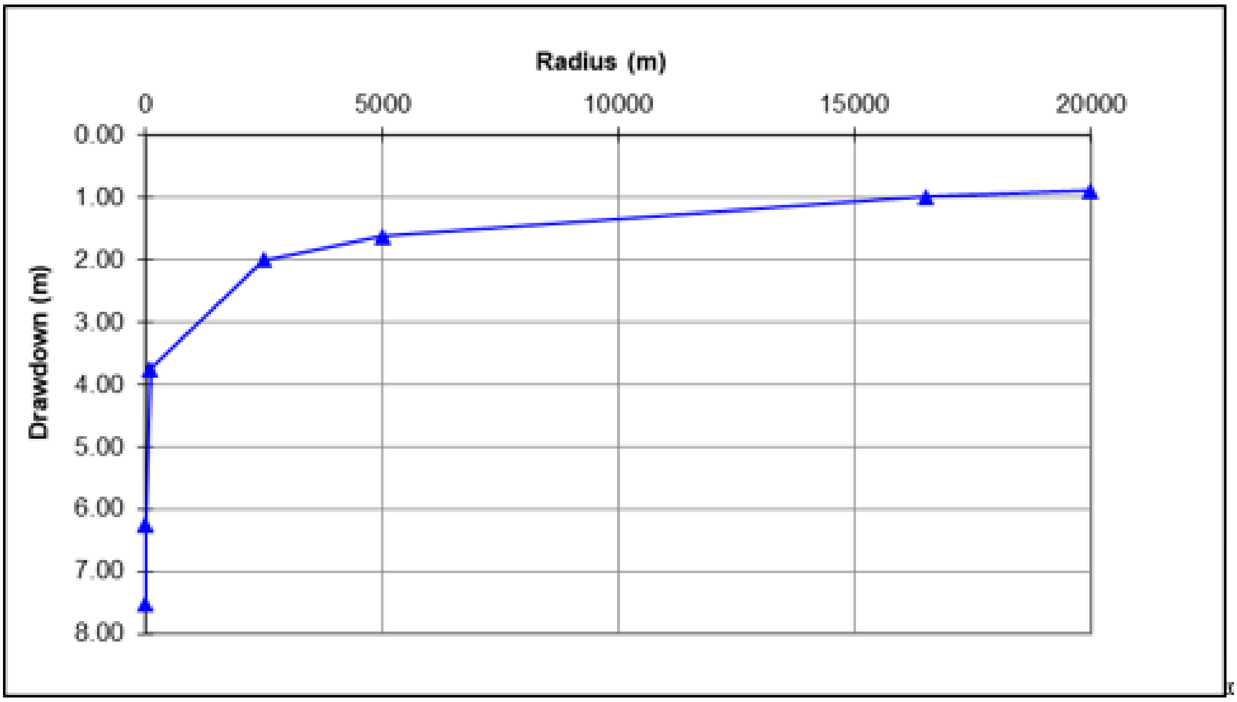


In the absence of any rainfall recharge, areas closer to the trench centrelines would experience more pronounced drops in water level, but even during a prolonged drought the maximum depth of drawdown (even very close to the point of brine abstraction) would not exceed about 1.5 m, as the depths of the trenches are themselves relatively shallow (Figure 4-20). Under normal conditions, the rate of pumping would be managed so that brine withdrawal does not significantly exceed influx from the walls and base of the trenches. The level of certainty surrounding the predicted groundwater drawdowns from brine abstraction is high, as the predictions are based upon field scale trials which included monitoring of surrounding water levels during test pumping from trenches over a period of several days.

Predicted drawdowns from groundwater abstraction at Cory Borefield

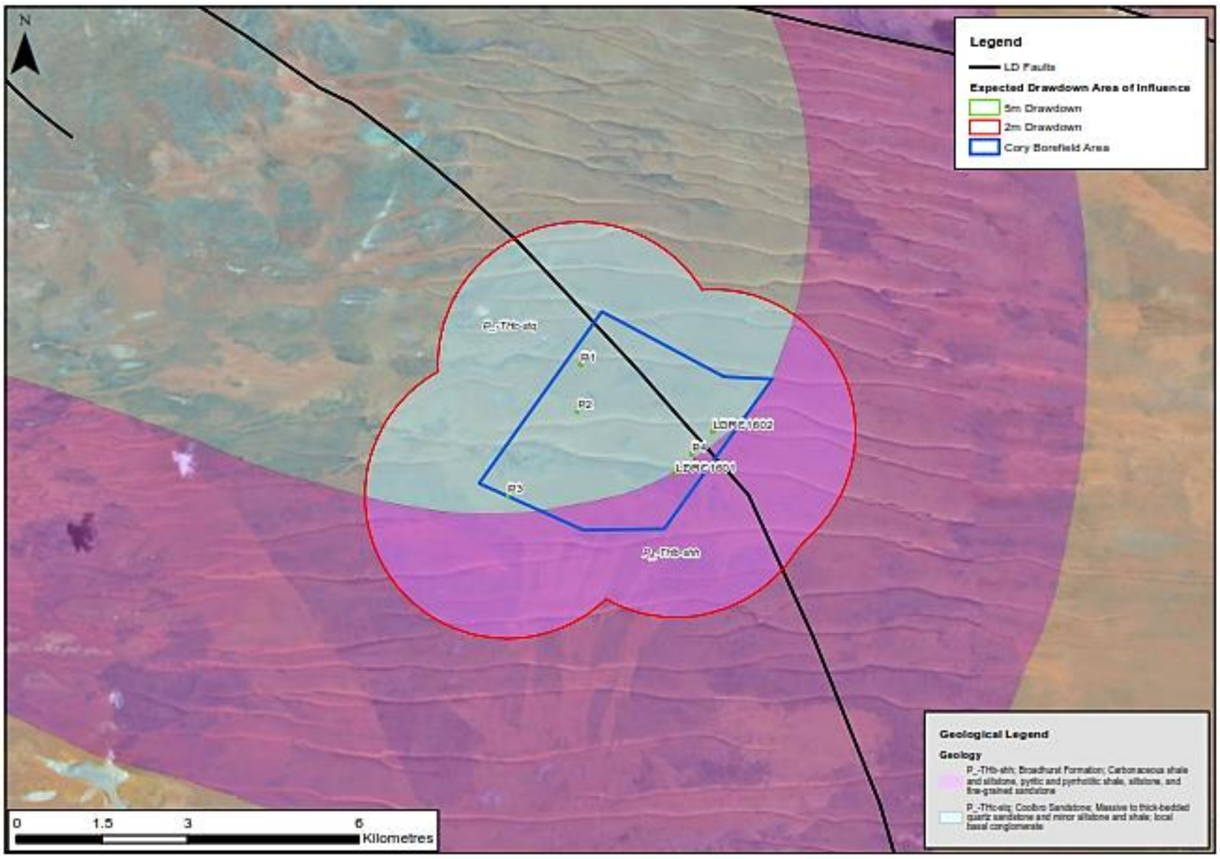
The Coolbro (previously named Gunanya) Sandstone is the target aquifer of the Cory Borefield. The nominated area of the borefield represents only a small proportion of the overall Gunanya Sandstone aquifer occurrence in the project locality. It is proposed to abstract 1.5 GL/a of brackish (TDS ~2500 mg/L) groundwater from a network of at least six bores over the 20-year project life. Bores will be screened from depths of approximately 10 m below ground level to a nominal depth of 150 m. Groundwater abstraction from the fractured rock aquifer will create a cone of depression within the aquifer, steepening the local hydraulic gradient and inducing flow from the surrounding fractured rock system. The lateral extent of the drawdown cone is estimated to range from less than 2 m (at a distance of up to 2.5 km) to about 7.5 m at the point of abstraction (Figure 4-23). A plan view of the estimated zone of influence of the Cory Borefield after 30 years of water abstraction at a rate of 1.5 GL/a (assuming no recharge) is shown in Figure 4-24.

Figure 4-23: Cory Borefield – cross-section of estimated groundwater drawdown (Appendix I1)



Note: Drawdown shown in Figure 4-23 is based on 30 years of pumping and assumes no groundwater recharge during the entire operational period

Figure 4-24: Life of project groundwater drawdown contours – Cory Borefield (Appendix I1)



The assumptions included in modelling the extent and magnitude of groundwater drawdown at the Cory Borefield are very conservative: direct recharge over the aquifer outcrop area in an average year is estimated at approximately 1.3 GL (Appendix I3). Recharge to the borefield is via direct infiltration of rainfall, groundwater throughflow and leakage from the overlying Quaternary sediments. The difference between the proposed annual abstraction (1.5 GL/a) and average recharge will be met by leakage from overlying formations and aquifer storage. Aquifer storage will be periodically replenished in above average rainfall years. No modelling has been done specifically to estimate groundwater recovery after project completion; however, based on the results of pumping tests completed to date and typical aquifer hydraulic parameters, it is likely that the groundwater will recover to approximately 90% of the premining water table level within 10 years of cessation of pumping (Appendix I1).

Predicted drawdowns from groundwater abstraction at Northern Borefield

Baseline hydrogeological investigations in the proposed Northern Borefield have defined three broad zones within the Quaternary and Tertiary sediments overlying the Neoproterozoic basement rock (see also Table 4–14):

- A shallow surface layer of high permeability vuggy conglomerates and weakly cemented sands
- A lower permeability layer of clays with some interbedded zones of greater sand and silt content
- A basal layer of sands, sandy clays and some quartzite within a sandy clay.

The second layer within the Quaternary/Tertiary sequence acts as an aquiclude, restricting movement of groundwater between the Layer 1 shallow aquifer and the Layer 3 deeper aquifer. The lack of interaction between Layer 1 and Layer 3 is evident in the difference in hydrochemistry between the two layers and is also indicated by the different groundwater levels and groundwater dynamics of the two layers. The groundwater within the unconfined surface aquifer can be very fresh with a conductivity typically of 400 µS/cm to 600 µS/cm, consistent with short-term streamflow after rainfall. The conductivity of the groundwater from Layer 3 is much higher at 14,000 µS/cm, indicating a far longer residence time.

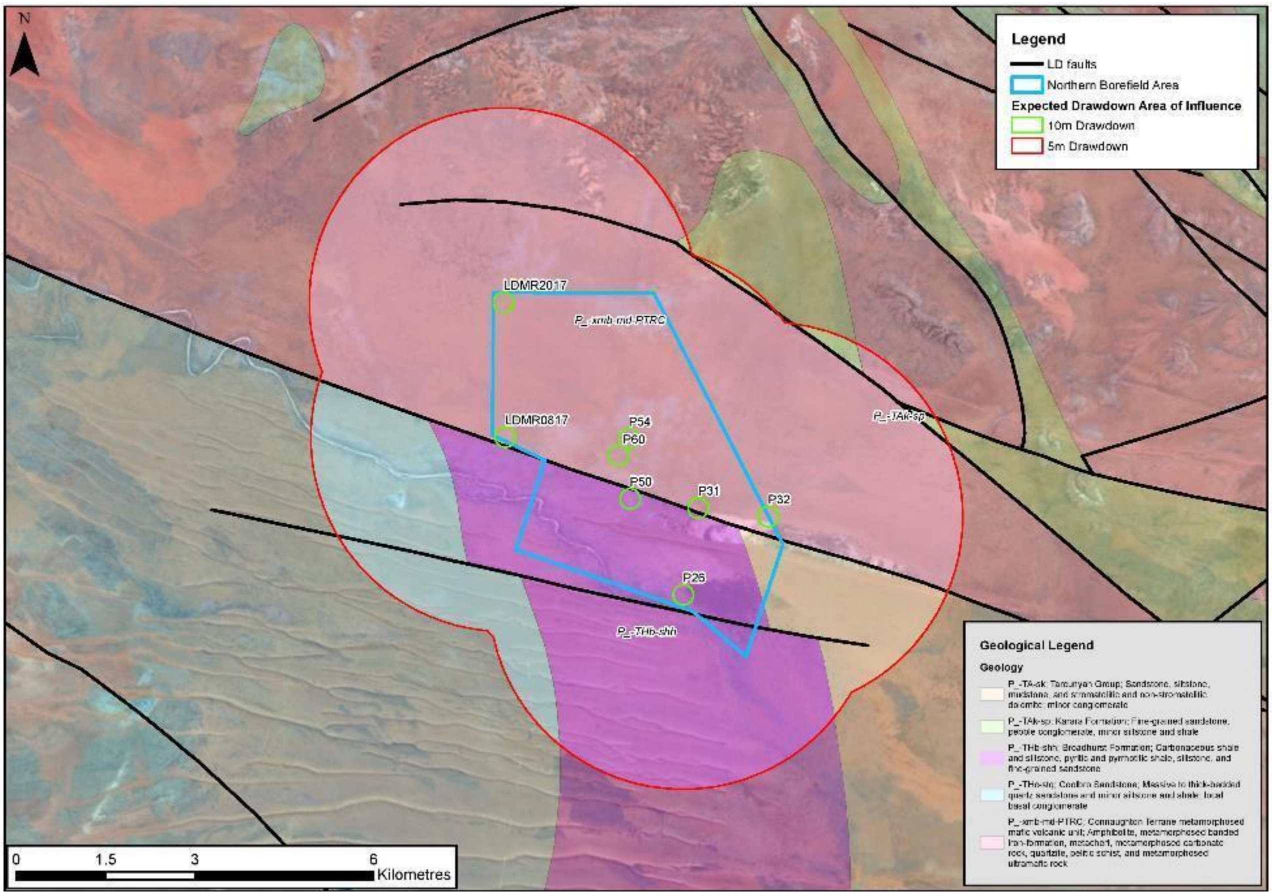
Proposed production bores at the Northern Borefield would draw up to 2 GL/a of brackish to saline water (TDS range from 2200 mg/L to 17,000 mg/L) from the basal layer of Tertiary sands and sandy clay overlying the McKay fault zone. The nominated area of the Northern Borefield represents only a small proportion of the overall Tertiary cover and the projected strike of the fault in the project locality.

The proposed Northern production borefield will consist of up to 18 production bores, each with one monitoring bore screened in the target aquifer and a short monitoring bore screened in the upper aquifer. Production bores would be screened in the basal sand layer below the intermediate clayey aquiclude. A regional monitoring network of shallow and deep monitoring bores will also be installed, comprising not fewer than 10 monitoring bore pairs. All bores will be fitted with data loggers and the resulting data will be reviewed monthly.

Numerical modelling of the proposed Northern Borefield predicts that groundwater abstraction from the confined Tertiary aquifer will result in the removal of groundwater from storage. Pumping from storage will create a pressure drop within the aquifer, which will draw water towards the pumping bores, creating a cone of depression within the confined aquifer. The model predicts that abstraction of water from the confined aquifer will result in minimal drawdown (less than 1 m) in the unconfined superficial (Layer 1) aquifer (Appendix I4). The estimated maximum extent of groundwater drawdown in the Layer 3 aquifer is 5 m which extends over a radius of approximately 6 km, as shown in Figure 4-25.

As with the Cory Borefield, the modelled extent of groundwater drawdown at the Northern Borefield is likely to be an overestimate, as it does not include any recharge for the entire duration of the project.

Figure 4-25: Groundwater drawdown contours – Northern Borefield (Appendix H1)



Seepage from on-playa pondage

Seepage from water impoundments has the potential to result in local mounding of groundwater near the perimeter of the impoundment. If allowed to persist, groundwater mounding can adversely affect the health of vegetation sensitive to submergence, mainly by reducing the amount of oxygen available to the plant roots. Salinity effects on vegetation are unlikely, as vegetation growing in close proximity to the playa is likely to be highly salt tolerant.

The salt production ponds proposed at Lake Disappointment will occupy a maximum area of approximately 3693 ha. The depth of brine stored in the ponds will typically be no more than 0.3 m, although a ponding depth of 0.8 m has been allowed in the small premix pond. Therefore, the hydraulic head driving seepage is relatively small. A layer of dense, precipitated salt approximately 0.5 m thick will form in the base of the ponds during the first two years of operation. Once established, this salt pavement will limit vertical seepage from the ponds.

The ponds will be constructed of local borrow materials from within the disturbance footprint, supplemented (if required) by borrow from an off-playa borrow pit. The soil used for pond embankments and floors will be moisture conditioned and compacted to 95% of standard maximum dry density, to achieve a target permeability of 5 x 10^{-9} m/s. It is not currently proposed to line the floors of the ponds with synthetic liners.

If necessary, lateral seepage through the pond embankments will be controlled by including a low permeability compacted zone in the perimeter embankments and/or a vertical cutoff trench keying into the denser, less permeability sediments at a depth of 1 m to 1.5 m below the playa surface. In the event that some seepage from the ponds were to occur, especially during the first two years of the project before the salt pavement base is fully established, it is unlikely that a pronounced groundwater mound would develop. This is because the brine abstraction trenches (from which brine is continuously pumped) will tend to create a local hydraulic gradient that causes shallow seepage to flow from the ponds towards the trenches (Figure 4-21). The 200 m offset distance between on-playa infrastructure and any surrounding riparian vegetation will also reduce the risk that vegetation will be exposed to groundwater mounding effects.

Impacts on other water users

There is negligible risk of significant impact to other (human) groundwater users. The nearest groundwater bore that is currently used by others is the Georgia Bore, 15 km east of the proposed Northern Borefield and 18 km north-east of the proposed Cory Borefield. Georgia Bore lies well beyond the predicted zone of groundwater drawdown that might result from abstraction of water from either the Cory Borefield or the Northern Borefield (Appendices I3 and I4). Moreover, the Georgia Bore draws on a different aquifer to those targeted by Reward. Accordingly, the risk of any discernible reduction in water availability is very low.

There are no other existing users of the brine in sediments beneath the Lake Disappointment playa.

Impacts on subterranean fauna

Groundwater salinity in the saturated sediments from which brine will be taken is typically in the order of 250,000–300,000 mg/L. This level of salinity is too high to provide suitable habitat for stygofauna. The saturated zone beneath and immediately surrounding the playa is too shallow to provide suitable troglofauna habitat. Accordingly, any changes to hydrological processes arising from the abstraction of brine from trenches will not affect subterranean fauna.

Baseline surveys have confirmed the presence of stygofauna in the proposed borefields, as well as in regional bores remote from the influence of proposed groundwater abstraction from production bores. Stygofauna sampling to date has included recovery of 22 samples from nine wells in the proposed borefields (six in the Northern Borefield and three in the Cory Borefield) and from five wells in the surrounding region. Stygofauna were found in 16 of 22 samples from 12 of 14 wells, although two of the regional wells yielded only rotifers, nematodes and a very widespread cyclopoid copepod. The proposed Cory Borefield appears to host more stygofauna than the proposed Northern Borefield. The fauna assemblages in the two borefields appear to be distinct from one another (Appendix F1).

Overall, the documented stygofauna community at Lake Disappointment and in the surrounding region is modest compared with many areas of the Pilbara and Yilgarn (Appendix F1). During the baseline studies, six of the stygofauna species collected at Lake Disappointment (including sampling of regional bores) have not previously been reported. Of these, two species, *Tubificidae* sp. B03 (LD) and nr *Pilbarus* sp. B07, are locally extensive and were recovered from areas outside the proposed borefields and predicted zones of groundwater drawdown. The remaining four species have so far only been recovered from bores constructed within the proposed borefields:

- *Enchytraeidae* sp. B18 (LD) was recorded only within the proposed Northern Borefield (at P26, P32 and P54);
- *Enchytraeidae* sp. B19 (LD) was recorded only within the proposed Northern Borefield at P54;

- *Atopobathynella* sp. B27 was recorded only within the proposed Cory Borefield (at bores LDRC1601 and LDRC1602); and
- *Dussartstenocaris* sp. B08 was recorded only within the proposed Cory Borefield (at bores LDRC1601 and LDRC1602).

The Northern Borefield will abstract from relatively deep aquifers that are regarded as being separated by a confining clay layer from the upper aquifers (potential stygofauna habitat). Due to the depth of the target aquifer and the presence of a substantial confining clay layer, it is unlikely that stygofauna occur in the target aquifer. The bores sampled in the proposed Northern Borefield during baseline subterranean fauna studies were screened full depth, so it is not possible to determine with certainty from which level in the water column the samples originated.

The fractured rock aquifer formation targeted by Reward at the proposed Cory Borefield is regionally extensive, such that the habitat represented by the formation can also be expected to exist in areas surrounding the proposed borefield. It is considered likely that *Atopobathynella* sp. B27 and *Dussartstenocaris* sp. B08 occur more widely throughout the Gunanya Sandstone and possibly throughout the Lake Disappointment area due to the apparent extent and connectivity of habitat. The locally extensive ranges of *Tubificidae* sp. B03 (LD) and nr *Pilbarus* sp. B07 support the notion that other species may also be widespread.

The habitat currently available for subterranean fauna in the areas within the potential groundwater drawdown zones of the proposed Cory and Northern Borefields will not be significantly reduced as a result of borefield operations (Table 4–16). Even at the point of groundwater extraction, no part of the aquifer is completely dewatered.

Table 4–16: Estimated proportion of subterranean fauna habitat loss within proposed borefields

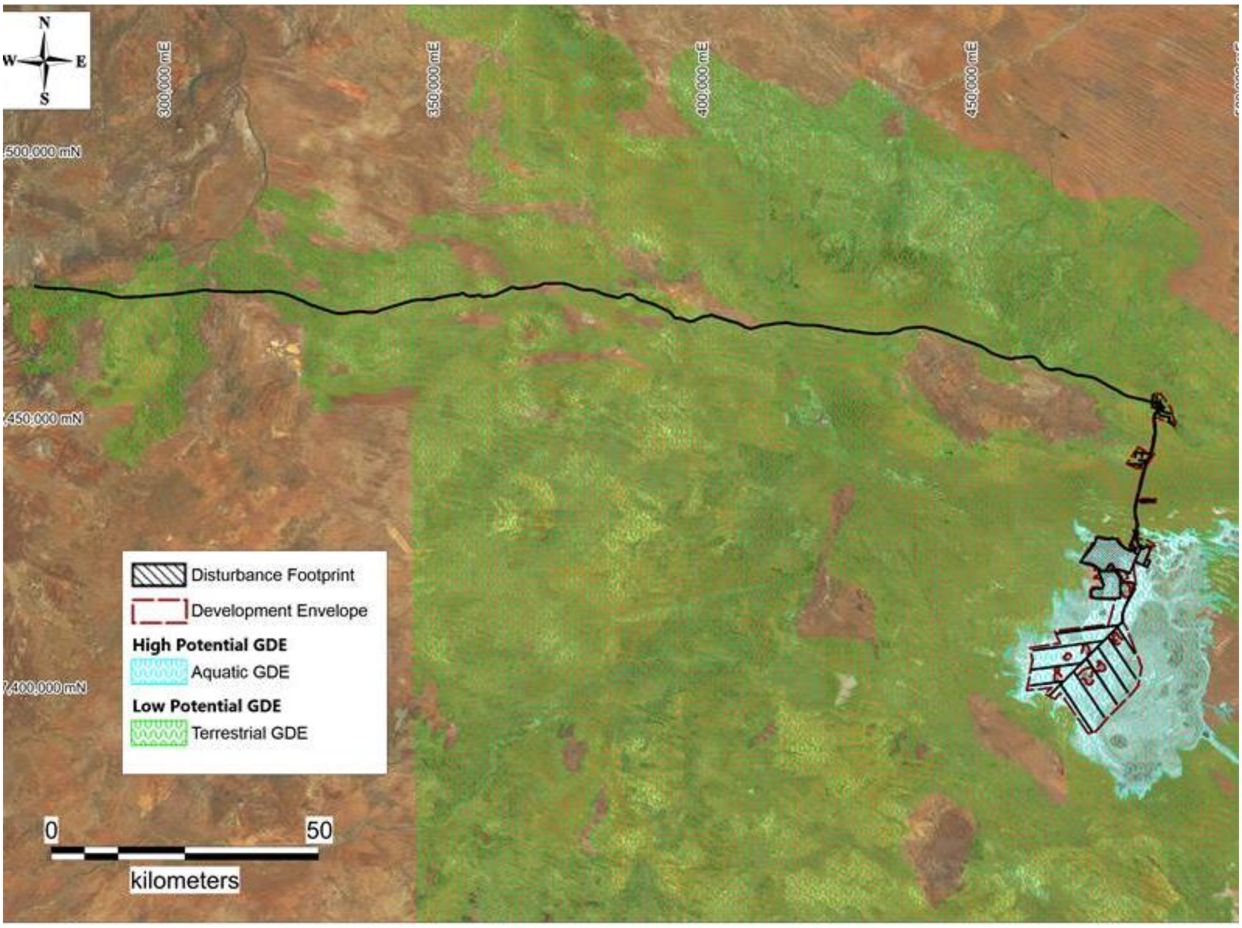
Borefield	Aquifer thickness (m)	Proportion of stygofauna habitat affected within drawdown zone (%)	Drawdown contour used to define 'drawdown zone' (m)
Northern (confined aquifer)	25	20%	5
Cory	100	2%	2

Impacts on vegetation

Given the shallow depth of groundwater beneath the Lake Disappointment playa, and the relatively shallow depth of groundwater in the proposed production borefields (typically in the order of 10 m below ground level), the baseline studies conducted for the project considered possible impacts on groundwater dependent vegetation.

National-scale maps in the *Atlas of Groundwater Dependent Ecosystems* (BOM 2017) indicate a high potential for vegetation interaction with groundwater in areas very close to the Lake Disappointment playa and low potential for vegetation interaction with groundwater in all other parts of the project area including the proposed borefields (Figure 4-26).

Figure 4-26: Likelihood of groundwater dependent ecosystems (BOM, 2017)



Note: Ecosystem extent shown in the map does not necessarily show the spatial extent of groundwater use. Rather, the ecosystem polygons should be interpreted as showing the area within which groundwater interaction may be occurring (Australian Government, 2012)

Site-specific studies were conducted to provide a more detailed assessment of the risk of vegetation impacts arising from abstraction of brine or taking of brackish water from the proposed production borefields, including:

- Level 2 flora and vegetation mapping (Appendix D1)
- Analysis of spectral data to detect signatures characteristic (Appendix D6)
- Root architecture characterisation of riparian zone vegetation (Appendix D3)
- Monitoring of groundwater levels by means of data loggers in selected locations.

By far the greater proportion of land in the project development envelope (~90%) comprises bare salt lake surface or previously cleared areas. Of the 3846 ha of vegetation within the development envelope, approximately 25% (972 ha) consisted of vegetation types commonly associated (by virtue of their position in the landscape) with surface water features (open or closed depressions, drainage lines) or groundwater (Table 4–17). The remaining vegetation types within the development envelope comprise shrub-steppe communities, open woodland and grassland vegetation characteristic of the arid interior with no known propensity for groundwater dependency (Appendix D1).

Table 4–17: Vegetation types associated with water features

Vegetation type	Vegetation code	Disturbance footprint total area (ha)	Development envelope total area (ha)
Heath of mixed *Tecticornia* spp. on salt lake edge	CD-CSSSF1	22	204
Open mixed herbs in clay-loam depression	CD-OGHSR1	3	34
Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline	OD-EW1	34	630
Low woodland of *Acacia* spp. over low scrub of *Senna artemisioides* and mixed dwarf scrub in drainage depression	OD-AFW1	3	102
Low woodland of *Hakea lorea/Melaleuca glomerata* over low heath of *Fimbristylis eremophila* in drainage depression	OD-OS1	0	2
Total		62	972

None of the 14 vegetation types identified during baseline surveys (including the five vegetation types identified as occurring in drainage depressions, riparian zones or along creek lines) showed the persistent 'high greenness, high wetness' spectral signature characteristic of vegetation that has ongoing access to groundwater (Appendix D6). Together with spectral data observations on estimated evapotranspiration relative to cumulative rainfall, no vegetation unit showed a high likelihood of being groundwater dependent.

There are methodological issues to using spectral signatures to identify groundwater dependency in areas very close to salt lakes (Appendix D6). Accordingly, root mapping of *Tecticornia* plants in the Lake Disappointment riparian zone was carried out to check how much of the root mass of the riparian vegetation lies within the zone that is permanently or intermittently saturated. Test pits excavated at three locations near the playa edge found that all *Tecticornia* roots were restricted to soil depths between 0 m and 0.3 m. The plants sampled each had a main tap root with multiple lateral roots extending horizontally from the tap root. There were no adventitious (above ground roots) present. Although groundwater levels beneath and near the playa are seasonally quite shallow (within 0.3 m of the ground surface), this is likely to be the case for about two months or less in most years. For the rest of the year, the permanently saturated zone would lie below the rooting zone of the *Tecticornia* plants that dominate the riparian vegetation community.

The quality of the groundwater in the riparian zone is very saline, even at the end of the wet season. Samples recovered on 28 April 2017 at five monitoring locations established as part of baseline vegetation studies at Lake Disappointment recorded salinities ranging from just under 60,000 mg/L (slightly under twice seawater concentration) to nearly 170,000 mg/L (nearly five times seawater concentration). These salinities correspond to a molar concentration range of approximately 1828 mmol/L to 5467 mmol/L. Although *Tecticornia* species show varying tolerance for salinity, published peer reviewed literature suggests that water concentrations greater than 2000 mmol/L are likely to adversely affect *Tecticornia* growth (English & Colmer 2011).

Taking into account the multiple lines of evidence generated by baseline investigations at Lake Disappointment, it seems unlikely that brine abstraction proposed during project implementation will adversely affect riparian vegetation health because:

- The magnitude of the predicted drawdown in the groundwater level near the lake edge is small and broadly within the range of natural seasonal variations; and
- It appears unlikely that *Tecticornia* rely heavily on shallow groundwater as the root mass of the plants lies above the groundwater level for most of the year; and
- The quality of shallow groundwater beneath the riparian zone is at or above the limit known to be injurious to *Tecticornia* species.

The risk of adverse impacts to riparian vegetation health has also been considered. Some *Tecticornia* species are known to be susceptible to injury from prolonged waterlogging (Konnerup et al, 2015). Large or persistent changes in groundwater levels (groundwater mounding) as a result of seepage from production ponds could result damage to riparian vegetation.

There is no evidence of groundwater dependent vegetation presence in the zone of influence of water abstraction from the proposed Cory Borefield (Appendix D2, Appendix D6). Natural standing water levels (SWL) of the proposed borefields are typically in the order of 10 m below ground level.

Spectral data analysis of vegetation types OD-EW1 (*Eucalyptus* woodland) and OD-AFW1 (*Acacia* woodland in drainage depression) near the McKay Creek and associated McKay Creek delta showed low, but not negligible, probability of water inflow dependence (Appendix D6). It is customarily assumed that large gum trees along watercourses are in some measure reliant on seasonal streamflows and this is also likely to be the case at the McKay Creek and delta. Reward does not propose any works that would modify flows along McKay Creek. No water would be abstracted from the creek or from the shallow unconfined aquifer immediately underlying the creekbed. Proposed groundwater abstraction from the Northern Borefield would draw brackish water from a confined aquifer. Groundwater modelling of water abstraction from the proposed Northern Borefield predicts that the clayey aquiclude between the shallow unconfined aquifer and the sandy aquifer targeted by Reward's production bores would prevent any material reduction of groundwater levels in the shallow aquifer. Accordingly, adverse impacts on vegetation in the McKay Creek delta as a result of water abstraction from the proposed Northern Borefield are unlikely.

Impacts on sediment quality

The potential for changes in groundwater levels to give rise to changes in sediment or groundwater quality (as a result of oxidation of sulphidic materials present in the sediment) is discussed in Section 2.6.2.

4.3.6 Management and mitigation measures

Abstraction of brines from trenches on the Lake Disappointment playa will have no impact on subterranean fauna (as none are likely to be present) and is unlikely to have a discernible adverse impact on riparian vegetation. However, in order to limit changes to the predevelopment hydrological regime in the riparian zone the trench network has been designed such that no trench approaches closer than 200 m to the vegetated riparian zone. The brine abstraction network has been designed so that the whole of the system is not drained simultaneously. Parts of the network can be active or rested, as required. This cyclical operation of the abstraction system can be used to manage local groundwater drawdown. A network of shallow groundwater piezometers will be established and maintained to enable verification of groundwater responses to brine abstraction.

Cory Borefield

The potential impacts on subterranean fauna arising from the proposed extraction of fresh to brackish groundwater from fractured rock beneath the Cory Borefield are unlikely to be significant: only about 2% of the saturated aquifer thickness within a nominal 3 km radius of the borefield centroid is predicted to be affected by groundwater drawdown. Reward will establish a network of groundwater monitoring bores to allow periodic verification of the aquifer response to water extraction. The use of production bores and reporting of monitoring results will be conducted in accordance with a Groundwater Operating Strategy approved by the DWER.

For the Cory Borefield, Reward has provisionally nominated:

- A management trigger level (a level that would initiate review of water use strategies) of a drawdown of 1.5 m (relative to seasonal average groundwater levels) at a distance of 2.5 km from the borefield centroid; and
- An action level (a level that would require reporting to senior management and review of hydrological models) of a drawdown of 2 m (relative to seasonal average groundwater levels) at a distance of 2.5 km from the borefield centroid.

These action and trigger levels are proposed as practical metrics that are large enough to be distinguishable from natural background variations in groundwater levels, but small enough to allow time to adjust management practices before subterranean fauna values are significantly impacted.

Northern Borefield

The key consideration for management of potential impacts from extraction of fresh to brackish water from the Northern Borefield is to ensure that water withdrawal from the confined Tertiary aquifer does not result in changes in groundwater levels in the shallow, unconfined alluvial aquifer associated with McKay Creek. Accordingly, the proposed monitoring thresholds for the Northern Borefield relate to water levels in the superficial aquifer, rather than in the confined aquifer (which is less prospective as a subterranean fauna habitat and source of water for vegetation). Reward will establish a network of groundwater monitoring bores to allow periodic verification of the shallow aquifer response (if any) to water extraction from the confined aquifer access by Northern Borefield production bores. The use of production bores and reporting of monitoring results will be conducted in accordance with a Groundwater Operating Strategy approved by the DWER. Baseline monitoring in the proposed Northern Borefield to date has shown that seasonal changes of groundwater level are typically less than 1 m, but may occasionally exceed 1.5 m (Figure 4-17, Figure 4-18 and Figure 4-22).

For the Northern Borefield, Reward has provisionally nominated:

- A management trigger level of a drawdown of 0.5 m (relative to average end of dry season groundwater levels) in shallow aquifer monitoring bores; and
- An action level of a drawdown of 1 m (relative to average end of dry season groundwater levels.

Groundwater levels and water quality would also be monitored in the confined aquifer to enable periodic review of the hydrological model, but are not considered critical from the perspective of protecting environmental values.

4.3.7 Predicted outcomes

Overall, the residual impacts of project implementation on hydrological processes—and on the biological systems that rely on hydrological processes—are consistent with the EPA’s objective of protecting environmental values by maintaining hydrological regimes. Table 4–18 summarises the means by which attainment of environmental outcomes will be practically demonstrated.

Table 4–18: Summary of impact assessment – hydrological processes (groundwater)

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
Groundwater drawdown – brine abstraction	Loss of subfauna habitat	Not required – habitat not suitable for subterranean fauna	Routine monitoring and annual reporting on groundwater levels, water abstraction and water quality Results of vegetation health monitoring in annual compliance report
	Impact on riparian vegetation	Establishment and routine monitoring of groundwater monitoring network Annual monitoring of riparian vegetation health; seasonal review of spectral data (wet season and dry season)	
	Impact on other water users	Not required – no other (human) users of brine	
Groundwater drawdown – abstraction of brackish water from Cory Borefield	Loss of subfauna habitat	Design and operation of production bore network to limit dewatering of upper 10 m of fracture rock aquifer Establishment and routine surveillance of a groundwater monitoring network under approved Groundwater Management Plan/Operating Strategy Definition of 'trigger levels' to identify when predicted drawdowns exceed predicted levels and/or threaten persistence of subfauna habitat	Routine monitoring and annual reporting on groundwater levels, water abstraction and water quality Exceptions reporting in case of trigger exceedance (1.5 m drawdown at 2 km radius from borefield centroid) Three-yearly review and recalibration of groundwater model Results of follow up subfauna monitoring when additional bores (groundwater monitoring network) are available Results of targeted monitoring at bore established to check water levels at Georgia Bore are not affected by Reward's water abstraction
	Impact on groundwater dependent vegetation	Not required – no groundwater dependent vegetation within likely zone of influence of borefield	
	Impact on other water users	Establishment and routine surveillance of a groundwater monitoring network under approved Groundwater Management Plan/Operating Strategy	

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
Groundwater drawdown – abstraction of brackish water from Northern Borefield	Loss of subfauna habitat	Screening of production bores in Layer 3 aquifer only Establishment and routine surveillance of groundwater monitoring network under approved Groundwater Management Plan/Operating Strategy; separate monitoring of water levels in superficial and confined aquifers Definition of 'trigger levels' to identify when predicted drawdowns exceed predicted levels and/or threaten persistence of subfauna habitat	Routine monitoring and annual reporting on groundwater levels, water abstraction and water quality Exceptions reporting in case of trigger exceedance (0.5 m drawdown relative to average end of dry season levels in superficial aquifer) Three-yearly review and recalibration of groundwater model Results of follow-up subfauna monitoring when additional bores (groundwater monitoring network) are available Results of vegetation health monitoring in annual compliance report Results of targeted monitoring at bore established to check water levels at Georgia Bore are not affected by Reward's water abstraction
	Impact on groundwater dependent vegetation	Separate monitoring of water levels in superficial and confined aquifers Definition of 'trigger levels' to identify when predicted drawdowns exceed predicted levels and/or threaten vegetation health Annual monitoring of vegetation health; seasonal review of spectral data (wet season and dry season)	
	Impact on other water users	Establishment and routine surveillance of telemetered groundwater monitoring network under approved Groundwater Management Plan/Operating Strategy	
Water storage – groundwater mounding as result of seepage from ponds	Impact on health of riparian vegetation	Design and construct ponds to minimise seepage Maintain minimum 200 m offset between toe of water storage and nearest riparian vegetation Routine monitoring of groundwater levels around pond perimeters Annual monitoring of vegetation health; seasonal review of spectral data (wet season and dry season)	As-built engineering reports for pond construction Results of routine monitoring and annual reporting on groundwater levels Results of vegetation health monitoring in annual compliance report

4.4 Key factor 2: Inland waters environmental quality

4.4.1 EPA objectives

To maintain the quality of groundwater and surface water so that environmental values are protected.

4.4.2 Policy and guidance

Table 4–19: Relevant policies, guidelines & standards – inland waters environmental quality

Environmental factor	Relevant policies, guidelines, and standards
Inland water quality – surface water and groundwater	DER, 2015. *Identification and investigation of acid sulfate soils and acidic landscapes*. DOW, 2006. WQPN 44: *Roads near sensitive water resources* DOW, 2007. WQPN 83: Infrastructure corridors near sensitive water resources DOW, 2009b. WQPN 15: *Extractive industries near sensitive water resources* DOW, 2009c. WQPN 51: *Industrial wastewater management and disposal* DOW, 2009d Operational policy no. 5.12 – *Hydrogeological reporting associated with a groundwater well licence* DOW, 2010. WQPN 52: *Stormwater management at industrial sites* DOW, 2013. *Western Australian water in mining guideline* DOW, 2015. WQPN 81: *Tracks and trails near sensitive water resources* EPA, 2016a. *Environmental factor guideline – inland waters environmental quality* NEPC, 2013. *National Environment Protection (Assessment of Site Contamination) Measure*

4.4.3 Receiving environment

This section provides an overview of surface water and groundwater quality in the Lake Disappointment area. The information presented in this section draws on baseline studies commissioned by Reward (Table 4–20). Copies of the baseline technical studies and laboratory reports are appended to this ERD. Laboratory reports with details of water quality are provided in Appendix G9.

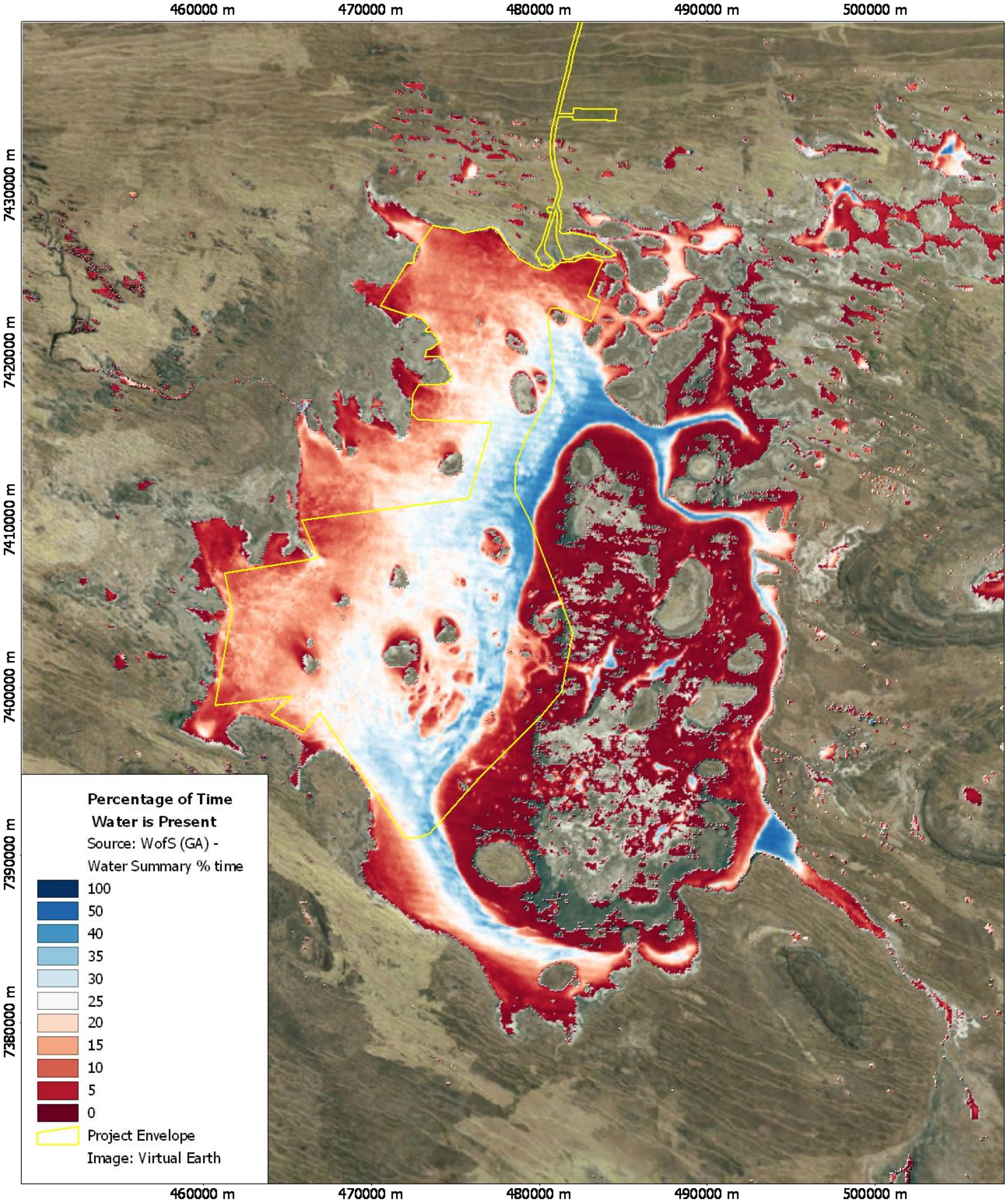
Table 4–20: Summary of relevant investigations (water quality)

Environmental factor	Study reference	Summary of work completed
Surface water quality	Appendix G8: Knight Piésold, 2017. Memorandum: LD Project – Salt Dissolution Testing and Brine Runoff Impact	Evaluates possible interactions between rainfall and stored material in the halite stockpile, addressing how much salt will be mobilised by the rainfall as it flows through and/or around the salt stack; assesses the potential impacts of brine outflow from the salt stack onto the playa surface, especially in cases where water which might be ponded on the playa
Lake ecology	Appendix E6: Bennelongia, 2017. Aquatic Ecology and Waterbirds at Lake Disappointment: Additional Studies	Characterisation of ecological values of Lake Disappointment via field survey following a major flooding event in March 2017; survey built on a previous survey in January–February 2016; specific objectives were to characterise aquatic invertebrate assemblages, diatom assemblages and post-flood use of the lake by waterbirds
	Appendix E7: Bennelongia, 2016. Ecological Character of Lake Disappointment	Preliminary assessment of the environmental values of Lake Disappointment, especially relating to wetland values; report describes aquatic biota and identifies and describes the key ecological and biophysical attributes of the playa system based on published information, consultant reports and on observations made during a site visit in January 2016
Sediment chemistry	Appendix G1: Galt Environmental, 2018. Technical Review of Studies on the Potential Presence of Monosulfidic Black Ooze at the Proposed Lake Disappointment Potash Project	Third party review of previous technical reports into acid sulfate soil risk at Lake Disappointment; review also considered sediment testing commissioned by Reward, but not included in earlier ASS assessments
	Appendix G2: Pendragon Environmental Solutions,. Acid Sulfate Soil Investigation Lake Disappointment	Assessment of playa sediment characteristics, especially in relation to the potential for general of acidic drainage through oxidation of sulphidic materials
	Appendix G4: ALS Environmental, 2016. Certificate of analysis EP1609409	Results of testing on a further 18 playa sediment samples for pH, organic carbon and chromium reducible sulphur
Terrestrial fauna	Appendix G7: Hydrobiology, 2016. Memorandum report: Lake Disappointment – Ecotoxicity Hazard Assessment	Ecotoxicological assessment of the potential for project implementation to directly or indirectly result in impact on Matters of National Environmental Significance including listed migratory birds through: • Hydrogeochemical changes to lake sediments and waters during wet and dry episodes • Reaction of acid sulfate soils • Mobilisation, bioavailability and toxicity of heavy metals (including uranium and thorium)

Surface water quality

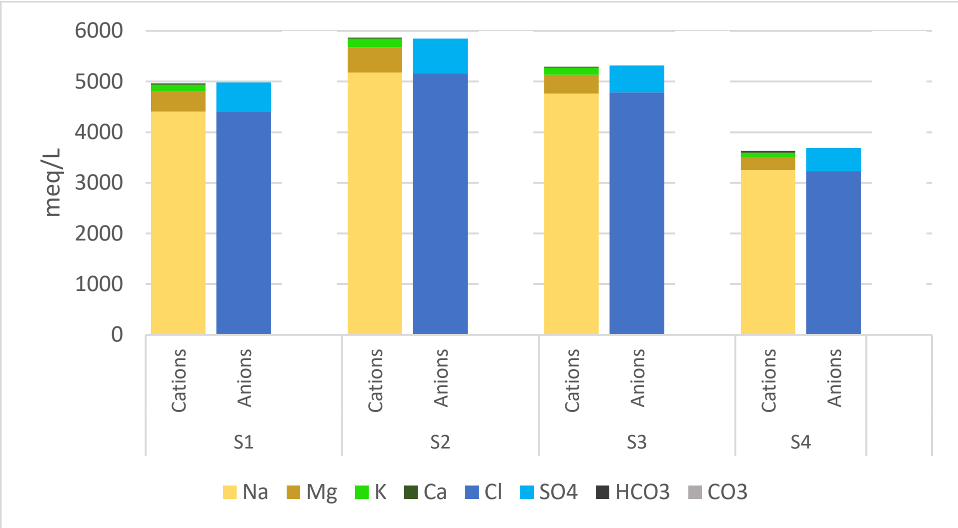
There are no permanent surface water bodies anywhere in the Lake Disappointment project development envelope, although there are limited areas of shallow ponded water at the mouth of Savory Creek (Figure 4-27). During the summer wet, season rainfall and runoff pond on the playa surface and in surrounding claypans.

Figure 4-27: Lake Disappointment – percentage of time with wetted surface (no development)



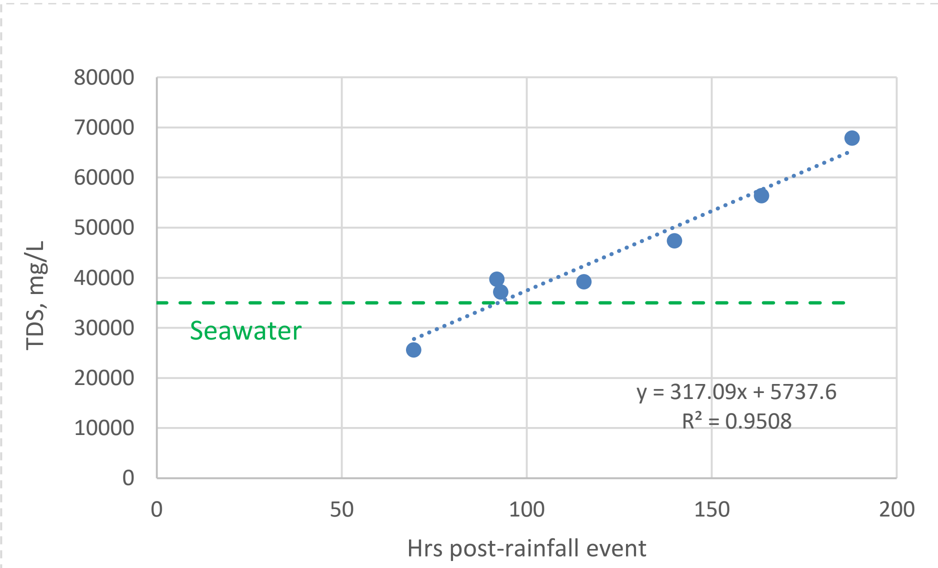
The quality of the ponded water on the playa is strongly influenced by the salt crust that covers the playa. The composition of ponded playa water is dominated by sodium and chloride, with lesser amounts of magnesium, calcium, sulfate and other soluble salts, including potassium (Figure 4-28).

Figure 4-28: Lake Disappointment playa surface water – major ion chemistry (April 2017)



Following a storm event, water ponded on the playa becomes progressively saltier, through a combination of evaporative concentration and dissolution of the salt crust. The increase in salinity is typically quite rapid: within three days, the lake water salinity may be as low as that of seawater (Figure 4-29). After that, the salinity rapidly increases with the evaporation rate exceeding 10 mm/d in summer months. If there has been sufficient rainfall for water to remain on the playa for as long as a month, the remaining water salinity approaches salt saturation (in the order of 200,000–300,000 mg/L TDS).

Figure 4-29: Lake Disappointment surface water – salinity increase post-rainfall (May 2016)

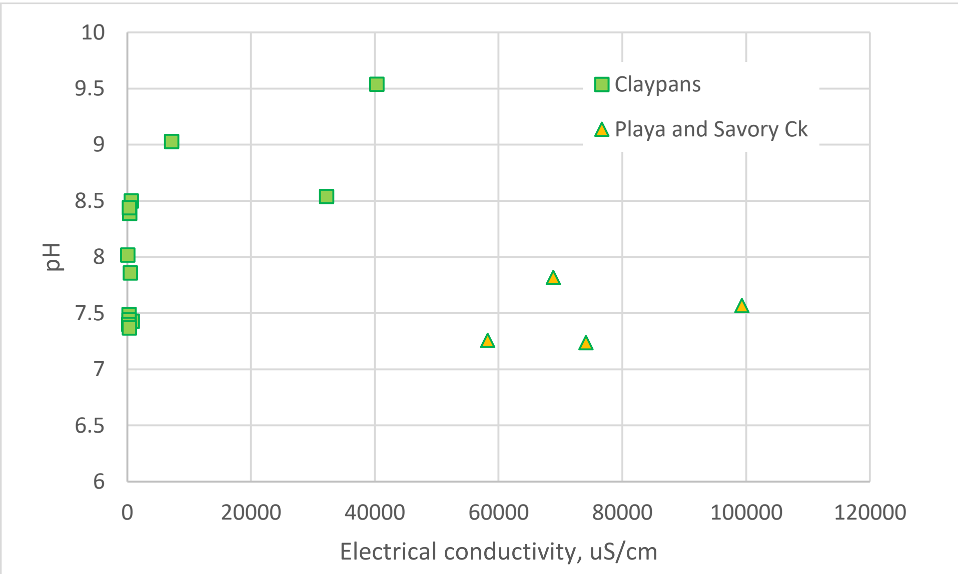


By contrast, the seasonal ponds that form in the clay pans surrounding the main playa are typically much fresher (and consequently more turbid, Figure 4-30), with salinities generally less than 1000 mg/L TDS (Appendix E6).

Figure 4-30: Water at Savory Creek (left) and claypan REM060 (right) (Appendix E6)

The pH of surface water in the playa and surrounding claypans is typically slightly to moderately alkaline. There is no obvious correlation between salinity and pH (Figure 4-31).

Figure 4-31: Surface water pH vs salinity – Lake Disappointment playa and claypans



Surface water quality, especially salinity, has an important influence on aquatic biota. As a general rule, salt lakes host depauperate biological communities, with an inverse relationship between species richness and salinity (Brock (1986) cited in Appendix E6). This inverse relationship between species richness and salinity is evident in the invertebrate fauna at Lake Disappointment: surrounding claypans that had electrical conductivities of 66–40,300 µS/cm in 2017 hosted much richer invertebrate assemblages than hypersaline sites (58,200–99,300 µS/cm) within the main lake and the Savory Creek tributary.

Baseline surveys of aquatic biota conducted at Lake Disappointment in 2016 and 2017 concluded that the overall number of species observed, when sampling of surrounding claypans is included, is towards the higher end of the documented spectrum of richness at inland Australian salt lakes (Appendix E6). The high overall richness is largely attributable to the inclusion in the sampling program of a number of freshwater claypans, which hosted a large proportion of recorded species. When only sites within the main playa are examined, invertebrate species richness at Lake

Disappointment is comparable to Lake Weelarrana, greater than Lake Carey and less than Lake Torrens and Lake Eyre[10].

Groundwater quality

Groundwater beneath the Lake Disappointment playa is nearly ten times as salty as seawater, with a median total dissolved solids concentration of approximately 326,000 mg/L. The composition of major salts in the groundwater has similar proportions of chloride and sulfate to seawater, but differs subtly in the make-up of cationic salts (sodium, calcium, magnesium and potassium, Figure 4-32). The groundwater beneath the playa has a neutral to slightly acidic pH, ranging from approximately pH 6.0 to pH 7.25 (Appendix G4). The playa groundwater has no noticeable enrichment in trace metals, including uranium and thorium (Table 4–21).

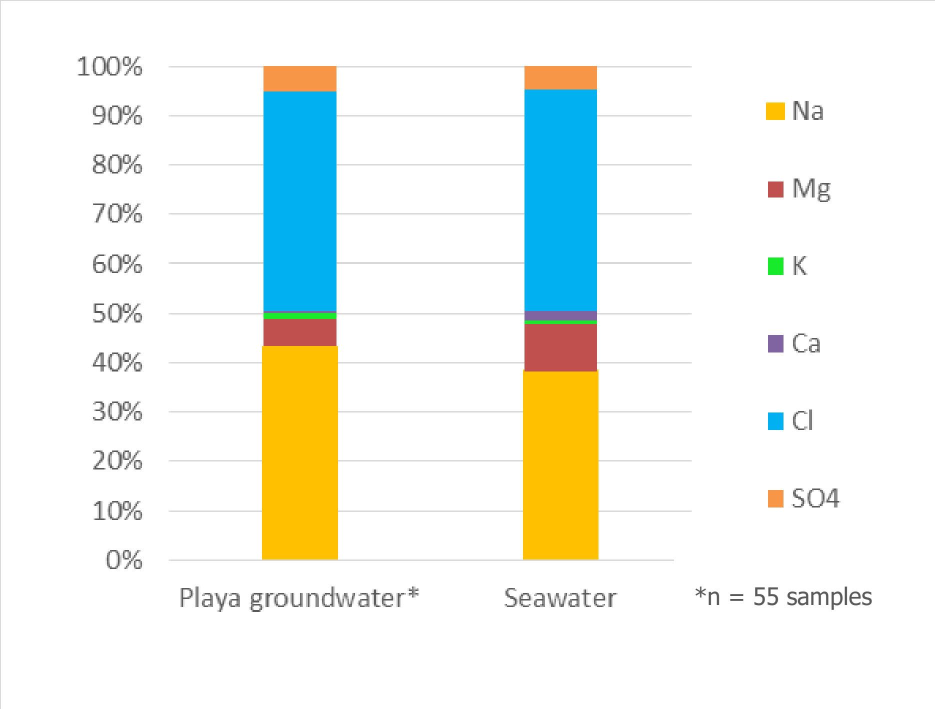
Table 4–21: Trace element chemistry – Lake Disappointment brine

	Units	Min	Max	Median	No. of samples	Typical concentration in seawater*
Aluminium	mg/L	<2	2	<2	5	0.001
Arsenic	mg/L	<0.005	<0.005	<0.005	5	0.003
Cadmium	mg/L	<0.001	0.002	0.0014	5	0.00011
Chromium	mg/L	<0.005	<0.005	<0.005	5	0.00005
Cobalt	mg/L	0.0002	0.0078	0.00035	5	0.0004
Copper	mg/L	0.0005	0.05	0.0018	5	0.003
Manganese	mg/L	0.0355	0.288	0.0613	5	0.002
Nickel	mg/L	<0.005	0.0114	0.008	5	0.007
Lead	mg/L	0.008	0.0283	0.0162	5	0.00003
Selenium	mg/L	<0.01	<0.01	<0.01	5	0.00009
Thorium	mg/L	<0.005	<0.005	<0.005	10	<0.0000005
Uranium	mg/L	<0.005	<0.005	<0.005	10	0.003
Zinc	mg/L	<0.05	<0.05	<0.05	5	0.01

Note: * Seawater data from Hem (1985). Metals other than uranium and thorium are presented in ALS report EP1606359. Uranium and thorium results are presented in Ammtec report B81752. Both laboratory reports are provided in Appendix G4.

[10] It is noted that variability between studies in sampling methods and effort should be considered when comparing estimates of richness at different locations.

Figure 4-32: Playa water and seawater – major ion chemistry (April 2017)



The magnesium chloride content of Lake Disappointment brine is much lower than evaporated sea water or brine from Great Salt Lake, USA (Table 4–22). The relatively minor quantity of magnesium chloride brine (bittern) is produced as a byproduct of SOP production and is unlikely to adversely affect aquatic biota at Lake Disappointment. Evaporated sea water and Great Salt Lake brine are known to support vigorous growth of halophytic organisms (such as brine shrimp), notwithstanding the higher magnesium chloride content than that occurring in Lake Disappointment brine. Great Salt Lake is a major global supplier of naturally harvested *Artemia* cysts, which are used as a feedstock in the aquaculture industry.

Table 4–22: Composition of brine: Lake Disappointment, Great Salt Lake, seawater

	Lake Disappointment (2)	**Great Salt Lake (3)**	**Sea water (4)**
$NaCl$ (1)	238.0	227.0	221.0
K_2SO_4	12.4	29.9	7.0
$MgCl_2$	5.4	45.2	29.9
$MgSO_4$	22.6	49.3	13.9
$CaSO_4$	1.56	-	0.50
TDS	280	343	272

Note1: All values in g/L dissolved salt

Note 2: Average grade of brine in surface zone of Lake Disappointment

Note 3: GSL brine evaporated to crystallisation point

Note 4: Sea water evaporated to halite crystallisation point

Groundwater in the proposed Cory and Northern Borefields is brackish to saline, with TDS typically ranging from slightly under 1000 mg/L to approximately 5000 mg/L. Background concentrations of dissolved metals in groundwater beneath the proposed borefields are generally low (Table 4–23): thorium is consistently less than 1 µg/L and the median concentration of uranium is approximately 7 µg/L (lower than the Australian drinking water guideline value of 17 µg/L) [11].

Table 4–23: Average concentrations of dissolved metals – Cory and Northern Borefield groundwater

	Units	Cory Borefield	Northern Borefield		Units	Cory Borefield	Northern Borefield
pH	pH units	8.04	7.9	Copper	mg/L	0.001	0.001
EC	µS/cm	4429	2570	Iron	mg/L	--	0.0375
TDS	mg/L	2510	1570	Lead	mg/L	--	0.001
Aluminium	mg/L	--	0.025	Manganese	mg/L	0.01	0.01
Arsenic	mg/L	0.002	0.001	Molybdenum	mg/L	--	0.002
Barium	mg/L	0.050	0.066	Selenium	mg/L	0.003	0.003
Cadmium	mg/L	--	0.0005	Thorium	mg/L	--	0.001
Chromium	mg/L	0.001	0.001	Uranium	mg/L	0.008	0.005
Cobalt	mg/L	0.001	0.001	Zinc	mg/L	--	0.008

Note: A dash '—' indicates that no testing was done for that parameter. Results are for groundwater samples recovered on multiple occasions between May 2016 and July 2017.

Groundwater in the fractured rock aquifer targeted by the proposed Cory Borefield is slightly alkaline in pH and brackish, with a typical TDS concentration between 2000 mg/L and 2500 mg/L (Appendix I3).

Water in the shallow unconfined alluvial aquifer is, on average, fresher than water in the confined water from which Reward proposes to draw its process water supply in the Northern Borefield (Table 4–24).

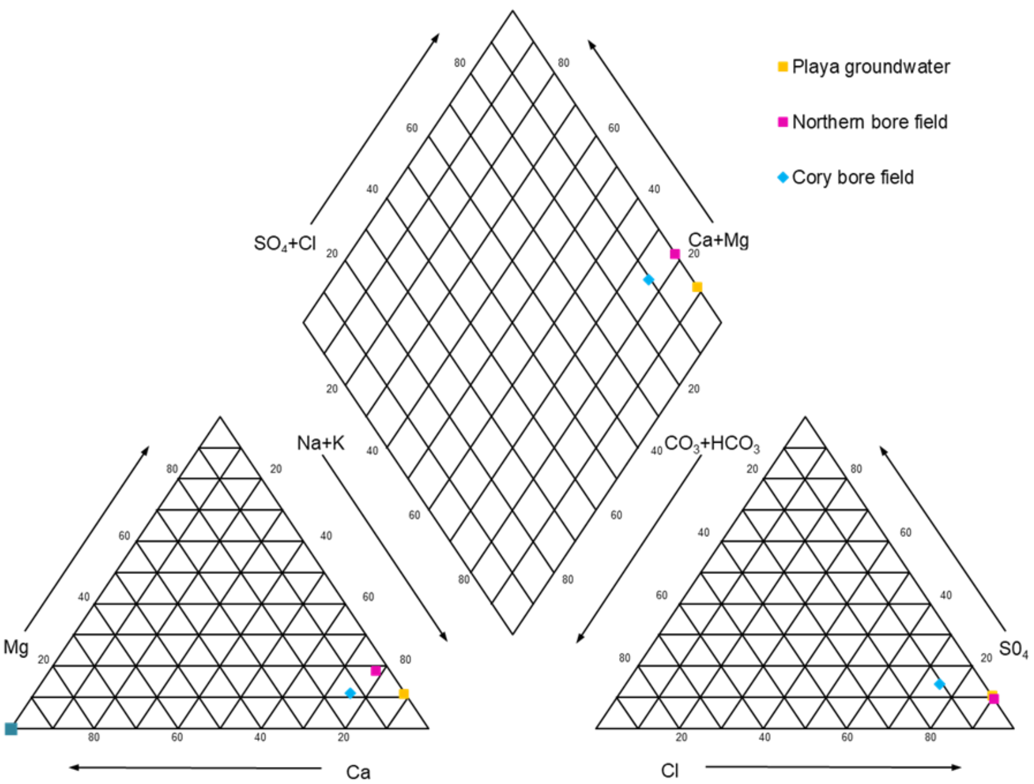
The groundwater chemistry in both of the aquifers targeted by Reward is dominated by sodium and chloride. However, both of the proposed process water sources have a slightly higher proportion of calcium than does the water in brine beneath the Lake Disappointment playa (Figure 4-33).

[11] Reward has investigated concentrations of uranium and thorium in groundwater because these elements are known to be naturally elevated in some other salt lake environments in Western Australia.

Table 4–24: Field pH and conductivity – Northern Borefield

	Bore ID	Field pH pH units	Field conductivity (µS/cm)	Approximate TDS (mg/L, by calculation)
Upper aquifer	P26	6.1	621	322
	P50	7.2	1781	978
	P60	7.0	2230	1234
	P31	7.3	1212	654
	P54	7.0	2300	1274
	LDMR0117	7.4	1330	721
Lower aquifer	P26	7.9	17,000	9600
	P50	7.6	1900	1100
	P60	7.6	2900	1700
	P31	8.0	2200	1200
	P54	7.9	2900	1700
	LDMR0117	7.7	5200	3000
	LDMR0817	7.9	9600	5000
	LDMR2017	7.8	2600	1445

Figure 4-33: Major ion chemistry – borefields and playa groundwater (mole percent data)



4.4.4 Potential impacts

Potential impacts of project implementation on surface water quality and groundwater quality are summarised in Table 4–25.

Table 4–25: Excerpt from project risk register – inland water quality

Event description	Potential impact
Ground disturbance for establishment of on-playa and off-playa infrastructure	Sediment mobilisation: increased turbidity
	Oxidation of shallow sediments results in acidification and mobilisation of metals
Brine abstraction from trenches results in water table drawdown	Oxidation of shallow sediments results in acidification and mobilisation of metals
Establishment of brine ponds and salt stockpiles on-playa: flood incursion results in release of salts	Discharge of salt to playa
Loss of containment: overtopping or failure of brine pond embankments, erosion from halite stockpiles	Discharge of salt to playa
Transport hydrocarbon fuels/chemicals: spillage as a result of transport accident with loss of containment	Contamination of soil, surface water or groundwater
Storage, dispensing and use of hydrocarbon fuels/chemicals: spillage results in contamination of surface or groundwater	Contamination of soil, surface water or groundwater
Treatment of septic wastes: effluent disposal contaminates groundwater	Contamination of groundwater
Landfilling of domestic waste: leachate results in groundwater contamination	Contamination of groundwater

4.4.5 Impact assessment

Increased turbidity

The flat topographic gradients in the playa areas mean that the flow velocities of wet season surface runoff tend to be low, and that erosion potential is commensurately low. The exception to this relates to channel flows where tributaries, such as Savory Creek, enter the playa. However, Reward has already established an exclusion zone near the mouth of Savory Creek (due to cultural considerations) and no other on-playa works lie close to the mouths of major tributaries. A further factor limiting potential impacts of increased turbidity is the extremely high salinity of playa water. Suspended sediment is rapidly precipitated in very saline water and will not remain suspended in the water column. The risk of increased turbidity to playa surface water quality is, therefore, low.

Acid sulfate soil risk

Excavation of trenches on the playa will involve placement of some shallow sediments on the playa surface to form bunds on either side of the brine trenches. Additionally, abstraction of brine from the trenches will result in local lowering of the groundwater table to a nominal depth of about 1.5 m (compared to a typical average groundwater depth of around 0.3 m to 0.5 m below the playa surface). Therefore, Reward has considered whether exposing shallow sediments to air has the potential to result in water quality impacts through the oxidation of sulphidic sediments. A summary of baseline investigations into acid sulfate soil risk at Lake Disappointment is provided in Table 2–5

Overall, the results of baseline investigations and testing of sediments from the Lake Disappointment playa indicate a low risk of impacts associated with acid sulfate soils for the following reasons:

1. The sediment samples tested—including those provisionally classified as MBOs—contain no actual acidity and have a significant acid neutralising capacity. They are also low in trace metals, when compared with sediment quality criteria recommended by the CSIRO (Simpson et al. 2013). These results are consistent with published, peer reviewed studies of trace element concentrations in Western Australian salt lakes (Lyons et al. 1990).
2. Where materials having the visual appearance of MBOs are present, they exist in very thin, discontinuous layers (typically less than 40 mm, and averaging approximately 6 mm) and are surrounded by non-MBO sediments with substantial neutralising capacity.
3. All samples logged as having the visual appearance of MBOs were recovered from depths of less than 0.5 m. This layer of sediment would be seasonally above the level of the groundwater table in most years and the sediments would be subject to wetting and drying even in the absence of project implementation.

An independent third party review of Reward's baseline studies into acid sulfate soil risk was conducted by Galt Environmental (Appendix G1). That work confirmed that the environmental impact from the disturbance of MBOs is considered to be 'very low' and that no further baseline sampling or analytical testing is required to verify the risk assessment.

Potential for overtopping of salt ponds/flood incursion into halite stockpiles

Flooding in the pond areas is not expected to be a significant issue. This is because all of the ponds are fully enclosed with no external contributing catchment. The embankments will have a minimum height of 1.5 m at any point around the perimeter and are located in a higher section of the lake, where flooding is less likely. Figure 4-34 shows the 72-hour 5% AEP flood depth and extent. Figure 4-35 shows the 72-hour 1% AEP flood depth and extent in the pond areas. In the latter case (which corresponds approximately to a 1-in-100 year storm event), the only ponds within the flood zone are the back mix ponds. The depth of flood water near the back mix ponds is less than 0.3 m deep during a 1-in-100 year flood event. The south-eastern tip of the halite stockpiles may also have minimal inundation around it, but as the stockpiles will include a 0.8 m high perimeter bund, the impact of this flooding is expected to be negligible.

Figure 4-34: Flood extent and depths – 5% AEP

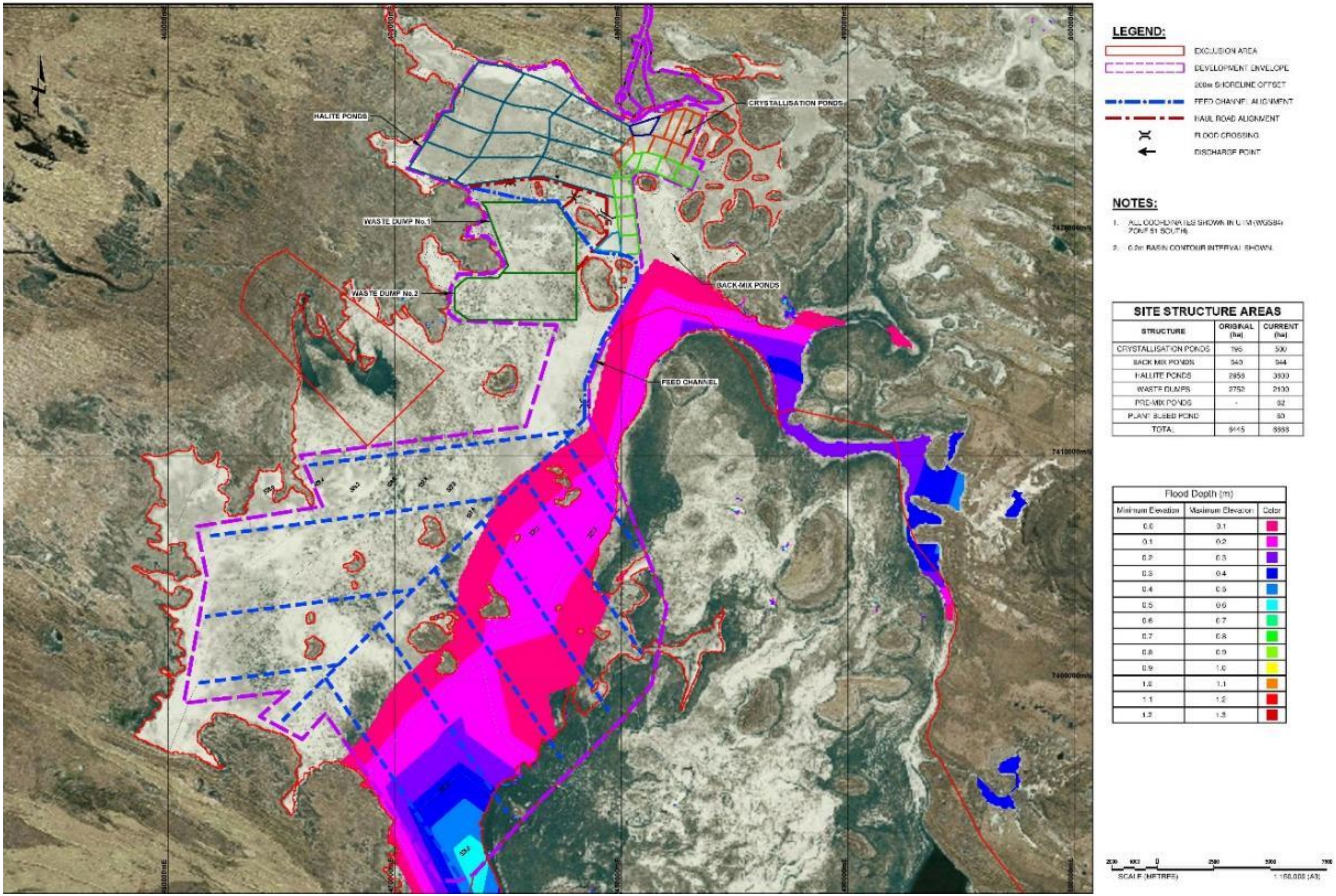
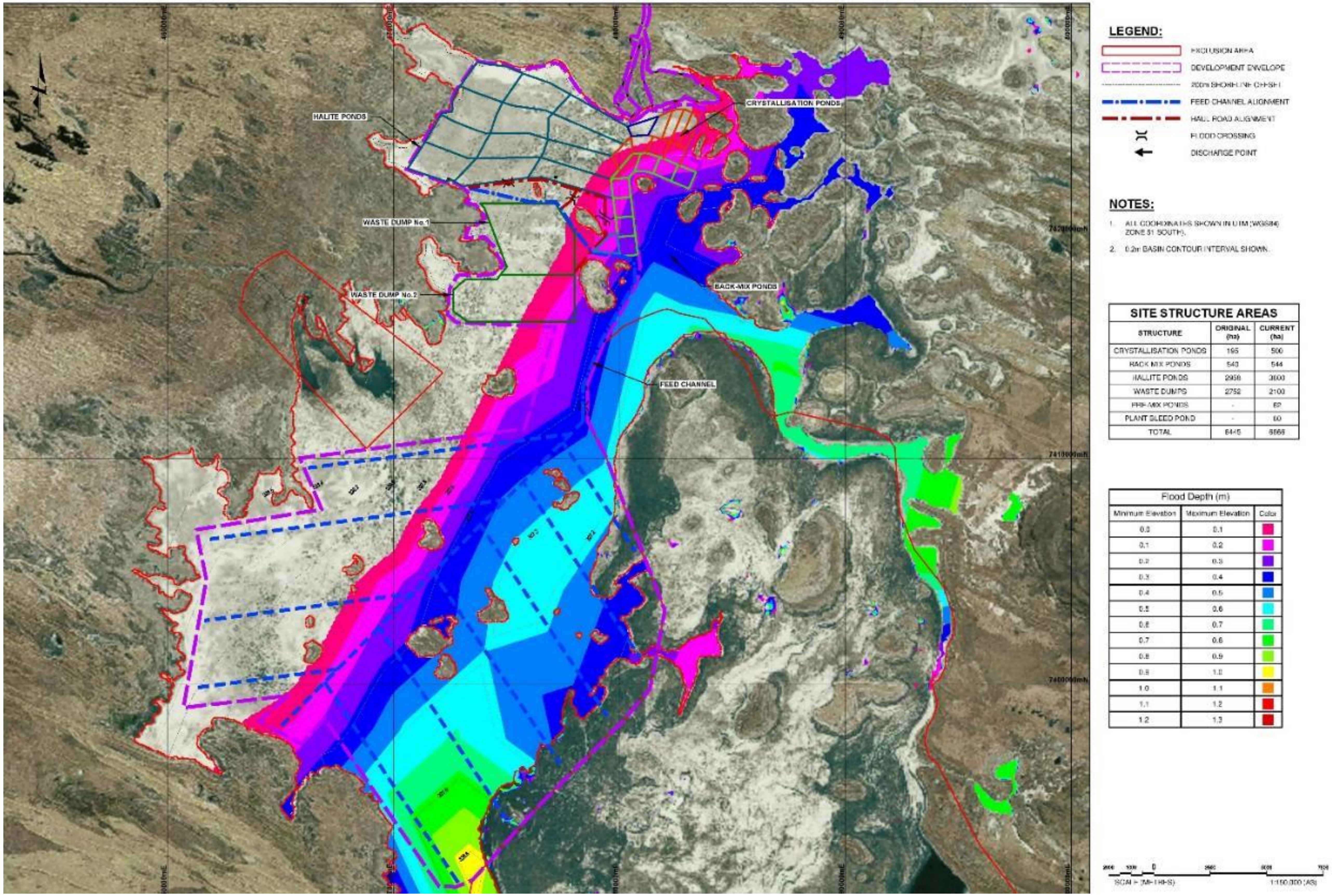


Figure 4-35: Flood extent and depths – 1% AEP



SITE STRUCTURE AREAS		
STRUCTURE	ORIGINAL (ha)	CURRENT (ha)
CRYSTALLISATION PONDS	195	500
BACK MIX PONDS	540	544
HALLITE PONDS	2958	3600
WASTE DUMPS	2752	2100
PRE-MIX PONDS	-	62
PLANT BLEED POND	-	60
TOTAL	6445	6866

Flood Depth (m)		
Minimum Elevation	Maximum Elevation	Color
0.0	0.1	
0.1	0.2	
0.2	0.3	
0.3	0.4	
0.4	0.5	
0.5	0.6	
0.6	0.7	
0.7	0.8	
0.8	0.9	
0.9	1.0	
1.0	1.1	
1.1	1.2	
1.2	1.3	

The conceptual design for the Lake Disappointment project involves dry harvesting of salt from the Halite and Back-Mix Ponds and placement of the salt into a stack on the playa surface. At maximum extent, the salt stacks will occupy an area of up to about 2013 ha. Rainfall runoff from the salt stack will be directed to the low point in the salt stack area and then flow through a permeable zone in the containment bund out onto the lake surface. It is envisaged that as part of the closure design, portions of the containment bund would be removed to allow the precipitated salt in the salt stack to reintegrate back to the lake surface materials.

Reward commissioned baseline investigations to consider:

- The interaction between rainfall and the material in the salt stack: how much salt will be picked up by the rainfall as it flows through and/or around the salt stack?
- The relative impact of the brine outflow from the salt stack onto the lake surface and on any water which might be ponded on the lake.

The investigations involved a combination of empirical testing (column testing) and hydrological modelling (Appendix G8).

The brine seeping from the salt stack due to a rainfall event will, over time (hours to days), flow out onto the playa surface. Following small rainfall events where the playa surface is not fully saturated, the brine will infiltrate the surface in the area between the salt stack and the brine feed channel to the south-east of the stack and will eventually report back to the brine collection system. If the playa surface is saturated (following a large rainfall event), the brine will migrate across the lake surface to the deepest zone of the lake, mixing with storm runoff from the surrounding catchment. It is estimated that the salt loading from brine entrained from the halite stockpiles would increase the salinity of water ponded on the playa by less than 5% (Appendix G8). Given that the background salinity of water ponded on the playa reaches a salinity approximating seawater concentration within about 48 hours of a large storm event (Figure 4-29), a small percentage increase in salinity is unlikely to be ecologically significant.

Over the life of the operation, approximately 300 Mt of salt will be placed in the salt stack. In the post-closure period, rain falling on the stacks will either infiltrate into the playa sediments, entraining with it some dissolved salt, or will flow out onto the playa and be distributed across the playa. Initial estimates based on column dissolution tests suggest that the salt stacks will take in the order of 250 years to fully dissipate.

Spillage or loss of containment of fuels or chemicals

Because of the remote location of the project fuel storage facilities must be adequate to ensure a secure supply for at least two weeks. The proposed fuel farm will be installed with a capacity of approximately 2,000,000 litres of diesel fuel, stored in ten 200 m^3 self-bunded fuel tanks. Fuels and chemicals will stored in a secure area within process plant site, which is located outside of the 1-in-100 year flood zone. No dispensing of chemicals or refuelling will occur on the playa. Overall, the risk of water pollution arising from spillage or loss of containment of fuels or chemicals is considered low, as the storage and dispensing facilities are located outside any flood zone and remote from the playa. Additional information on proposed management measures to limit water quality hazards associated with the transport, storage, dispensing and use of fuels and chemicals is provided in Section 4.4.6.

Groundwater contamination by septage or landfill leachate

The risk of significant impacts on groundwater quality as a result of seepage from either the sewage treatment facilities or the onsite putrescible waste landfill is low. The amount of septage and putrescible waste likely to be generated during project operations is low, commensurate with the relatively low staffing levels. Conventional management controls normally applied to rural landfills and small community waste treatment facilities will prevent unacceptable impacts on groundwater quality.

4.4.6 Management and mitigation measures

Sediment control

Site drainage works will be designed and constructed to prevent scouring associated with concentrated surface flows. Appropriately engineered culverts, floodways and bypass structures will be provided where off-playa works traverse drainage lines. Any works intersecting drainage lines would be developed in consultation with the DWER and permitted (if required) under a bed and banks permit issued pursuant to the *Rights in Water and Irrigation Act 1914*.

Acid sulfate soil hazard

Reward has already conducted a substantial program of sediment characterisation to evaluate the risk of acid sulfate soils. The results of that work indicted a low risk of acid generation. Notwithstanding this, Reward will implement a sediment screening procedure to guide handling of materials during establishment of on-playa infrastructure. Routine monitoring of shallow groundwater quality will be conducted surrounding the brine trench network under Reward's Groundwater Operating Strategy. A supply of neutralising material will be kept on site in case unexpected pockets of acid generating material are encountered during construction. If such a situation were to arise, the problem sediment would be segregated and treated with lime to prevent acid release.

Seepage or discharge of salt from on-playa infrastructure

Brine ponds will be designed and constructed to minimise seepage losses and prevent overtopping. A perimeter bund will be provided around the halite stockpiles to reduce the risk of stormwater incursion during major flood events. Overall, the need for control of salts is driven by operational considerations, rather than environmental ones. The salts stored on the playa are sourced from the shallow sediments of Lake Disappointment and the release of salts through seepage or runoff will not materially alter the hypersaline conditions that exist naturally on the playa. At closure, it is intended that the halite will slowly dissolve (over hundreds of years) and return to the shallow groundwater.

Hydrocarbon and chemicals

Diesel fuel and emissions reduction fluid will be stored in self-bunded tanks. Refuelling facilities will be constructed with concrete or HDPE-lined pads to contain any drips and spills. The pads will drain to a sump to allow removal of collected material. All hydrocarbon and chemical storages will be designed and constructed in accordance with relevant requirements of Australian standards AS 1940 and AS 1692.

Vehicle and equipment maintenance workshop facilities will be located on concrete pads. Hydrocarbon spill kits will be provided at workshops, at maintenance and refuelling locations and at any location where fuel is stored or handled in bulk. Employees will be trained in the use of spill kits.

The transport, storage or use of any designated Dangerous Good or substance will be conducted in accordance with applicable Dangerous Goods permits and in accordance with the *Dangerous Goods Safety Act 2004* and *Dangerous Goods Safety (Road and Rail Transport of Non-Explosives) Regulations 2007*. No explosives will be stored or used at the site.

Equipment and vehicles will be inspected regularly and maintained to reduce the likelihood of spills and leakages occurring. An incident reporting procedure, including reporting of hydrocarbon or chemical spills, will be implemented and maintained. Hydrocarbon wastes will be segregated from other wastes and collected for offsite disposal by a licensed contractor.

Septage and putrescible wastes

Both the sewage treatment facility and the putrescible waste landfill will be set back from the playa and positioned in locations where the shallowest seasonal depth to groundwater is at least 3 m below the base of the waste disposal cells. The facilities will be located in accordance with recommended separation distances described in relevant Australian standards and DWER water quality protection notes. No waste treatment or disposal facility will be sited within the 1-in-100 year flood zone.

Sewage treatment facilities and the putrescible landfill will be constructed, operated and maintained in accordance with the DWER and Department of Health/local government approval conditions. Effluent discharge from the sewage treatment facility will be managed to allow effluent to infiltrate or evaporate and to prevent surface ponding or runoff from the effluent disposal area

4.4.7 Predicted outcomes

Implementation of the Lake Disappointment project is unlikely to alter the hypersaline conditions that currently prevail at the Lake Disappointment playa. At present, salt concentrations are largely controlled by solubility, not by the availability of salt. This would continue to be the case during project implementation.

The potential for generation of acidic or metalliferous seepage through oxidation of sulphidic sediments has been assessed as low. Notwithstanding this, sediment screening procedures will be implemented during project implementation to detect and manage materials with higher than expected acid-generating potential.

Activities involving the storage and dispensing of hydrocarbons and chemicals are located outside potential flood zones, and conventional engineering design and management measures will provide adequate control of seepage, spillage or runoff of contaminated water. Treatment and disposal of septic wastes and domestic waste will be sited and operated to reduce risk of seepage or runoff.

There are no other significant developments (or proposed developments) in the project locality, hence there will be no cumulative impacts on inland water.

Overall, the residual risk of inland water quality impacts from project implementation is low: project activities can be readily managed so that the EPA's environmental objective for inland environmental quality will be met. The means by which attainment of environmental outcomes will be practically demonstrated are summarised in Table 4–26.

Table 4–26: Summary of impact assessment – inland water quality

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
Establishment of on-playa infrastructure	Increased turbidity	Conduct earthworks during the dry season (to the extent practicable) to limit the risk of large rainfall events entraining stockpiled soils	Opportunistic water quality monitoring (when surface water present on playa)

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
		Design and construct site drainage works to prevent scouring associated with concentrated surface flows Provide appropriately engineered culverts, floodways and bypass structures where off-playa works traverse drainage lines	Satellite imagery observations (inspect for sediment plumes after large rainfall events)
	Oxidation of acid sulfate soils	Implement a sediment screening procedure to guide handling of materials during establishment of on-playa infrastructure Conduct routine monitoring of shallow groundwater quality surrounding the brine trench network as part of the groundwater operating strategy Maintain a supply of neutralising material on site in case unexpected pockets of acid generating material are encountered during construction	Records from soil screening procedure Routine water quality monitoring results
Brine abstraction from trenches	Oxidation of acid sulfate soils	Conduct routine monitoring of shallow groundwater quality and water levels surrounding the brine trench network as part of the groundwater operating strategy	Routine water quality monitoring results
Storage of salts in ponds and stockpiles	Increased surface or groundwater water salinity	Design and construct brine ponds to minimise seepage losses and prevent overtopping Establish perimeter bund around the halite stockpiles to reduce the risk of stormwater incursion during major flood events	Construction compliance report submitted to DWER
Transport, storage, dispensing and use of hydrocarbons/ chemicals	Surface water or groundwater contamination by hydrocarbons or chemicals	All hydrocarbon and chemical storages will be designed and constructed in accordance with relevant requirements of Australian standards AS 1940 and AS 1692 Vehicle and equipment maintenance workshop facilities will be located on concrete pads Hydrocarbon spill kits will be provided at workshops, at maintenance and refuelling locations and at any location where fuel is stored or handled in bulk; employees will be trained in the use of spill kits	Annual compliance reports Incident reports Routine groundwater monitoring
Treatment of septic waste; landfilling of putrescible waste	Groundwater contamination	Design, construct and operate sewage treatment facilities and putrescible landfill in accordance with the DWER and Department of Health/local government approval conditions	Annual compliance reports Incident reports Routine groundwater monitoring

4.5 Key factor 3: Flora and vegetation

4.5.1 EPA objectives

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

As applied to flora and vegetation, 'ecological integrity' refers to the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements.

4.5.2 Policy and guidance

Table 4–27: Relevant policies, guidelines & standards – flora and vegetation

Environmental factor	Relevant policies, guidelines, and standards
Flora and vegetation	EPA, 2016e. *Environmental factor guideline – flora and vegetation* EPA, 2016k. *Technical guidance – flora and vegetation surveys for environmental impact assessment*

The survey designs adopted in baseline flora and vegetation studies conducted for the Lake Disappointment project are generally consistent with current EPA guidelines. The earliest botanical surveys conducted at Lake Disappointment pre-dated current EPA technical guidelines on flora and vegetations surveys. The monitoring program of riparian vegetation conducted in 2012 was developed in consultation with the EPA and the (then) DEC. The monitoring method agreed with the EPA and DEC in 2012 was carried through to subsequent monitoring events to minimise methodological sources of variability which might otherwise compromise interpretation of data.

Shown in Figure 4-36, 117 quadrats were established for baseline vegetation surveys. Surveys were conducted in multiple seasons (before and after the wet season). Targeted surveys of riparian vegetation were designed to satisfy the EPA's recommendation that such surveys

> *'…should be guided by the habitat preference of the flora or vegetation being targeted…sampling sites should be placed at representative locations throughout the survey area considering landform, geology, elevation, slope, aspect, surface or groundwater expression, and soil type, as well as structure, composition and condition of vegetation'* (EPA, 2016k)

To achieve compliance with the approach recommended by the EPA, surveys of riparian vegetation involved establishment of transects and quadrats along a transect oriented parallel and perpendicular to the playa shoreline. This design sought to capture relevant information about a range of soil, hydrological and landform factors that vary with distance from the playa. Details are provided in Appendix D1.

Figure 4-36: Baseline vegetation surveys – quadrat locations

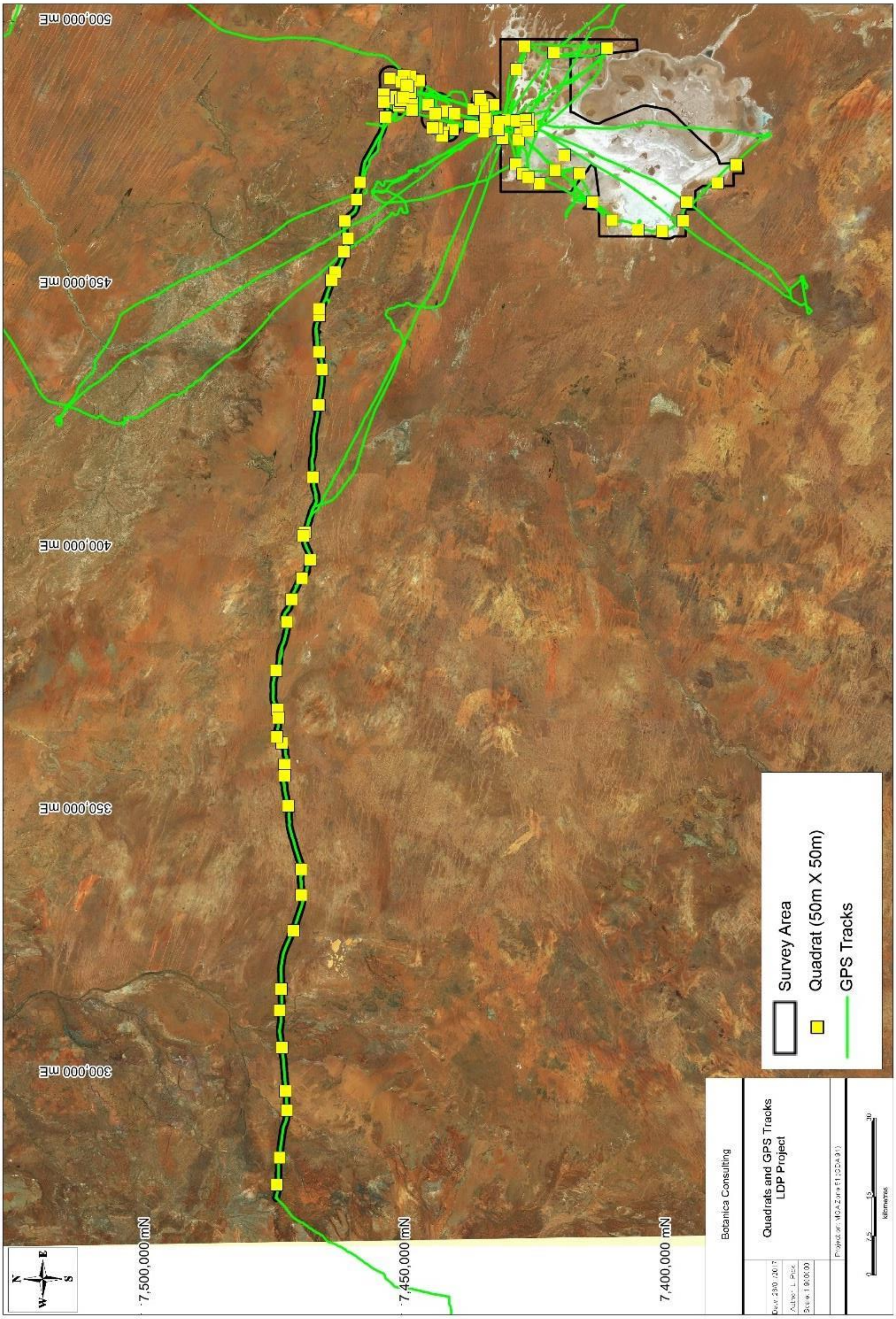


Table 4–28: Summary of Lake Disappointment flora and vegetation studies

Study reference	Scope of Investigation
Appendix D1: Botanica Consulting, 2018. Level 2 Flora & Vegetation Survey Lake Disappointment Project	Consolidated review of past flora and vegetation surveys with additional information on access roads and borefields
Appendix D2: Botanica Consulting, 2018. Flora & Vegetation Impact Assessment Report - Lake Disappointment Project	Presents a quantitative assessment of potential direct and indirect direct impacts on flora and/or vegetation associated with project implementation; comments on need for biodiversity offsets to compensate for unavoidable impacts on flora/vegetation
Appendix D3: Botanica Consulting, 2017. Soil Characterisation and Assessment of *Tecticornia* Root Structure of the Lake Disappointment Riparian Zone	Report describes the root architecture of *Tecticornia* plants growing in the riparian zone of Lake Disappointment and summarises information about the physical and chemical properties of soils within the riparian zone
Appendix D4: Botanica Consulting, 2015. Riparian Vegetation Monitoring at Lake Disappointment	Riparian vegetation survey methodologies and results from Botanica's third year of monitoring
Appendix D5: Botanica Consulting, 2015. Sand Dune Vegetation Monitoring Lake Disappointment Potash Project	Sand dune vegetation survey methodologies and results from Botanica's third year of monitoring
Appendix D6: Hydrobiology, 2017. Memorandum: Lake Disappointment: NDVI, NDWI and ET calculations	Technical memorandum presenting the results of analysis of spectral data to inform an assessment of the likely groundwater dependency of vegetation near Lake Disappointment.

4.5.3 Receiving environment

Vegetation Associations

During baseline survey of the project area and surrounds, 14 vegetation types were identified (Table 4–29; Figure 4-37 through Figure 4-39). These vegetation types were located within six different landform types and fell into eight major vegetation groups, based on the National Vegetation Information System (NVIS):

- Eucalypt woodland
- Acacia forests and woodlands
- Casuarina forests and woodlands
- Mallee woodlands and shrublands
- Hummock grasslands
- Chenopod shrublands, samphire shrublands and forbland
- Other shrublands
- Other grasslands, herb lands, sedgelands and rush lands.

In total, 134,800 ha were surveyed during baseline flora and vegetation studies. Descriptions of the methods used during desktop and field surveys and in the analysis of floristic data are provided in the technical reports presented in Appendix D, along with maps of vegetation types (including locations of priority or novel flora).

Some parts of the playa could not be surveyed because they lie within Aboriginal heritage exclusion zones which may not be accessed under the terms of a land access agreement between the Martu

Traditional Owners and Reward. These areas lie outside the proposed development envelope and will not be impacted by project implementation.

According to EPA Position Statement 2 (since replaced by EPA 2016e), vegetation areas retaining less than 30% of their pre-European vegetation extent generally experience accelerated species loss, while areas with less than 10% are considered 'endangered'. Each of the vegetation associations in the survey area retains more than 99% of its original vegetation extent (Appendices D1 and D2).

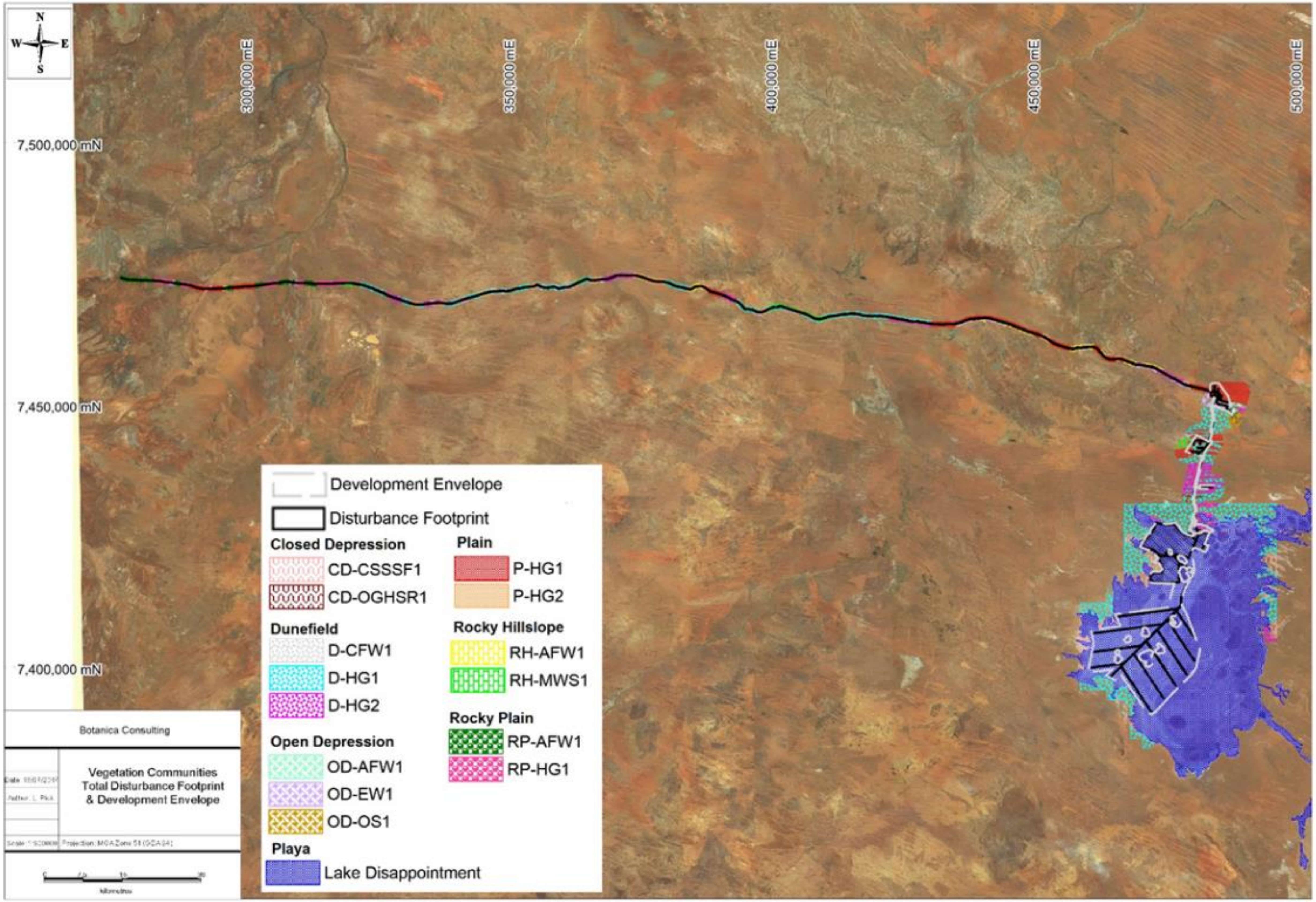
Table 4–29: Summary of vegetation types

Landform	Major vegetation group	Vegetation type	Vegetation code	Area surveyed (ha)	Area (%)
Closed depression	Chenopod shrublands, samphire shrublands and forblands (MVG22)	Heath of mixed *Tecticornia* spp. on salt lake edge	CD-CSSSF1	5984	4.4
	N/A	Salt lake (not vegetated)	CD-SL1	70,529	52.3
	Other grasslands, herblands, sedgelands and rushlands (MVG21)	Open mixed herbs in clay-loam depression	CD-OGHSR1	478	0.4
Dunefield	Casuarina forests and woodlands (MVG8)	Low forest of *Allocasuarina decaisneana* over open scrub of *Acacia/Grevillea* and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-CFW1	642	0.5
	Hummock grasslands (MVG20)	Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-HG1	36,118	26.8
		Scrub of *Acacia/Eremophila/Grevillea* spp. over mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-HG2		
Open depression	Acacia forests and woodlands (MVG6)	Low woodland of *Acacia* spp. over low scrub of *Senna artemisioides* and mixed dwarf scrub in drainage depression	OD-AFW1	516	0.4
	Eucalypt woodland (MVG5)	Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline	OD-EW1	3029	2.2
	Other shrublands (MVG17)	Low woodland of *Hakea lorea/Melaleuca glomerata* over low	OD-OS1	698	0.5

Landform	Major vegetation group	Vegetation type	Vegetation code	Area surveyed (ha)	Area (%)
		heath of *Fimbristylis eremophila* in drainage depression			
Plain	Hummock grasslands (MVG20)	Open low woodland of *Corymbia* spp./*Hakea lorea* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia* spp. in sandplain	P-HG1	11,162	8.3
		Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia bivenosa* and mid-dense hummock grass of *Triodia basedowii* in sandplain	P-HG2		
Rocky hillslope	Acacia forests and woodlands (MVG6)	Scrub of *Acacia* spp. over mixed low scrub and mid-dense hummock grass of *Triodia pungens* on rocky hillslope	RH-AFW1	1077	0.8
	Mallee woodlands and shrublands (MVG14)	Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia* spp. on rocky hillslope	RH-MWS1	1,356	1.0
Rocky plain	Acacia forests and woodlands (MVG6)	Low woodland of *Acacia* spp. over low scrub of *Eremophila/Senna* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain	RP-AFW1	1572	1.2
	Hummock grasslands (MVG20)	Open low woodland of *Corymbia aspera* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain	RP-HG1	1639	1.2
Total				134,800	100

Note: 'Area (%)' means the proportion of the area included in baseline surveys in which the specified vegetation type was observed.

Figure 4-37: Vegetation types near proposed Lake Disappointment Potash Project



Note: Additional detailed maps of vegetation along Talawana Track are provided in Appendix D1.

Figure 4-38: Vegetation types near proposed borefields and airstrip

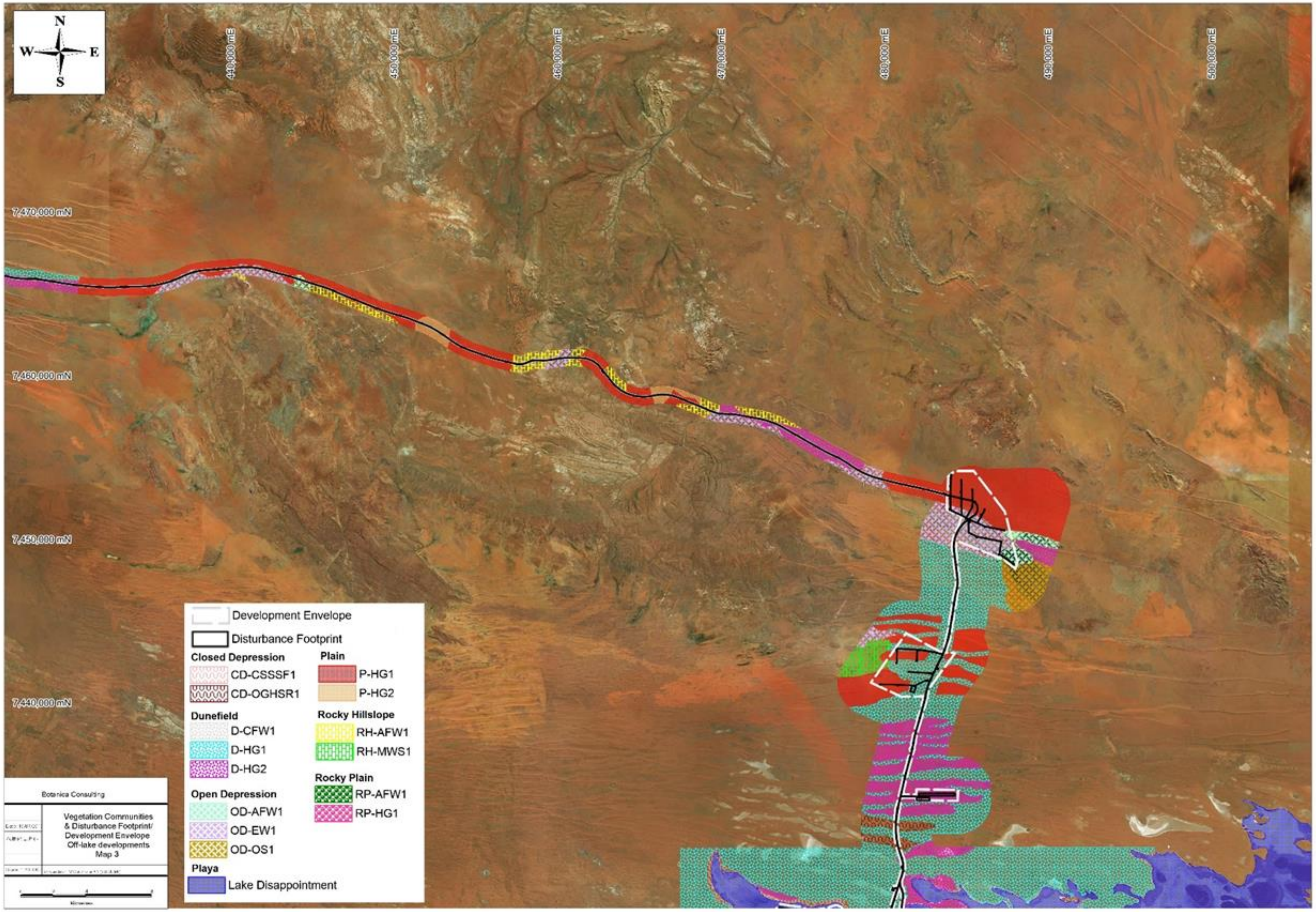
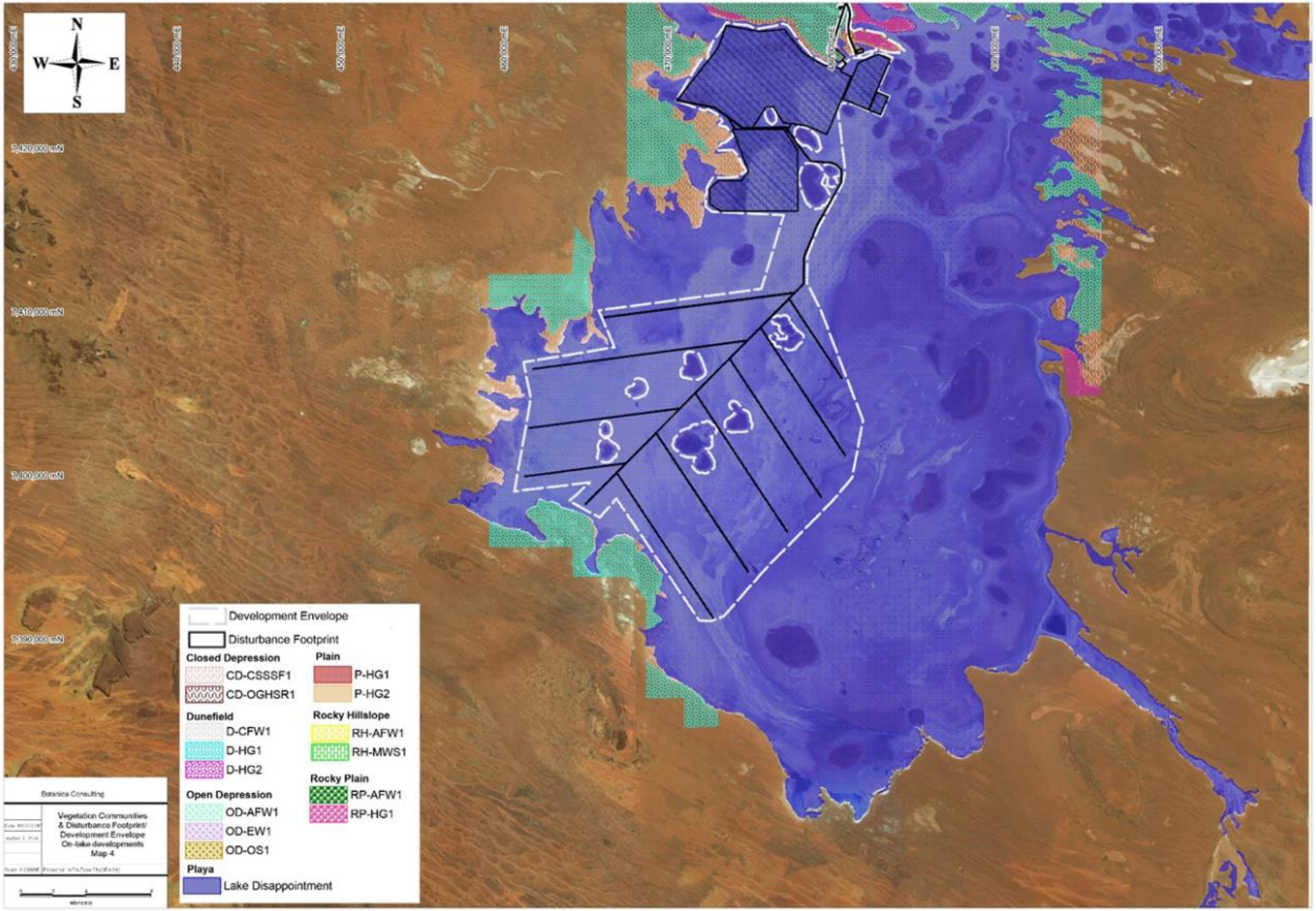


Figure 4-39: Vegetation types near Lake Disappointment playa and proposed mine operations area



Vegetation condition

Based on a vegetation condition rating scale adapted from Keighery (1994) and Trudgen (1988), three floristic communities in the survey area were rated as 'poor', one rated as 'good' and the remaining 11 communities had a vegetation condition rating of 'very good' (Table 4–30, Figure 4-40). The main threatening factors currently affecting vegetation condition in the project locality include:

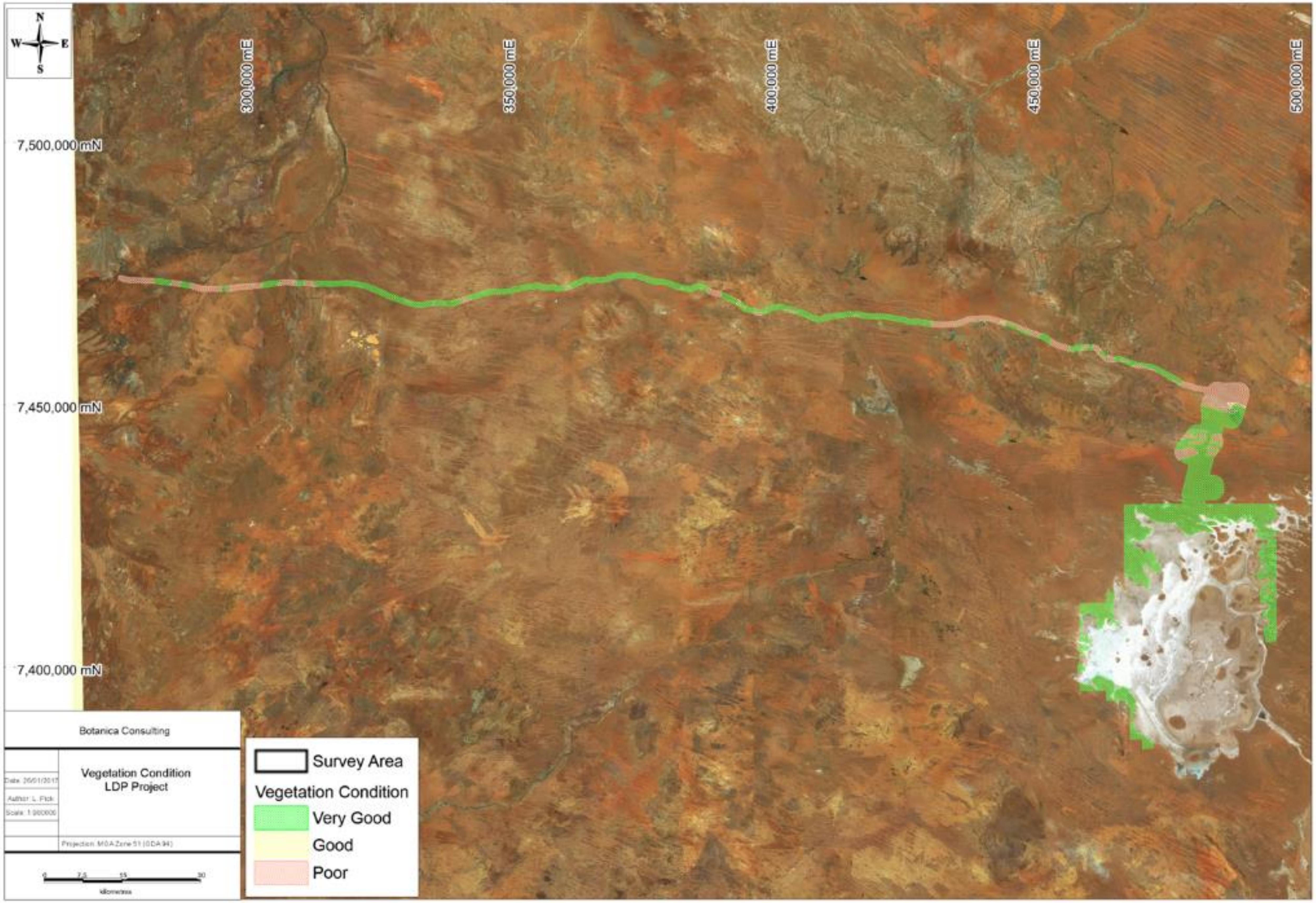
- Weed invasion (high density presence of the introduced species *Cenchrus ciliaris* (buffel grass))
- Grazing by donkeys and camels
- Recent and/or frequent fires
- Development and use of access tracks
- Exploration disturbance.

Table 4–30: Vegetation condition ratings - Lake Disappointment Potash Project survey area

Landform	Major vegetation group	Floristic community	Vegetation code	Condition rating
Closed depression	Chenopod shrublands, samphire shrublands and forblands (MVG22)	Heath of mixed *Tecticornia* spp. on salt lake edge	CD-CSSSF1	Very good
	N/A	Salt lake	CD-SL1	N/A
	Other grasslands, herblands, sedgelands and rushlands (MVG21)	Open mixed herbs in clay-loam depression	CD-OGHSR1	Very good
Dunefield	Casuarina forests and woodlands (MVG8)	Low forest of *Allocasuarina decaisneana* over open scrub of *Acacia/Grevillea* and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-CFW1	Very good
	Hummock grasslands (MVG20)	Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-HG1	Very good
		Scrub of *Acacia/Eremophila/Grevillea* spp. over mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-HG2	Very good

Landform	Major vegetation group	Floristic community	Vegetation code	Condition rating
Open depression	Acacia forests and woodlands (MVG6)	Low woodland of *Acacia* spp. over low scrub of *Senna artemisioides* and mixed dwarf scrub in drainage depression	OD-AFW1	Good
	Eucalypt woodland (MVG5)	Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline	OD-EW1	Poor
	Other shrublands (MVG17)	Low woodland of *Hakea lorea/Melaleuca glomerata* over low heath of *Fimbristylis eremophila* in drainage depression	OD-OS1	Very good
Plain	Hummock grasslands (MVG20)	Open low woodland of *Corymbia* spp./*Hakea lorea* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia* spp. in sandplain	P-HG1	Poor
		Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia bivenosa* and mid-dense hummock grass of *Triodia basedowii* in sandplain	P-HG2	Very good
Rocky hillslope	Acacia forests and woodlands (MVG6)	Scrub of *Acacia* spp. over mixed low scrub and mid-dense hummock grass of *Triodia pungens* on rocky hillslope	RH-AFW1	Very good
	Mallee woodlands and shrublands (MVG14)	Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia* spp. on rocky hillslope	RH-MWS1	Very good
Rocky plain	Acacia forests and Woodlands (MVG6)	Low woodland of *Acacia* spp. over low scrub of *Eremophila/Senna* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain	RP-AFW1	Poor
	Hummock grasslands (MVG20)	Open low woodland of *Corymbia aspera* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain	RP-HG1	Very good

Figure 4-40: Vegetation condition – Lake Disappointment project area



Vegetation of conservation significance

No threatened flora species, vegetation assemblages or ecological communities recognised under the Australian Government EPBC Act were recorded during baseline surveys of the Lake Disappointment project area.

No Threatened Ecological Communities (TEC) or Threatened Flora listed under the Government of Western Australian EP Act or WC Act have been recorded within the project development envelope or the proposed disturbance footprint.

No Priority Ecological Communities (PEC) as listed by the DPaW (now DBCA) were recorded within the development envelope/disturbance footprint. The nearest PEC is the Priority 3 Ecological Community '*Riparian vegetation including phreatophytic species associated with creek lines and watercourses of Rudall River*' (described as semi-permanent pools along courses of Rudall River (DPaW, 2016)), which is located approximately 20 km north of the development envelope (Northern Borefield). No ecosystems listed under the IUCN Red List (2018) of ecosystems occur within the development envelope/disturbance footprint.

Apart from flora and vegetation formally protected under state and federal legislation, Reward has considered other attributes that may influence the significance of flora and vegetation, including:

- Listing as a priority species or ecological community;
- Restricted occurrence; locally endemic or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- New species or anomalous features that indicate a potential new species;
- Unusual species, including restricted subspecies, varieties or naturally occurring hybrids;
- Representative of the range of a species (particularly, at the extremes of range recently discovered range extensions, or isolated outliers of the main range);
- Relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape;
- Vegetation role as a refuge for significant species; and
- Vegetation function is required to maintain ecological integrity of a significant ecosystem.

An assessment of the potential conservation significance of flora/vegetation within the development envelope/disturbance footprint against these criteria is presented in Table 4–31. The following two vegetation types were identified as being of possible conservation significance:

- Heath of mixed *Tecticornia* spp. on salt lake edge (CD-CSSF1); and
- Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline (OD-EW1).

The remaining vegetation types identified within the development envelope/disturbance footprint are not considered to be of local or regional conservation significance, according to the flora/vegetation conservation significance criteria listed above.

Table 4–31: Assessment of conservation significance – flora and vegetation

Vegetation type	Conservation significant flora	Conservation significant vegetation
Heath of mixed *Tecticornia* spp. on salt lake edge (CD-CSSF1)	1 Priority 1 flora taxon 3 potentially new species	Potential aquatic GDE[12]
Open mixed herbs in clay-loam depression (CD-OGHSR1)	None identified	None identified
Low forest of *Allocasuarina decaisneana* over open scrub of *Acacia/Grevillea* and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales (D-CFW1)	None identified	None identified
Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales (D-HG1)	None identified	None identified
Scrub of *Acacia/Eremophila/Grevillea* spp. over mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales (D-HG2)	None identified	None identified
Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline (OD-EW1)	None identified	Potential GDE (terrestrial)[13]
Low woodland of *Acacia* spp. over low scrub of *Senna artemisioides* and mixed dwarf scrub in drainage depression (OD-AFW1)	None identified	None identified
Low woodland of *Hakea lorea/Melaleuca glomerata* over low heath of *Fimbristylis eremophila* in drainage depression (OD-OS1)	None identified	None identified
Open low woodland of *Corymbia* spp./*Hakea lorea* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia* spp. in sandplain (P-HG1)	None identified	None identified
Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia bivenosa* and mid-dense hummock grass of *Triodia basedowii* in sandplain (P-HG2)	None identified	None identified
Scrub of *Acacia* spp. over mixed low scrub and mid-dense hummock grass of *Triodia pungens* on rocky hillslope (RH-AFW1)	None identified	None identified
Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia* spp. on rocky hillslope (RH-MWS1)	None identified	None identified
Low woodland of *Acacia* spp. over low scrub of *Eremophila/Senna* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain (RP-AFW1)	None identified	None identified

[12] Due to association with water feature (i.e. playa).
[13] Due to association with *Eucalyptus camaldulensis* (river red gum)

Vegetation type	Conservation significant flora	Conservation significant vegetation
Open low woodland of *Corymbia aspera* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain (RP-HG1)	None identified	None identified

Heath of mixed Tecticornia spp. on salt lake edge (CD-CSSSF1)

The following flora of conservation significance were identified within the Heath of mixed *Tecticornia* spp. on Salt Lake edge (CD-CSSSF1 vegetation type:

- *Tecticornia* sp. nov. A (as identified by K.A Shepherd 867), potentially new species (Figure 4-41);
- *Tecticornia* sp. nov. B (as identified by K.A Shepherd 867), potentially new species (Figure 4-41);
- *Tecticornia* aff. *calyptrata* (as identified by K.A Shepherd 867), potentially new species (Figure 4-42); and
- Tecticornia sp. Sunshine Lake (K.A. Shepherd et al. KS 867)-Priority 1 taxon (Figure 4-42).

Figure 4-41: *Tecticornia* sp. nov. A (left) and *Tecticornia* sp. nov. B (right)

Figure 4-42: *Tecticornia aff. calyptrata* (left) and *Tecticornia sp. Sunshine Lake* (right)

Tecticornia aff. *calyptrata* was identified by *Tecticornia* specialist Dr Kelly Shepherd as a potentially distinct taxon related to *Tecticornia calyptrata.* Further taxonomic work is required to confirm if it should be supported as a distinct taxon. Until the question of whether or not this plant is a distinct taxon is resolved, it is provisionally considered to be of conservation significance.

Tecticornia sp. nov. A (related to the 'ovate seed aggregate' in the *T. halocnemoides* complex) and *Tecticornia* sp. nov. B (related to the 'round seed aggregate' in the *T. halocnemoides* complex) are currently undescribed taxa and are provisionally considered to be of conservation significance as they represent potentially new taxa (pending further taxonomic work).

Tecticornia sp. Sunshine Lake (K.A. Shepherd et al. KS 867) is not restricted to Lake Disappointment. Records of *Tecticornia* sp. Sunshine Lake (K.A. Shepherd et al. KS 867) also exist from the Murchison and Little Sandy Desert Region.

A map showing the locations of flora and vegetation of conservation significance in relation to the disturbance footprint/development envelope is provided in Figure 4-44. A plan showing the estimated extent of *Tecticornia*-dominated vegetation in the wider Lake Disappointment area is presented in Figure 4-45 (detail provided in Figure 4-46). This figure is based on a combination of a desktop study of aerial imagery and on-ground surveys. Less than 0.5% of the estimated area occupied by samphire-dominated vegetation at Lake Disappointment lies within the project development envelope (Figure 4-43).

Figure 4-43: Samphire-dominated vegetation extents

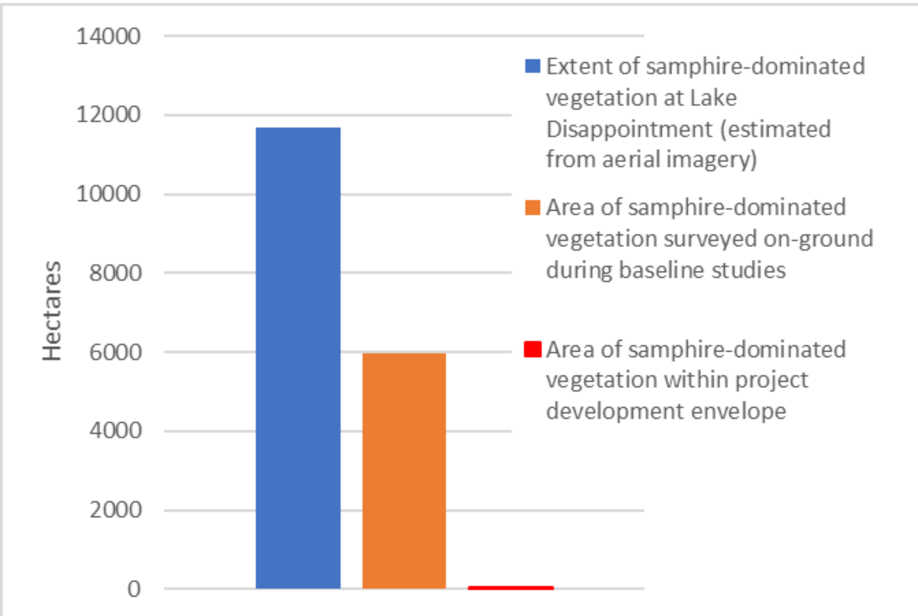


Figure 4-44: Conservation significant *Tecticornia* (regional scale)

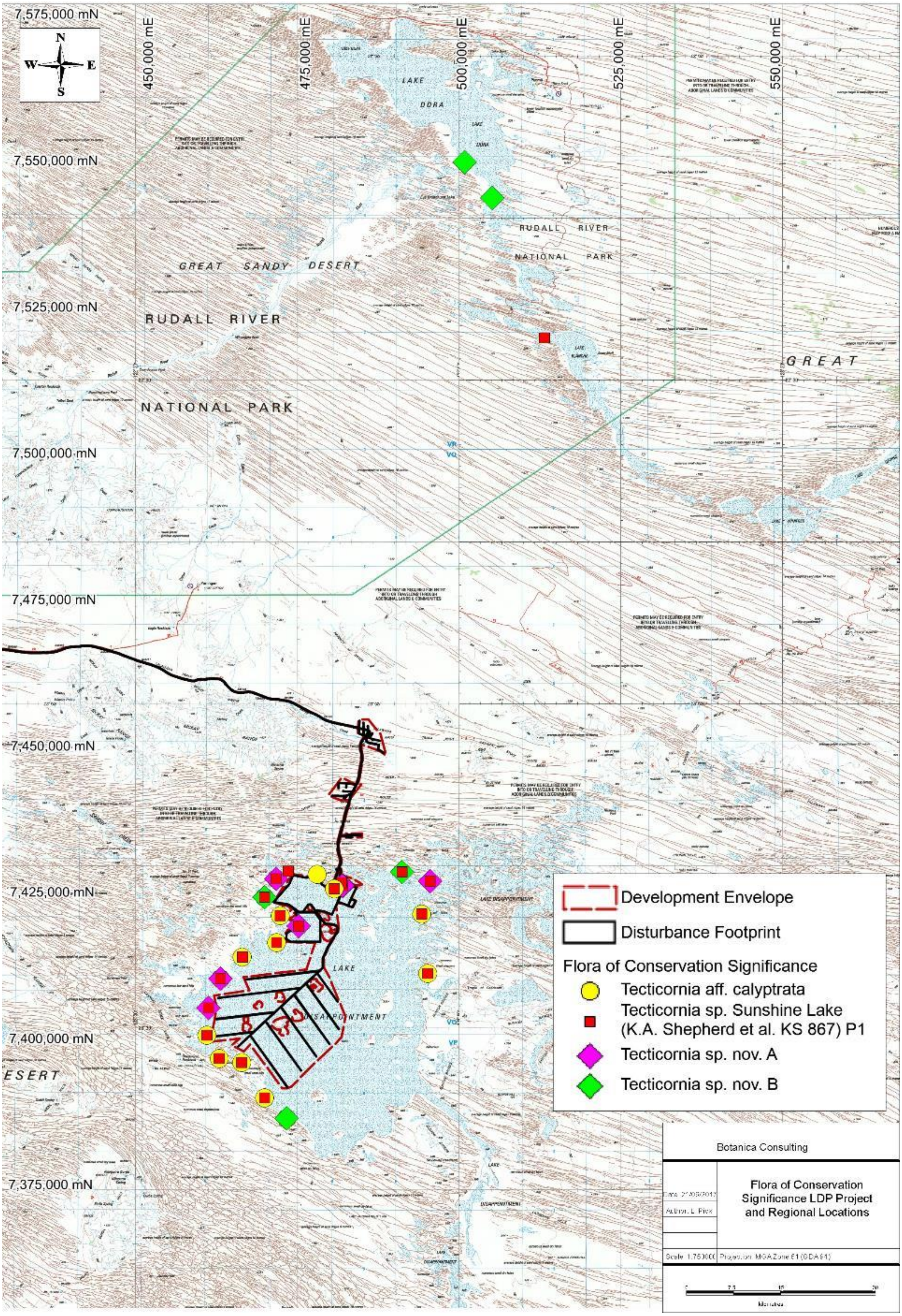


Figure 4-45: *Tecticornia*-dominated vegetation near Lake Disappointment

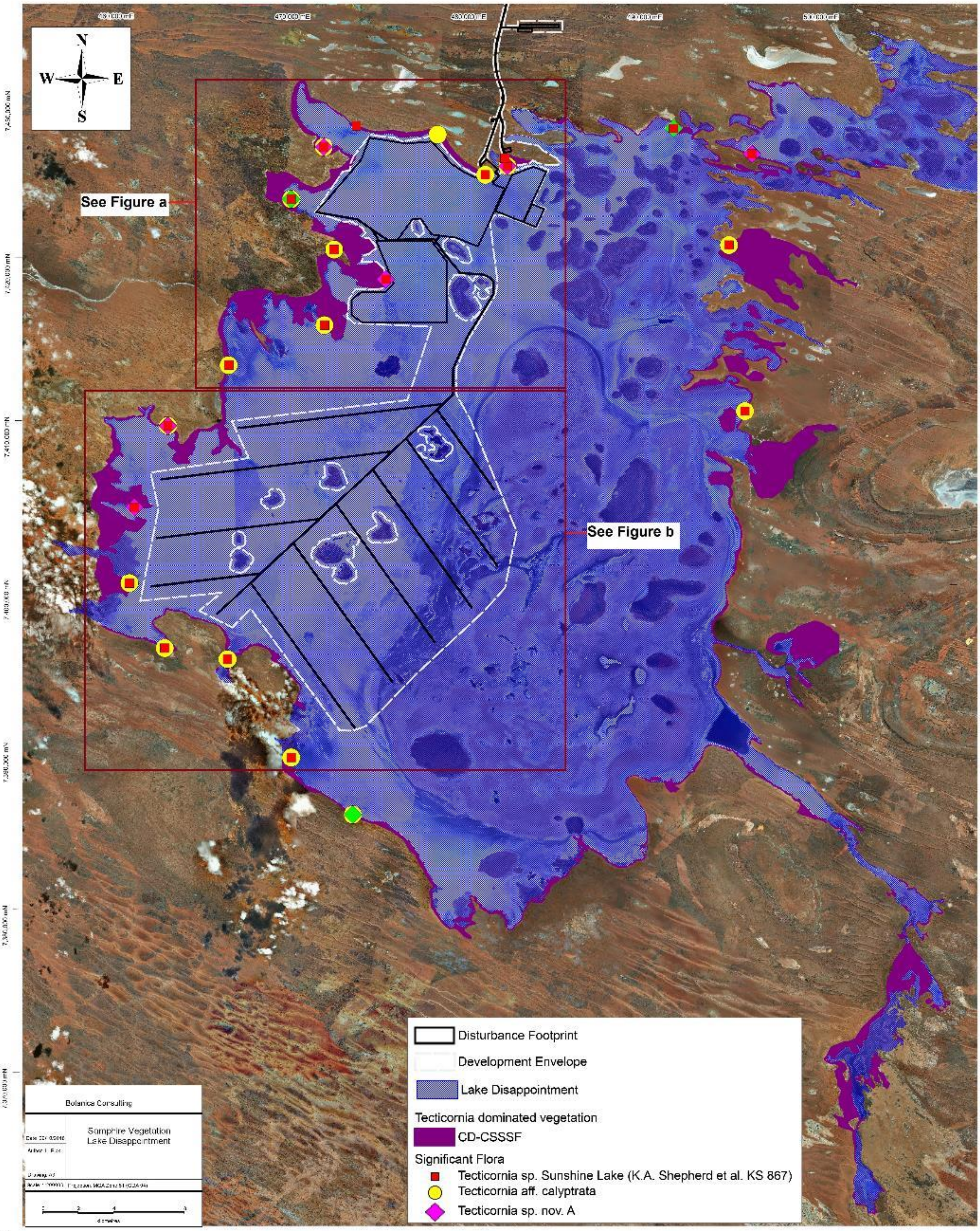
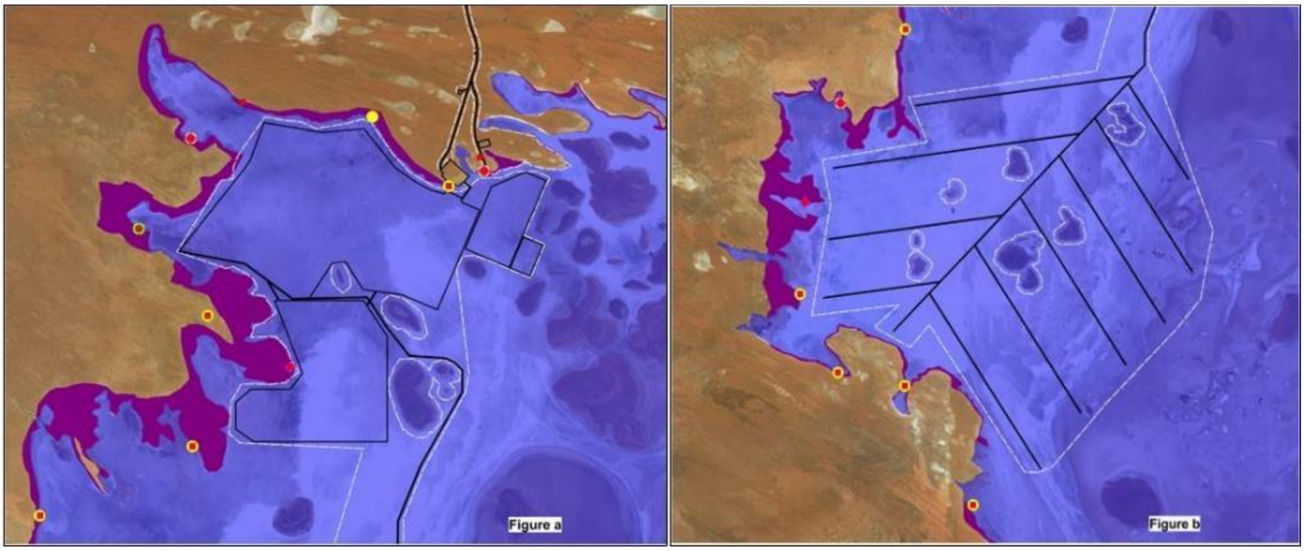


Figure 4-46: *Tecticornia*-dominated vegetation near Lake Disappointment (detail)



Open low woodland of Eucalyptus camaldulensis/Corymbia in creekline (OD-EW1)

Vegetation associated with McKay Creek (overlapped in part by the proposed Northern Borefield) was described as Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline (OD-EW1, Figure 4-47). This vegetation unit was identified as potentially of local conservation significance due to its association with a spatially restricted feature (creekline) and potential dependency upon the hydrological conditions peculiar to that location.

Figure 4-47: Open low *Eucalyptus camaldulensis/Corymbia* woodland along McKay Creek

E. camaldulensis is adapted to episodic flooding and drought. Published literature suggests its water requirements exceed those provided by rainfall alone and are usually met by the trees accessing groundwater[14] (Doody et al. 2015). As an adaptation to arid and semi-arid environments, *E. camaldulensis* is opportunistic in its water use. Water sources include fresh to moderately saline groundwater, lateral bank recharge and overbank flooding which replenish floodplain groundwater.

Introduced plant species

One introduced species, *Cenchrus ciliaris* (buffel grass), was identified in six vegetation types within the survey area. According to the DPIRD (formerly DAFWA), this species is not listed as a Declared Plant under Section 22 of the *Biosecurity and Agriculture Management Act 2007*.

4.5.4 Potential impacts

Potential impacts of project implementation on floristic and vegetation values are summarised in Table 4–32.

Table 4–32: Excerpt from project risk register – flora and vegetation

Event description	Potential impact
Clearing and ground disturbance for establishment of off-playa infrastructure	Vegetation loss; clearing impacts on conservation significant flora
Clearing and ground disturbance for establishment of on-playa infrastructure	Vegetation loss; clearing impacts on conservation significant flora
Establishment and operation of on-playa infrastructure: increased inundation	Changed hydrology adversely affects health or species composition of riparian vegetation
Brine abstraction from trenches results in water table drawdown	Changed hydrology adversely affects health or species composition of riparian vegetation
Water abstraction from lower salinity borefields results in watertable drawdown	Changed hydrology adversely affects health or species composition of riparian vegetation
Movement of vehicles and machinery during construction and operations: transport of weeds or pathogens	Introduction/spread of weeds and/or pathogens: impacts to ecosystem health
Movement of vehicles and machinery during construction and operations: unauthorised clearing	Vegetation loss; clearing impacts on conservation significant flora
Movement of vehicles and machinery during construction and operations: dust generation	Adverse impact on vegetation health
Stockpiling and handling of salt: dust generation	Adverse impact on vegetation health

[14] Dependent on groundwater availability and quality

4.5.5 Impact assessment

Reduction in pre-European vegetation extent

The implementation of the Lake Disappointment Potash Project will not significantly reduce the pre-European extent of any vegetation association in the project area (Appendix D2). At a local scale (calculating direct project disturbance relative to the extent of vegetation recorded during baseline surveys of the project area), the maximum percentage of vegetation loss is:

- Approximately 1.1% of vegetation unit RH-AFW1 (Scrub of *Acacia* spp. over mixed low scrub and mid-dense hummock grass of *Triodia pungens* on rocky hillslope); and
- 1.09% of vegetation unit OD-EW1 (Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline).

The estimated direct disturbance areas associated with these two vegetation units in the project disturbance footprint are: 12 ha (for RH-AFW1) and 33 ha (for OD-EW1) (Table 4–33). At a regional scale, the percentage reduction in each vegetation type is much smaller (well below 0.5% of each vegetation type/associated pre-European vegetation association) (Table 4–34).

Table 4–33: Direct impacts on vegetation (local scale)

Vegetation description	Vegetation code	Development envelope (ha)	Disturbance footprint (ha)	Survey area (ha)	% local habitat (survey area) intersected by development envelope	% Local habitat (survey area) proposed to be impacted - disturbance footprint
Heath of mixed *Tecticornia* spp. on salt lake edge	CD-CSSSF1	56	0	5984	0.94	0
Open mixed herbs in clay-loam depression	CD-OGHSR1	34	3	478	7.18	0.56
Low forest of *Allocasuarina decaisneana* over open scrub of *Acacia/Grevillea* and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-CFW1	6	6	642	0.93	0.94
Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-HG1	1753	257	36,118	4.85	0.71
Scrub of *Acacia/Eremophila/Grevillea* spp. over mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-HG2					
Low woodland of *Acacia* spp. over low scrub of *Senna artemisioides* and mixed dwarf scrub in drainage depression	OD-AFW1	102	3	516	19.77	0.58
Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline	OD-EW1	628	33	3029	20.73	1.09
Low woodland of *Hakea lorea/Melaleuca glomerata* over low heath of *Fimbristylis eremophila* in drainage depression	OD-OS1	2	0	698	0.29	0.00
Open low woodland of *Corymbia* spp./*Hakea lorea* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia* spp. in sandplain	P-HG1	1253	83	11,162	11.23	0.74

Vegetation description	Vegetation code	Development envelope (ha)	Disturbance footprint (ha)	Survey area (ha)	% local habitat (survey area) intersected by development envelope	% Local habitat (survey area) proposed to be impacted - disturbance footprint
Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia bivenosa* and mid-dense hummock grass of *Triodia basedowii* in sandplain	P-HG2					
Scrub of *Acacia* spp. over mixed low scrub and mid-dense hummock grass of *Triodia pungens* on rocky hillslope	RH-AFW1	12	12	1077	1.11	1.11
Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia* spp. on rocky hillslope	RH-MWS1	22	6	1356	1.62	0.45
Low woodland of *Acacia* spp. over low scrub of *Eremophila/Senna* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain	RP-AFW1	5	5	1572	0.32	0.33
Open low woodland of *Corymbia aspera* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain	RP-HG1	3	3	1639	0.18	0.16
Cleared vegetation	CV	168	168	0	N/A	N/A
Salt lake	CD-SL1	35,934	7198	70,529	50.95	10.21

Table 4–34: Direct impacts on vegetation (regional scale)

Vegetation description	Vegetation code	Development envelope (ha)	Disturbance footprint (ha)	Pre-European vegetation	Extent in PIL1 subregion (ha)	Extent in PIL2 subregion (ha)	Extent in LSD1 subregion (ha)	Extent in LSD2 subregion (ha)	Regional habitat intersected by development envelope (%)	Regional habitat proposed to be impacted (disturbance footprint) (%)
Heath of mixed *Tecticornia* spp. on salt lake edge	CD-CSSSF1	56	0	Little Sandy Desert 125			980	225,061	0.0248	0
Open mixed herbs in clay-loam depression	CD-OGHSR1	34	3	Little Sandy Desert 134	828	100	10,003	7,363,935	0.0005	0.0000
Low forest of *Allocasuarina decaisneana* over open scrub of *Acacia/Grevillea* and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-CFW1	6	6	Little Sandy Desert 194				59,064	0.0102	0.0102
Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-HG1	1753	257	Little Sandy Desert 134	828	100	10,003	7,363,935	0.0238	0.0032
Scrub of *Acacia/ Eremophila/Grevillea* spp. over mid-dense hummock grass of *Triodia basedowii* on sand dunes/swales	D-HG2			Little Sandy Desert 158			178,188	49,274	0.7707	0.1130

Vegetation description	Vegetation code	Development envelope (ha)	Disturbance footprint (ha)	Pre-European vegetation	Extent in PIL1 subregion (ha)	Extent in PIL2 subregion (ha)	Extent in LSD1 subregion (ha)	Extent in LSD2 subregion (ha)	Regional habitat intersected by development envelope (%)	Regional habitat proposed to be impacted (disturbance footprint) (%)
Low woodland of *Acacia* spp. over low scrub of *Senna artemisioides* and mixed dwarf scrub in drainage depression	OD-AFW1	102	3	Little Sandy Desert 99			398,672	65,175	0.0220	0.0006
Open low woodland of *Eucalyptus camaldulensis/Corymbia* spp. over mid-dense hummock grass of *Triodia* spp. in creekline	OD-EW1	628[15]	33[16]	Little Sandy Desert 99			398,672	65,175	0.1354	0.0071
				Little Sandy Desert 117			191,412	958,39	0.2186	0.0115
				Little Sandy Desert 134	828	100	10,003	7,363,935	0.0085	0.0004
Low woodland of *Hakea lorea/Melaleuca glomerata* over low heath of *Fimbristylis eremophila* in drainage depression	OD-OS1	2	0	Little Sandy Desert 99			398,672	65,175	0.0004	0.0000
Open low woodland of *Corymbia* spp./*Hakea lorea* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia* spp. in sandplain	P-HG1	1253	83	Abydos Plain – Chichester 111	80,894	24,482			1.1891	0.0788
				Little Sandy Desert 99			398,672	65,175	0.2710	0.0179

[15] 616 ha of OD-EW1 within the development envelope is associated with McKay Creek; the remaining area is associated with un-named, non-perennial drainage lines
[16] 22 ha of OD-EW1 within the disturbance footprint is associated with McKay Creek; the remaining area is associated with un-named, non-perennial drainage lines

Vegetation description	Vegetation code	Development envelope (ha)	Disturbance footprint (ha)	Pre-European vegetation	Extent in PIL1 subregion (ha)	Extent in PIL2 subregion (ha)	Extent in LSD1 subregion (ha)	Extent in LSD2 subregion (ha)	Regional habitat intersected by development envelope (%)	Regional habitat proposed to be impacted (disturbance footprint) (%)
Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia bivenosa* and mid-dense hummock grass of *Triodia basedowii* in sandplain	P-HG2			Little Sandy Desert 134	829	100	10,003	7,363,935	0.0170	0.0011
				Little Sandy Desert 158-			178,188	49,274	0.5509	0.0365
Scrub of *Acacia* spp. over mixed low scrub and mid-dense hummock grass of *Triodia pungens* on rocky hillslope	RH-AFW1	12	12	Little Sandy Desert 99-			398,672	65,175	0.0026	0.0026
				Little Sandy Desert 134-	829	100	10,003	7,363,935	0.0002	0.0002
Open shrub mallee of *Eucalyptus gamophylla/E. kingsmillii* subsp. *kingsmillii* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia* spp. on rocky hillslope	RH-MWS1	22	6	Little Sandy Desert 99-			398,672	65,175	0.0047	0.0013
				Little Sandy Desert 134-	829	100	10,003	7,363,935	0.0003	0.0001
				Abydos Plain – Chichester 111	80,894	24,482			0.0209	0.0058
Low woodland of *Acacia* spp. over low scrub of *Eremophila/Senna* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain	RP-AFW1	5	5	Little Sandy Desert 99			398,672	65,175	0.0011	0.0011
				Little Sandy Desert 134	829	100	10,003	7,363,935	0.0001	0.0001

Vegetation description	Vegetation code	Development envelope (ha)	Disturbance footprint (ha)	Pre-European vegetation	Extent in PIL1 subregion (ha)	Extent in PIL2 subregion (ha)	Extent in LSD1 subregion (ha)	Extent in LSD2 subregion (ha)	Regional habitat intersected by development envelope (%)	Regional habitat proposed to be impacted (disturbance footprint) (%)
Open low woodland of *Corymbia aspera* over low scrub of *Acacia* spp. and mid-dense hummock grass of *Triodia basedowii* on rocky plain	RP-HG1	3	3	Little Sandy Desert 158-			178,188	49274	0.0013	0.0012
				Little Sandy Desert 99-			398,672	65,175	0.0006	0.0006
				Little Sandy Desert 134-	829	100	10,003	7,363,935	0.0000	0.0000
Cleared vegetation	CV	168	168	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Salt lake (unvegetated)	CD-SL1	35,934	7198	Little Sandy Desert 125-	N/A	N/A	980	225,061	15.9	3.2

Direct impacts on conservation significant flora

No conservation significant *Tecticornia* have been recorded within the project's proposed disturbance footprint and very few have been recorded in the project development envelope, compared to the number recorded outside the project envelope during baseline surveys. A quantitative assessment of the direct impacts on *Tecticornia* of conservation significance within the development envelope and disturbance footprint is provided in Table 4–35. Project implementation will not significantly impact conservation-significant *Tecticornia* species.

Table 4–35: Direct impacts on priority or other conservation significant *Tecticornia* species

	Tecticornia* aff. *calyptrata	***Tecticornia* sp. nov. A Figure 4-41**	***Tecticornia* sp. nov. B Figure 4-41**	***Tecticornia* sp. Sunshine Lake (P1) (K.A. Shepherd et al. KS 867)**
No. plants within development envelope	1	3	0	287
No. plants within disturbance footprint	0	0	0	0 (3)
No. plants in local area (within 20 km)	758	1,741	1,050	46,445
No. populations in local area (within 20 km) (1)	11	6	3	4
No. populations in regional area (within 100 km)	11	6	5	9
Development envelope: % impact on local populations (2)	0.13	0.17	0	0.62
Disturbance footprint: % impact on local populations	0	0	0	0.0

Note 1: Separate populations determined based on occurrence of plants >500 m apart.

Note 2: Refers to the percentage of plants impacted in relation to the total number of plants recorded within 20 km of the development envelope.

Note 3: No observations of conservation significant *Tecticornia* were recorded within the disturbance footprint during surveys completed to date; CD-CSSSF1 occupies an area of 56 ha within the development envelope (0.14% of the total development envelope). CD-CSSSF1 does not occur within the proposed disturbance footprint.

Indirect impacts on conservation significant flora and vegetation

Impacts of brine abstraction on riparian vegetation

An assessment of potential impacts of proposed brine abstraction on riparian vegetation surrounding the Lake Disappointment playa is provided in Section 4.3.5. Although there is no evidence in credible peer-reviewed literature that *Tecticornia*-dominated vegetation is groundwater dependent, and based on assessments detailed in Appendix D2, samphire vegetation of Lake Disappointment has not been identified as groundwater dependent, Reward is aware that some stakeholders have expressed concern about possible harm to *Tecticornia* vegetation as a result of groundwater drawdown caused by brine extraction. To address this concern, Reward has estimated the extent of *Tecticornia*-dominated vegetation in the area potentially affected by groundwater drawdown (Table 4–36). Hydrological modelling of the potential impacts of brine extraction (Appendices I1 and I5), suggests that less than 2.5% of the *Tecticornia*-dominated vegetation in the Lake Disappointment riparian zone will lie within the area estimated to experience a drawdown of more than 0.7 m (which broadly corresponds to the natural range of groundwater variability in areas near the Lake Disappointment playa). In reality, the extent of *Tecticornia*-dominated vegetation within the zone of influence of brine extraction operations is almost certainly much less, as the modelling used to estimate the drawdown contours assumed that no recharge would occur for a period of up to 10 years, which is a very conservative assumption.

Table 4–36: Extent of *Tecticornia*-dominated vegetation within groundwater drawdown area

Samphire vegetation within potential drawdown	Area (ha)	% of total samphire vegetation
Extent of *Tecticornia*-dominated vegetation (CD-CSSSF) within 0.1–0.3 m groundwater drawdown contour	1749.2	15
Extent of *Tecticornia*-dominated vegetation (CD-CSSSF) within 0.3–0.7 m groundwater drawdown contour	1071.5	9
Extent of *Tecticornia*-dominated vegetation (CD-CSSSF) within 0.7–1.7 m groundwater drawdown contour	185.6	2
Total extent of *Tecticornia*-dominated vegetation (CD-CSSSF) within groundwater drawdown (0.1–1.7 m)	3006.3	26
Total estimated extent of *Tecticornia*-dominated vegetation (CD-CSSSF) in Lake Disappointment riparian zone (based on aerial imagery)	11,703	100

Impacts of on-playa infrastructure on riparian vegetation (altered hydrology)

An assessment of potential impacts of the establishment of on-playa infrastructure on riparian vegetation surrounding the Lake Disappointment playa—chiefly related to the possibility of changes in surface hydrology or associated movement of sediments—is provided in Section 0.

Impacts of brackish water abstraction on riparian vegetation (Northern Borefield)

An assessment of potential impacts of brackish water abstraction from the proposed Northern Borefield along McKay Creek and in the McKay Creek delta is provided in Section 4.3.5.

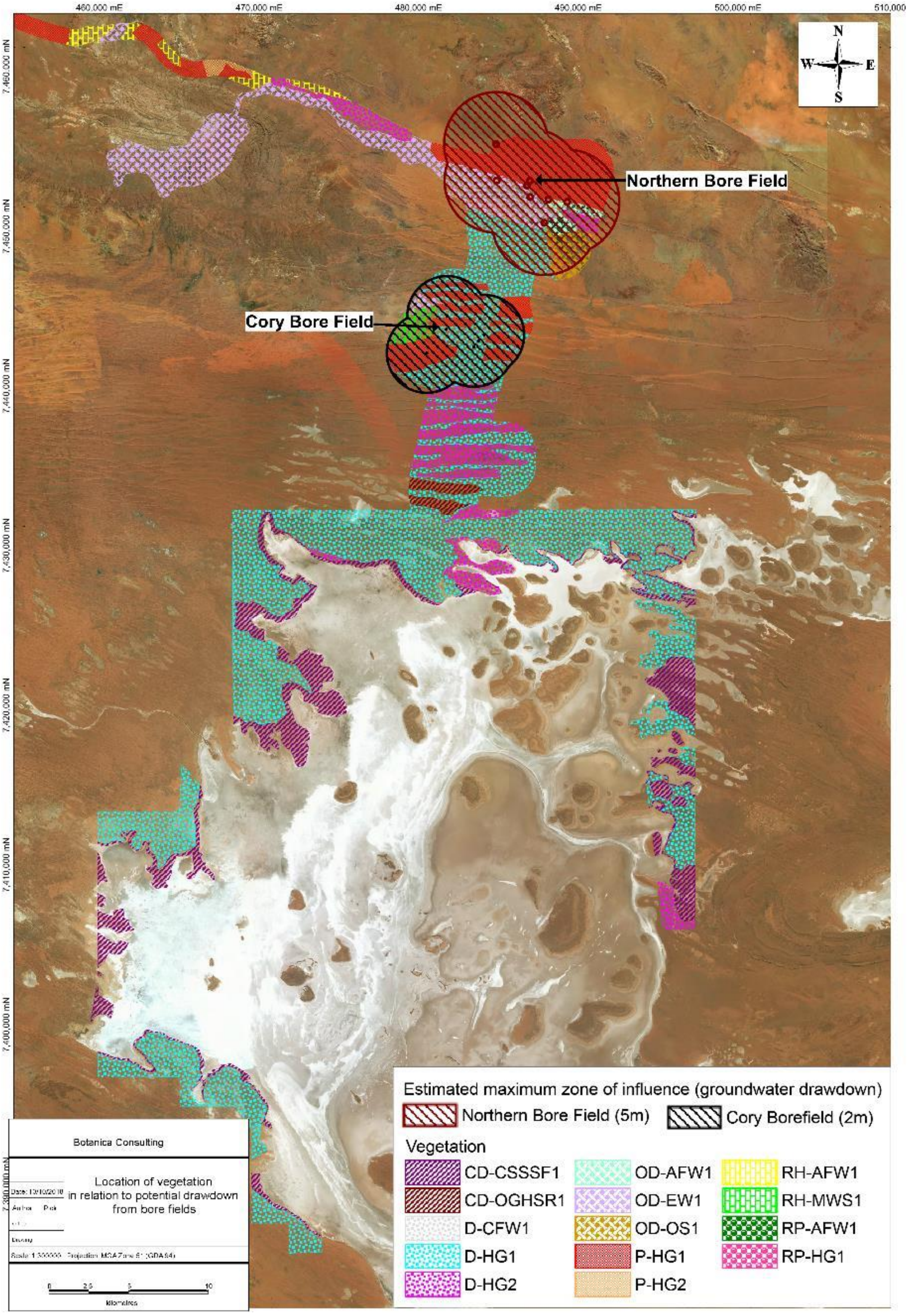
An assessment on the area of McKay Creek vegetation (OD-EW1) and all other native vegetation within the modelled borefield drawdown contours is provided in Table 4–37 and Figure 4-48. It is important to note that the modelling represents a very conservative assessment of possible drawdown, based on a 30 year no-recharge scenario, which is very unlikely to occur. Also, from the previous assessments specified in Appendix D2, no vegetation has been identified as groundwater dependent and any potential drawdown is considered unlikely to impact on vegetation.

The groundwater drawdown extents shown for the Northern Borefield are in the confined aquifer from which water will be extracted and not in the superficial alluvial aquifer. Because of the presence of a thick aquitard, it is unlikely that withdrawal of groundwater from the confined aquifer will result in discernible groundwater responses in the shallow strata accessed by vegetation along McKay Creek.

Table 4–37: Extents of vegetation within borefields' potential zone of influence

Vegetation	Area (ha)	%
McKay Creek vegetation (Northern Borefield)		**% of total McKay Creek vegetation**
Extent of OD-EW1 within 5 m groundwater drawdown contour	1478	30
Extent of OD-EW1 within 10 m groundwater drawdown contour	27.2	1
Total extent of OD-EW1 within groundwater drawdown (5–10 m)	1505.2	31
Total estimated extent of OD-EW1 vegetation at McKay Creek (based on aerial imagery)	4,899	
McKay Creek vegetation (Cory Borefield)		**% of total McKay Creek vegetation**
Extent of OD-EW1 within 2 m groundwater drawdown contour	0	0
Extent of OD-EW1 within 5 m groundwater drawdown contour	0	0
Total extent of OD-EW1 within groundwater drawdown (2–5 m)	0	0
Total extent of OD-EW1 vegetation at McKay Creek (based on aerial imagery)	499	
All vegetation (Northern Borefield)		**% of total vegetation within local survey area**
Extent of native vegetation within 5 m groundwater drawdown contour	8420	13
Extent of native vegetation within 10 m groundwater drawdown contour	73	0
Total extent of native vegetation within groundwater drawdown (5–10 m)	8493	13
Total extent of native vegetation (based on flora survey)	64,271	
All vegetation (Cory Borefield)		**% of total vegetation within local survey area**
Extent of native vegetation within 2 m groundwater drawdown contour	4597	7
Extent of native vegetation within 5 m groundwater drawdown contour	0.8	0
Total extent of native vegetation within groundwater drawdown (2–5 m)	4597.8	7
Total extent of native vegetation (based on flora survey)	64,271	

Figure 4-48: Vegetation in relation to borefields' potential zone of influence



Dust impacts on vegetation

There is little risk of dust generation associated with brine processing, as it is a wet process. Stockpiled halite typically forms a surface crust and is not susceptible to wind erosion. The main potential for dust impacts on vegetation is from wheel-generated dust associated with vehicular traffic on access roads landward of the playa. Reward conducted monitoring of vegetation health in proximity to its exploration activities annually between 2013 and 2016 as a means of assessing the risk to vegetation health of dust from vehicle movements. In April 2013, ten monitoring sites (quadrats) and ten control sites were established on the ridges of sand dunes along the Lake Disappointment site access track (Figure 4-49).

The dune vegetation monitoring program was designed to assess the biodiversity and health of native vegetation immediately surrounding the main site access track (within 250 m of track[17]) to determine whether use of the site access track by project vehicles is having an impact on the surrounding vegetation. Control sites were established at least 1 km from the Willjabu access track.

The monitoring results for the period from 2013 to 2016 show no clear trends suggestive of adverse dust impacts on vegetation (Figure 4-50, Figure 4-51). There is no evidence that dust generated by vehicle traffic has had a significant impact on sand dune vegetation.

The area of native vegetation within 50 m either side of the site access roads (conservative estimate of the maximum potential dust deposition from vehicle travel on site access roads) is 2499 ha of vegetation, which represents 6.2% of the total development envelope. As shown in the previous monitoring described above, there have been no adverse impacts to vegetation within 20 m of the site access tracks during the active exploration phase of the Lake Disappointment project. No samphire vegetation or conservation significant flora are located within a 50 m radius of the site access roads (Figure 4-52).

[17] Monitoring sites were established within 20 m of the site access track

Figure 4-49: Sand dune vegetation monitoring sites – Willjabu access track

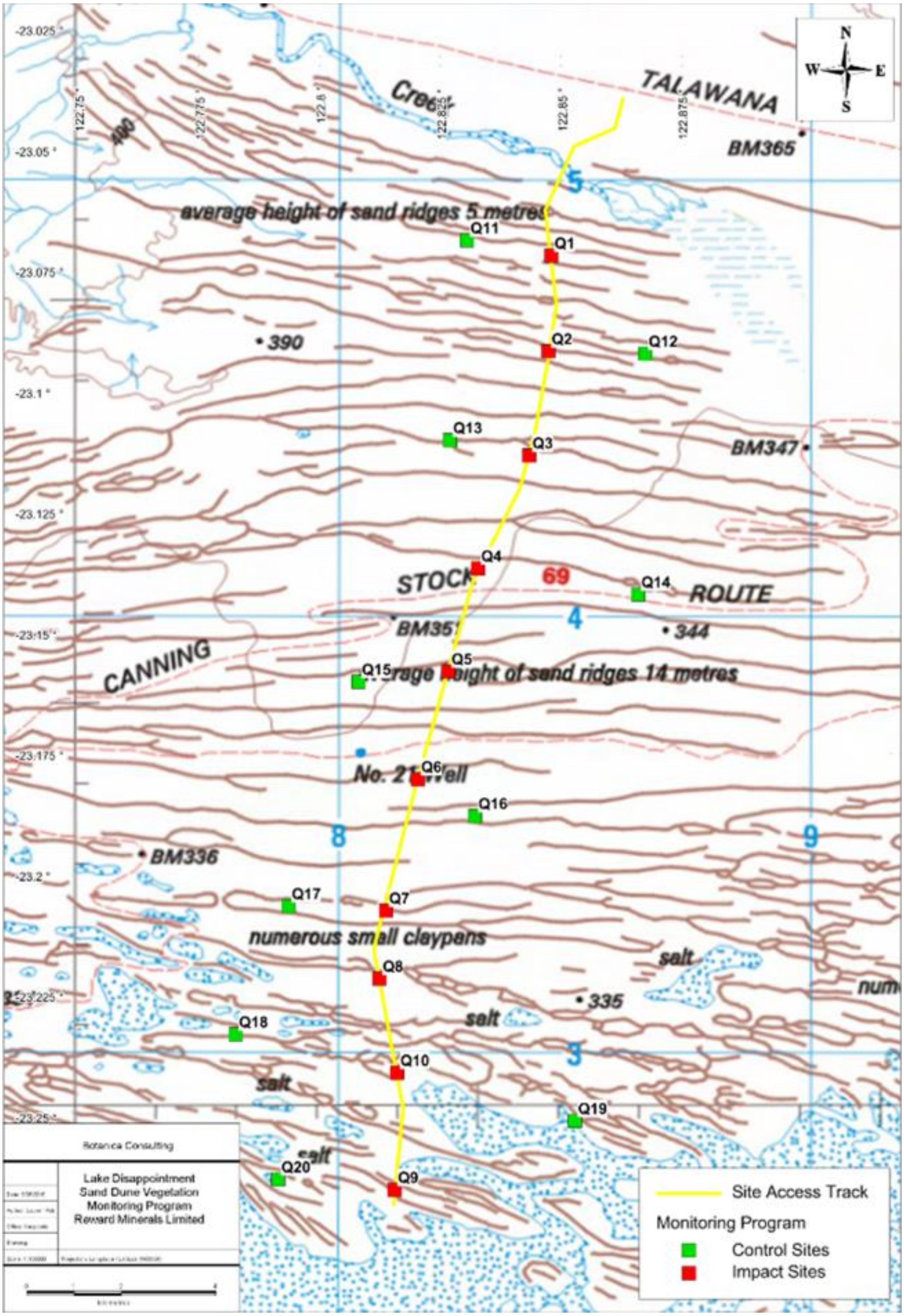


Figure 4-50: Access track vegetation monitoring – species diversity and density

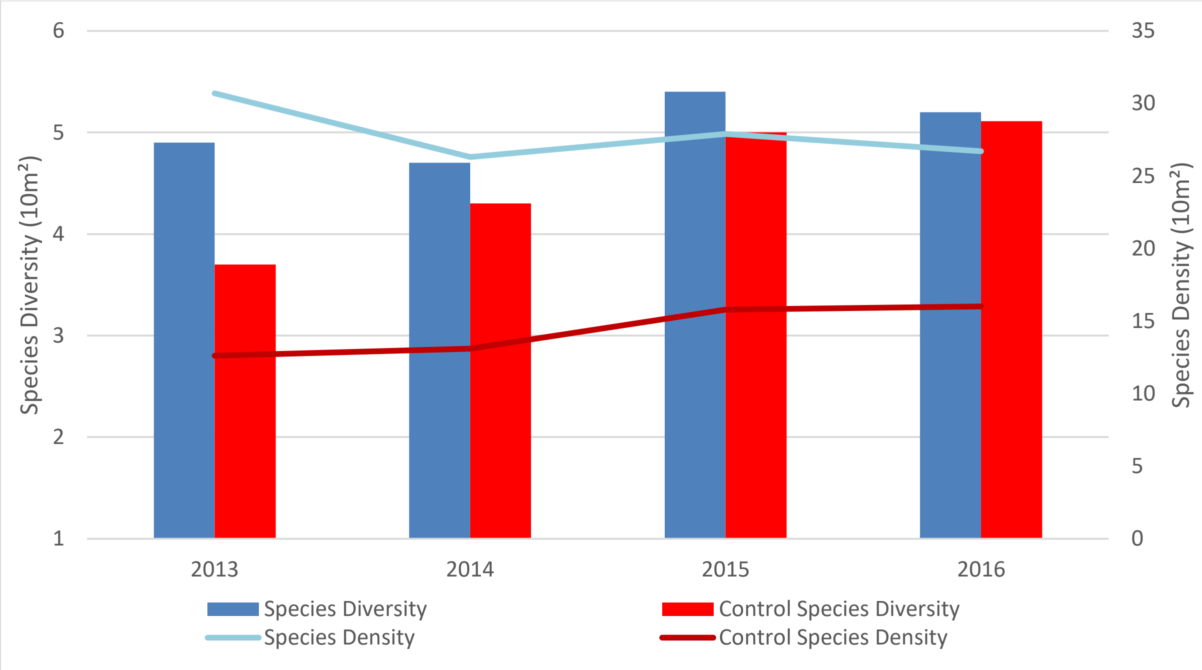


Figure 4-51: Access track vegetation monitoring – vegetation health and cover

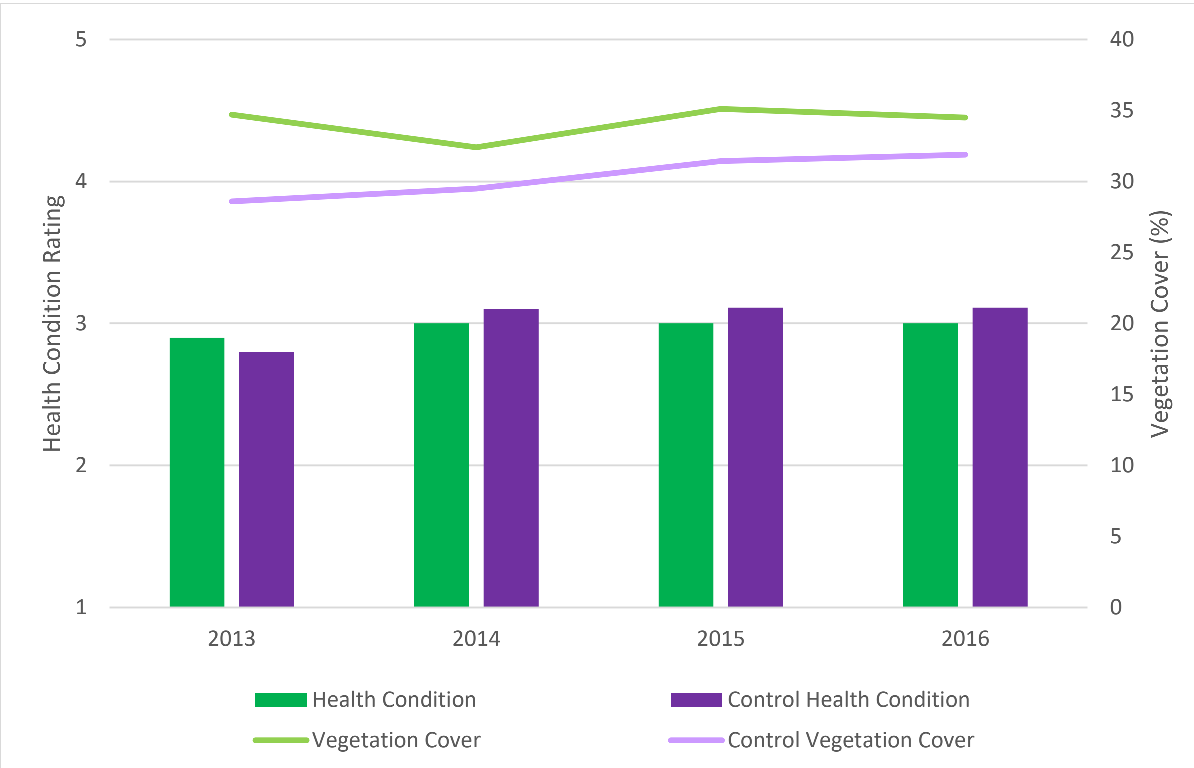
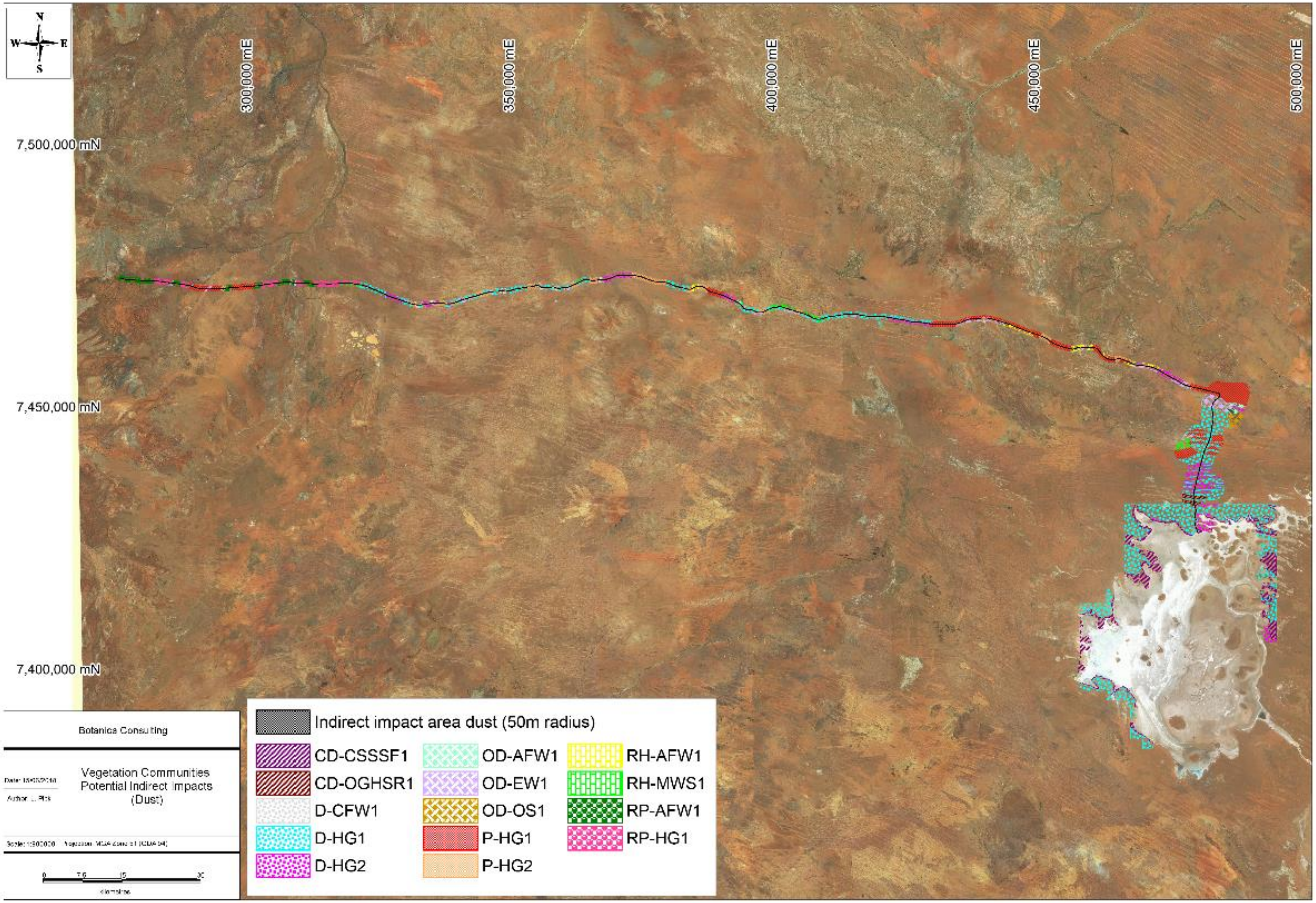


Figure 4-52: Area of native vegetation within 50 m of site access roads (potential dust generation)



4.5.6 Management and mitigation measures

The management and mitigation measures proposed by Reward to protect flora and vegetation during the construction and operation of the Lake Disappointment Project build on the practices already in place under the Conservation Management Plan[18] being implemented by Reward to guide its exploration activities. All activities will be carried out in a manner that minimises the risk of the unauthorised clearing and/or harm to native vegetation.

Vegetation clearing

Disturbance of vegetation will be minimised by siting project infrastructure on existing disturbed areas and/or on unvegetated areas, to the extent that this is compatible with other environmental requirements (avoiding important habitat areas, avoiding flood zones, avoiding culturally significant areas). During detailed design, the project layout will be systematically reviewed to check for opportunities to consolidate the disturbance footprint in order to further reduce vegetation clearing. An internal clearing permit system will be implemented to ensure that clearing occurs only in approved locations. All staff and contractors will be required to participate in an environmental induction which will include information about the requirements for protection of flora and vegetation.

Protection of riparian vegetation

The project layout will seek to avoid direct disturbance of riparian vegetation as a means of limiting possible disturbance of novel *Tecticornia* species and of high value habitat associated with drainage lines. Preclearance targeted surveys for novel/Priority listed *Tecticornia* species will be conducted in those riparian zones of the playa which cannot be avoided. If conservation significant species are detected, an application to impact Priority Flora will be submitted to DBCA.

In order to limit changes to the predevelopment groundwater regime in the riparian zone, the brine trench network has been designed such that no trench approaches closer than 200 m to the vegetated riparian zone. The brine abstraction network has been designed so that the whole of the system does not need to be drained simultaneously. Parts of the network can be active or rested, as required. This cyclical operation of the abstraction system will help to manage local groundwater drawdown. A network of shallow groundwater piezometers will be established and maintained to enable verification of groundwater responses to brine abstraction.

A minimum 200 m buffer zone would be established between the nearest lake edge vegetation and any on-playa project infrastructure. Coupled with the engineered drainage measures described in Section 4.2, the buffer zone will help to reduce the likelihood of increased duration or depth of inundation in the riparian zone.

Track upgrades at the McKay Creek crossing will be designed to maintain natural surface water flow regimes. The upgraded crossing will be located at the position of the existing crossing. Clearing of large trees is unlikely to be required.

Water abstraction

No water would be abstracted from the McKay Creek or from the shallow unconfined aquifer immediately underlying the creek bed. Proposed groundwater abstraction from the Northern Borefield would draw brackish water from a confined aquifer. Groundwater modelling of water abstraction from the proposed Northern Borefield predicts that the clayey aquiclude between the

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[18] Lake Disappointment Conservation Management Plan was approved by DPAW in November 2015.

shallow unconfined aquifer and the sandy aquifer targeted by Reward's production bores would prevent any material reduction groundwater levels in the shallow aquifer. Routine monitoring of groundwater levels and annual monitoring of vegetation health would provide evidence that riparian vegetation near the McKay Creek is not being affected by water abstraction from the Northern Borefield.

Weed hygiene

With the exception of one introduced species (*Cenchrus ciliaris* (buffel grass)), which is widespread across the region, the project area is relatively free of weeds. Vehicle and equipment hygiene procedures will be implemented to control the risk of introducing and/or spreading weeds and soil borne diseases. Compliance with the weed hygiene procedures will be audited, especially during the construction phase of the project. Weed surveillance and treatment, if required, will be carried out at least every two years.

Fire management

The project site induction will include information on the prevention and management of fires. Vehicles will not be permitted to leave designated access tracks or cleared areas. All machinery and vehicles undertaking clearing activities will be fitted with firefighting equipment, and staff and contractors will be trained in fire response.

Lightning protection equipment will be installed at the mine operations area where necessary. Fire breaks will be installed in consultation with DFES to protect key infrastructure where required. Mosaic burns will be conducted as required to limit fire risk (in consultation with DBCA and Traditional Owners). Firefighting equipment will be maintained at the site and emergency personnel trained will be trained in fire response. A hot work permit system will be developed and implemented.

Dust control

The main source of dust is wheel-generated dust associated with vehicle movements and dust generated during initial construction activities. Speed limits will be implemented to minimise dust emissions in frequently trafficked areas. Dust suppression agents will be used as needed to minimise dust emissions from roads and other disturbed areas.

Revegetation

A Mine Closure and Rehabilitation Plan conforming to DMIRS and EPA requirements will be implemented. A draft copy of the closure plan is provided in Appendix K of the ERD. Local provenance seed collection will be undertaken with assistance from the Traditional Owners, both prior to project commencement and throughout the project life. Progressive rehabilitation will be undertaken as land becomes available. Progress on rehabilitation will be reported annually in the project's annual environmental report.

4.5.7 Predicted outcomes

Project implementation does not pose a material threat to the objective of maintaining biological diversity and ecological integrity of flora and vegetation in the project locality. No threatened flora will be impacted by project implementation and no vegetation type will have a reduced conservation status as a result of project activities. The means by which flora and vegetation objectives will be achieved and the evidence by which outcomes will be demonstrated are summarised in Table 4–38.

Table 4–38: Summary of impact assessment – flora and vegetation

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
Establishment of off-playa infrastructure	Reduction in extent of vegetation communities; loss of conservation significant species	Site project infrastructure on existing disturbed areas and/or on unvegetated areas, to the extent that this is compatible with other environmental requirements Implement internal vegetation clearing permit system	Internal clearing permit audit results; annual environmental report with clearing records
	Dust impacts on vegetation health	Conduct vegetation health monitoring	Vegetation health monitoring records
Establishment of on-playa infrastructure	Reduction in extent of vegetation communities; loss of conservation significant species	Conduct pre-clearing surveys targeting novel/Priority listed *Tecticornia* Minimise project footprint in riparian zone Maintain 200 m buffer zone between the vegetated riparian zone and any on-playa infrastructure	Results of preclearing targeted surveys; internal clearing permit audit results; annual environmental report with clearing records
	Altered surface water regimes (increased inundation) adversely affects riparian vegetation	Maintain 200 m buffer zone between the vegetated riparian zone and any on-playa infrastructure Implement Water Management Plan/Groundwater Operations Strategy Monitor depth, extent and duration of ponding Monitoring groundwater depths upstream and downstream of on-playa assets Conduct annual vegetation health monitoring	Vegetation health monitoring records; surface water monitoring (depth and duration of inundation) records
	Altered groundwater regimes (water table lowering as result of brine abstraction) adversely affects riparian vegetation		Vegetation health monitoring records; groundwater monitoring records
	Altered groundwater regimes (groundwater mounding as result of seepage from brine ponds) adversely affects riparian vegetation		Vegetation health monitoring records; groundwater monitoring records

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
Brackish water abstraction from borefields	Altered groundwater regime (water table lowering as result of water abstraction from Northern Borefield) adversely affects riparian vegetation	Implement Water Management Plan/Groundwater Operations Strategy. Monitor depth, extent and duration of ponding. Routine groundwater monitoring in accordance with borefield operations strategy Conduct annual vegetation health monitoring	Vegetation health monitoring records; groundwater monitoring records
Movement of vehicles and machinery during construction and mining operations	Unauthorised clearing	Implement internal vegetation clearing permit system Restrict machinery movement to designated roads and works areas	Results of pre-clearing targeted surveys; internal clearing permit audit results; annual environmental report with clearing records
	Dust impacts on vegetation health	Conduct annual vegetation health monitoring	Vegetation health monitoring records
	Increased fire risk	Prepare and implement Fire Management Plan	Controlled burning records; implementation of bush fire plan. Fire Management Plan
	Introduction or spread of weeds	Implement and audit weed hygiene procedures	Weed survey and control records

4.6 Key factor 4: Terrestrial fauna

4.6.1 EPA objectives

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

In the context of terrestrial fauna, 'ecological integrity' means the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements.

4.6.2 Policy and guidance

Table 4–39: Relevant policies, guidelines & standards – terrestrial fauna

Environmental factor	Relevant policies, guidelines, and standards
Terrestrial fauna and habitats	DEWHA, 2010a. *Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the* Environment Protection and Biodiversity Conservation Act 1999*.* DEWHA, 2010b. *Survey guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the* Environment Protection and Biodiversity Conservation Act 1999*.* DPaW, 2017. *Interim guideline for preliminary surveys of Night Parrot (*Pezoporus occidentalis*) in Western Australia* EPA, 2016f. *Environmental factor guideline – terrestrial fauna* EPA, 2016l. *Technical guidance – sampling methods for terrestrial vertebrate fauna* EPA, 2016o. *Technical guidance – sampling of short range endemic invertebrate fauna* Government of Western Australia, 1997. *Wetlands conservation policy for Western Australia* SEWPaC, 2011a. *Survey guidelines for Australia's threatened mammals. Guidelines for detecting mammals listed as threatened under the* Environment Protection and Biodiversity Conservation Act 1999. SEWPaC, 2011b. *Survey guidelines for Australia's threatened reptiles. Guidelines for detecting reptiles listed as threatened under the* Environment Protection and Biodiversity Conservation Act 1999.

This section provides an overview of terrestrial fauna and habitats in the Lake Disappointment area. It includes consideration of both vertebrate and invertebrate fauna and includes information about aquatic fauna that occur in Lake Disappointment water (when present). The information presented in this section draws on baseline studies commissioned by Reward (Table 4–40). Copies of the baseline technical studies are appended to this ERD.

A summary of the survey effort expended on baseline characterisation of fauna and fauna habitats is provided in Table 4–41 and Table 4–42. Readers seeking detailed information on survey design and sampling methods should refer to appended technical reports.

Table 4–40: Terrestrial fauna studies appended to ERD

Study reference	Scope of Work
Appendix E1: Bennelongia Environmental Consultants and Terrestrial Ecosystems, 2018. Lake Disappointment Potash Project: Potential Impacts on Fauna	Fauna impact assessment addressing the potential impacts of the proposed Lake Disappointment potash project on terrestrial vertebrates, waterbirds and aquatic invertebrates; report describes the potential threats to the various conservation significant species, provides strategies for minimisation and mitigation of these threats, and evaluates the residual impacts for key species
Appendix E2[19]: Harewood, G, 2018. Night Parrot Survey Report - Lake Disappointment Potash Project	Presents results of three targeted night parrot surveys conducted near Lake Disappointment in June, August/September and October/November 2017
Appendix E3: Bennelongia Environmental Consultants, 2018. Consolidation report: Short-Range Endemic Invertebrates at Lake Disappointment	Report summarises the results of six surveys of SREs undertaken at Lake Disappointment and comments on the potential for significant adverse impacts on SRE fauna if the Lake Disappointment project is implemented
Appendix E4: Harewood, G, 2017b. Fauna Survey Report - Lake Disappointment Potash Project	Consolidated report summarising the results of fauna surveys conducted in the Lake Disappointment project area and surrounds between 2012 and 2017
Appendix G1 in Appendix E4: Phoenix Environmental Sciences, 2014. Short-range endemic invertebrate fauna survey of the Disappointment Potash Project	Desk top review and field survey of SRE invertebrates in the Lake Disappointment area; field survey consisted of foraging, combined soil/leaf litter sifting and opportunistic trapping of invertebrates at 15 primary survey sites and 14 opportunistic sites in May 2013; habitats from which samples were collected included: playa, samphire/riparian zone and sand dunes
Appendix G2 in Appendix E4: Scorpion ID, 2016. Taxonomy and short-range endemic assessment of invertebrates from Lake Disappointment	Taxonomic identification and SRE assessment of 70 invertebrate samples from the Lake Disappointment area
Appendix G3 in Appendix E4: Alacran Environmental Science, 2016. Taxonomy and short range endemic Assessment of Invertebrates from Lake Disappointment	Taxonomic identification and SRE assessment of 13 samples (12 scorpion samples and one isopod sample) from the Lake Disappointment area
Appendix G4 in Appendix E4: Alacran Environmental Science, 2017. Taxonomy and short range endemic Assessment of Invertebrates from Lake Disappointment	Taxonomic identification and SRE assessment of a collection of 38 invertebrate samples obtained from dry pitfall traps from the Lake Disappointment area
Appendix E5: Harewood, G, 2017. Conservation Significant Vertebrate Fauna Assessment, Talawana Track Upgrade	This assessment included a review of previous fauna survey data carried out along and near the Talawana Track, with a primary focus on identifying any likely impacts on vertebrate fauna species of conservation significance which may result because of the proposed works.

[19] The report provided in Appendix E7 has been redacted at the request of Western Australian and Australian Government regulators in order to control access to information about night parrot locations.

Study reference	Scope of Work
	Based on the literature review, current documented distributions, habitat preferences and field survey results, 11 fauna species of conservation significance were identified as potential species for the Talawana Track study area. In all cases, impacts on these species were considered unlikely to be significant given the fact that the area of vegetation clearing required is relatively small, scattered over a wide area and the presence of vast expanses of similar habitat in adjoining areas. Report includes recommendations for avoidance or management of fauna impacts should the project be implemented.
Appendix E6: Bennelongia Environmental Consultants, 2018. Aquatic Ecology and Waterbirds at Lake Disappointment: Additional Studies	A characterisation of ecological values of Lake Disappointment following a major flooding event; study aimed to characterise aquatic invertebrate assemblages, diatom assemblages and post-flood use of the lake by waterbirds. The field survey comprised sampling for aquatic invertebrates (250 µm and 50 µm sweep netting), diatoms and macrophytes at 18 sites in and around Lake Disappointment, including less-saline claypans around the hypersaline main playa. A comprehensive waterbird survey of the main playa and some surrounding claypans was undertaken by helicopter.
Appendix E7: Bennelongia Environmental Consultants, 2016. Ecological Character of Lake Disappointment June 2016	Ecological characterisation of aquatic biota and key ecological and biophysical attributes of the Lake Disappointment/Savory Creek system, based on published information, consultant reports and studies undertaken for the Lake Disappointment project; study included a site visit and sampling of aquatic biota in January 2016
Appendix E8: Harewood, G, 2015. Marsupial Mole Monitoring Survey (April 2014)	Presents results of field survey conducted in April 2014 in the Lake Disappointment area to provide a baseline dataset on marsupial mole activity
Appendix G7: Hydrobiology, 2016. Memorandum report: Lake Disappointment – Ecotoxicity Hazard Assessment	Risk-based review of acid sulfate soil test results and relevant fauna reports to assess ecotoxicological hazard of proposed operations at Lake Disappointment

4.6.3 Receiving environment

Fauna surveys have been carried out at Lake Disappointment over a six-year period, starting in 2012, covering an area of 134,800 ha (of which 70,567 ha coincide with parts of the Lake Disappointment playa). Parts of the Lake Disappointment playa have restricted access, even for the purpose of non-destructive scientific surveys, and were not surveyed. These exclusion zones were defined at the request of the Traditional Owners (the Martu People). No part of the project's proposed development envelope encroaches on the Aboriginal heritage exclusion zone.

Table 4–41: Summary of survey effort and methods – terrestrial vertebrates

Survey type/phase	Targeted	Targeted	Phase 1	Phase 2	Aquatic	Phase 3	Phase 4	Targeted
Dates	**16–19 October 2012**	**7–9 April 2014**	**1–10 May 2013**	**16–24 October 2013**	**26–27 January 2016**	**11–19 October 2016**	**9–16 March 2017**	**16–24 June 2017 (1)**
Targeted transects – conservation significant fauna	~84 person hours	~6 person hours	~26 person hours	~20 person hours		~20 person hours	N/A	~80 person hours
Trenches – marsupial mole survey	3	20	N/A	N/A		N/A	N/A	N/A
Acoustic surveys for night parrots	N/A	N/A	N/A	N/A		N/A	N/A	403 recording nights (64 locations; ~4836 h recording); 9 h of listening surveys at 6 locations
Cage trap/Elliott 'B' trap	N/A	20 trap nights	110 trap nights	112 trap nights		84 trap nights	84 trap nights	N/A
Elliott 'A' trap	N/A	N/A	550 trap nights	560 trap nights		196 trap nights	196 trap nights	N/A
Pit traps	N/A	N/A	550 trap nights	560 trap nights		280 trap nights	280 trap nights	N/A
Funnel trap	N/A	N/A	1100 trap nights	1120 trap nights		560 trap nights	560 trap nights	N/A
Camera traps	N/A	N/A	41 camera traps for ~170 days (~6970 trap nights)			32 camera traps for ~246 days (~7872 trap nights)		12 camera traps for ~8 days (~96 trap nights)
Diurnal search	Targeted - see above	Targeted - see above	Opportunistic: ~36 person hours	Opportunistic: ~30 person hours		Opportunistic: ~30 person hours	Opportunistic: ~10 person hours	Targeted - see above
Nocturnal search	N/A	N/A	~15 person hours	~18 person hours		~4 person hours	~4 person hours	N/A

Survey type/phase	**Targeted**	**Targeted**	**Phase 1**	**Phase 2**	**Aquatic**	**Phase 3**	**Phase 4**	**Targeted**
Dates	**16–19 October 2012**	**7–9 April 2014**	**1–10 May 2013**	**16–24 October 2013**	**26–27 January 2016**	**11–19 October 2016**	**9–16 March 2017**	**16–24 June 2017 (1)**
Bird survey	Opportunistic: ~32 person hours	Opportunistic: ~24 person hours	Targeted: ~60 person hours; Opportunistic: ~160 person hours	Targeted: ~40 person hours; Opportunistic: ~160 person hours		Opportunistic: ~72 person hours	Targeted: ~4 person hours; Opportunistic – ~64 person hours	Opportunistic: 144 person hours
Bat survey	N/A	N/A	6 recording nights (~60 hours)	4 recording nights (~40 hours)		4 recording nights (~40 hours)	4 recording nights (~40 hours)	21 recording nights (~210 hours)
Waterbird survey					6 person hours, including aerial (helicopter) survey		28 person hours, including aerial (helicopter) survey	
Aquatic invertebrate survey					12 person hours fieldwork, 84 hours laboratory work		26 person hours fieldwork, 240 h laboratory identification work	

Note 1: Survey effort for night parrots includes work done during surveys in June 2017, Aug/Sept 2017, Oct/Nov 2017, Dec 2017, Mar/April 2018 and Aug/Sept 2018.

Table 4–42: Summary of survey effort – terrestrial invertebrates

Habitat	Target fauna [1]	Sampling method	Sampling events [2]					
			May-13	Oct-13	Nov-14	Oct-16	Mar-17	Total
Saline playa	SRE	Hand foraging	0/15					15
		Dry pitfall			8/21			29
Riparian samphire	SRE	Hand foraging	1/14					15
		Dry pitfall			1/0			1
Sand dunes	SRE	Hand foraging	3/12					15
		Leaf litter	3/12					15
	VERT	Dry pitfall	75/5	75/5		20/10	20/10	220
Creek line	VERT	Dry pitfall				10/0	10/0	20

Note 1: VERT = vertebrates.

Note 2: Sampling effort in each sampling event shown as No. of samples from within the development envelope/No. of samples from outside.

Terrestrial Fauna Habitats

Based on vegetation and landform characteristics, seven main terrestrial vertebrate fauna habitat types have been defined in the project area (Table 4–43 and Figure 4-53 through Figure 4-56). By far the dominant habitat type is the one described as 'swales and dune crests with shrubs over spinifex with few or no trees' accounting for about 90% of the vegetated land within the project development envelope and approximately 80% of the vegetated land within the proposed disturbance footprint (Figure 4-57). The second most common habitat type is 'flat plain with scattered shrubs over spinifex with few or no trees'. Small areas of drainage line, halophytic riparian areas and other habitats are intersected by the disturbance footprint.

Table 4–43: Extents of habitats (project envelope and disturbance footprint)

Habitat type	Distinguishing characteristics	Development envelope (ha)	Disturbance footprint (ha)
Flat plain with few to numerous trees over scattered shrubs over spinifex	Flat plain where the density of trees (*Acacia* sp.) varies over few shrubs (*Eremophila/Senna* sp.) with or without hummocks of mostly sparse spinifex (*Triodia* sp.)	7	7
Flat plain with scattered shrubs over spinifex with few or no trees	Flat plain where there are very few trees, but sparely vegetated with shrubs with or without hummocks of mostly sparse spinifex (*Triodia* sp.)	11	11
Swales and dune crests with shrubs over spinifex with few or no trees	Low dunes interspersed with swales that are vegetated with occasional trees (*Corymbia* sp.) low shrubs (*Acacia* sp. and *Grevillea* sp.) over spinifex (*Triodia* sp.) with few or no trees	3519	379
Creek or drainage line	Mostly dry creek or drainage lines that have an increased density of low trees (*Eucalyptus/Corymbia* sp.) relative to adjacent areas	107	10
Halophytic vegetation	Flat plain supporting low halophytic vegetation (i.e. *Tecticornia* spp.) mostly around the periphery of Lake Disappointment	56	0
Clay or salt pan mostly devoid of vegetation	Flat plain that has an elevation that is slightly lower than the adjacent area that is mostly devoid of vegetation	10	0
Rocky area or breakaway	Rocky area or breakaway most little vegetation or sparsely vegetated with spinifex	59	2
Trees and shrubs over tussock grasses	Flat plain or shallow depression that supports relatively dense trees (*Acacia* sp.), dwarf shrubs (e.g. *Senna* sp.) over tussock grasses	106	0.9

Figure 4-53: Fauna habitats – western portion of Talawana Track

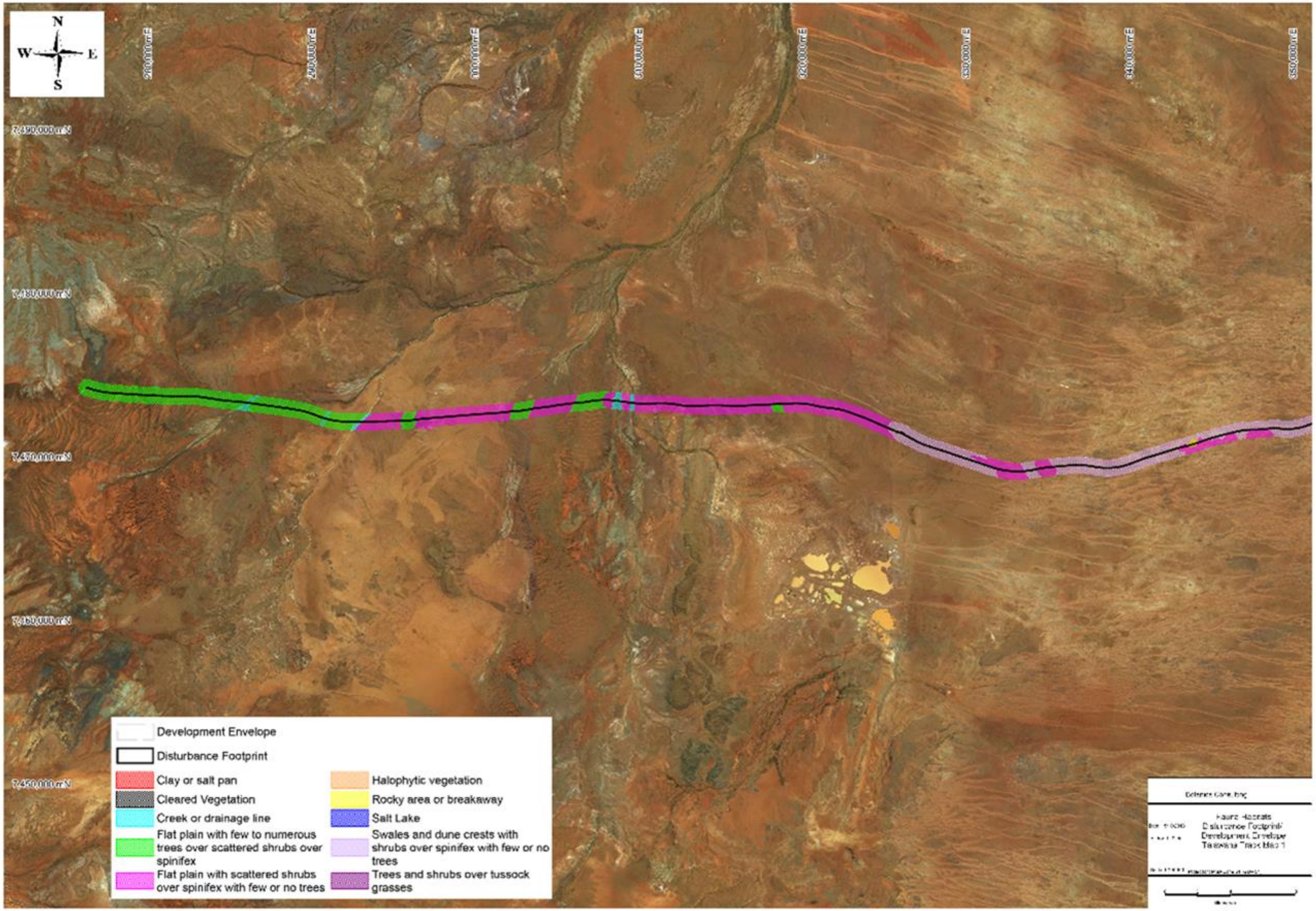


Figure 4-54: Fauna habitats – eastern portion of Talawana Track

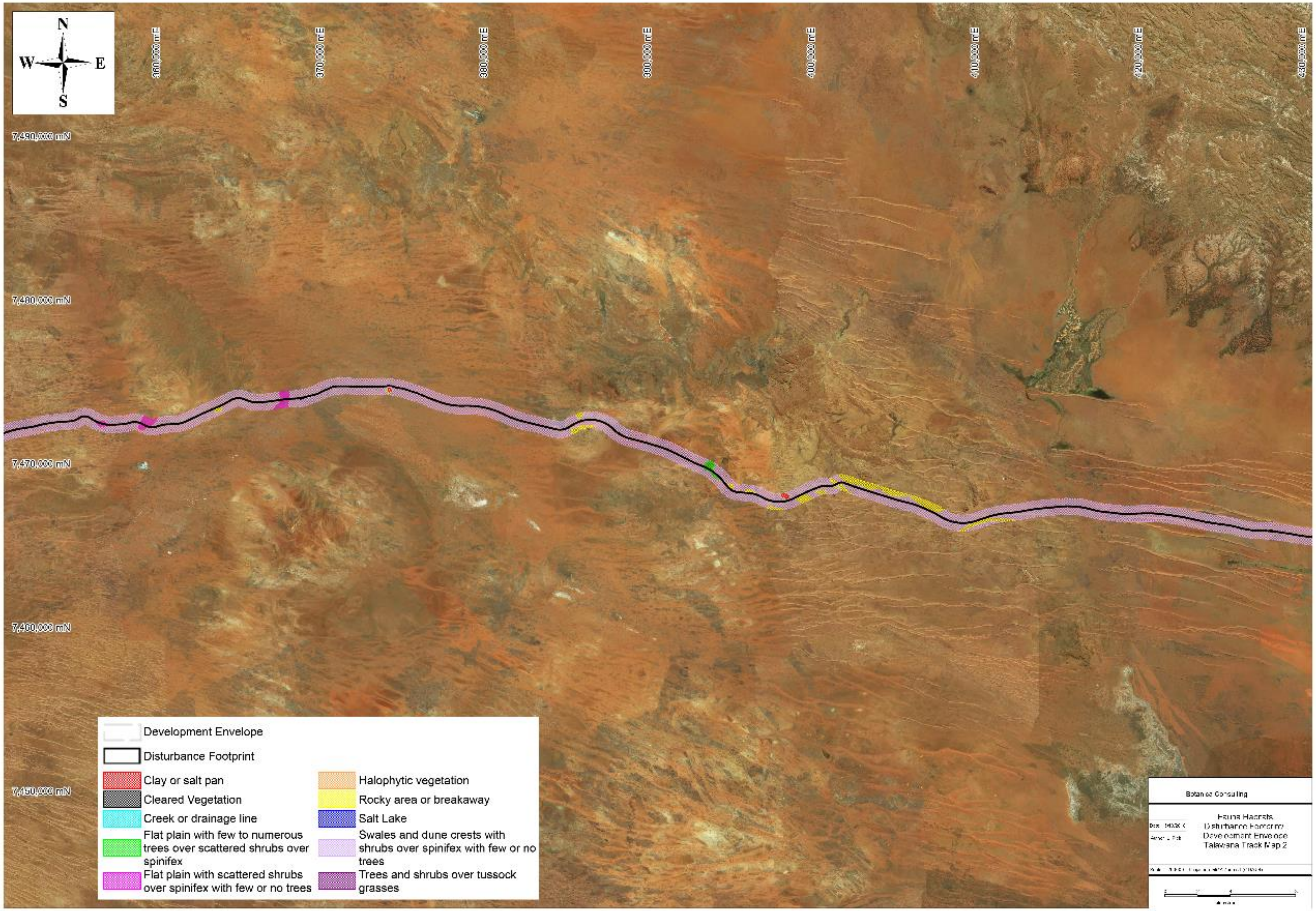


Figure 4-55: Fauna habitats – Wiljabu Track and eastern portion of Talawana Track

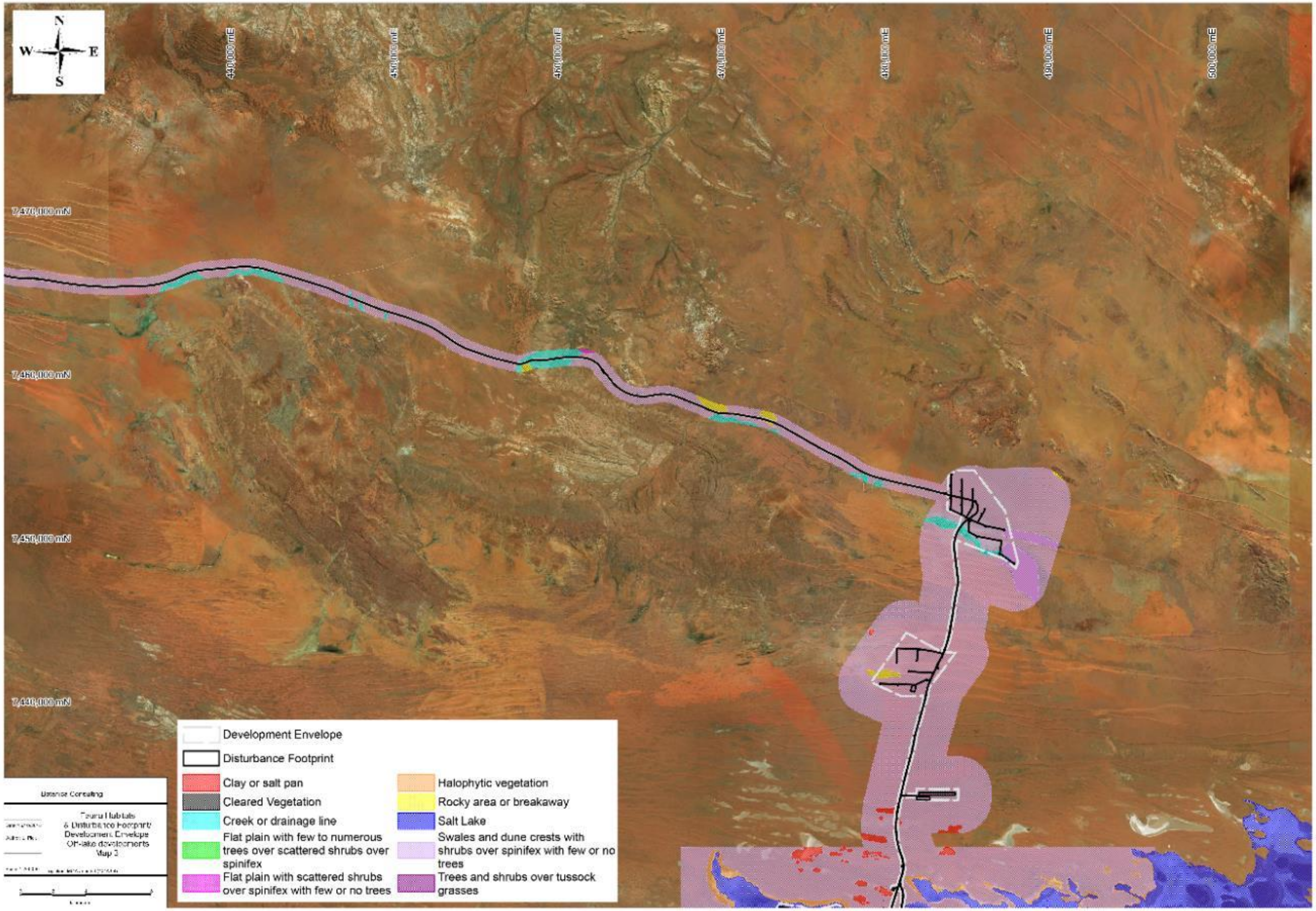
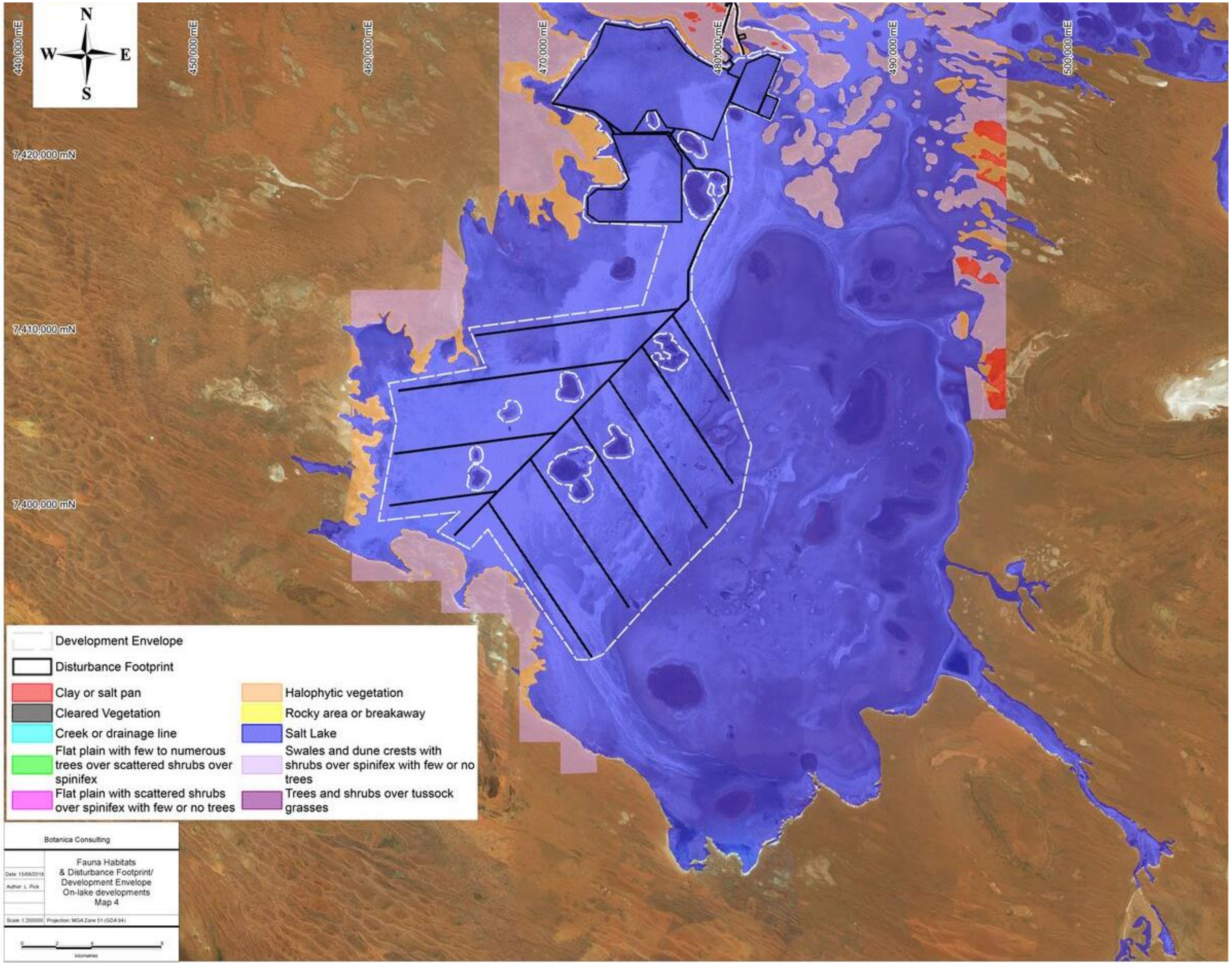


Figure 4-56: Fauna habitats – Lake Disappointment



Note: Figure does not include areas that are bare of vegetation

Figure 4-57: Habitat types in disturbance footprint and development envelope

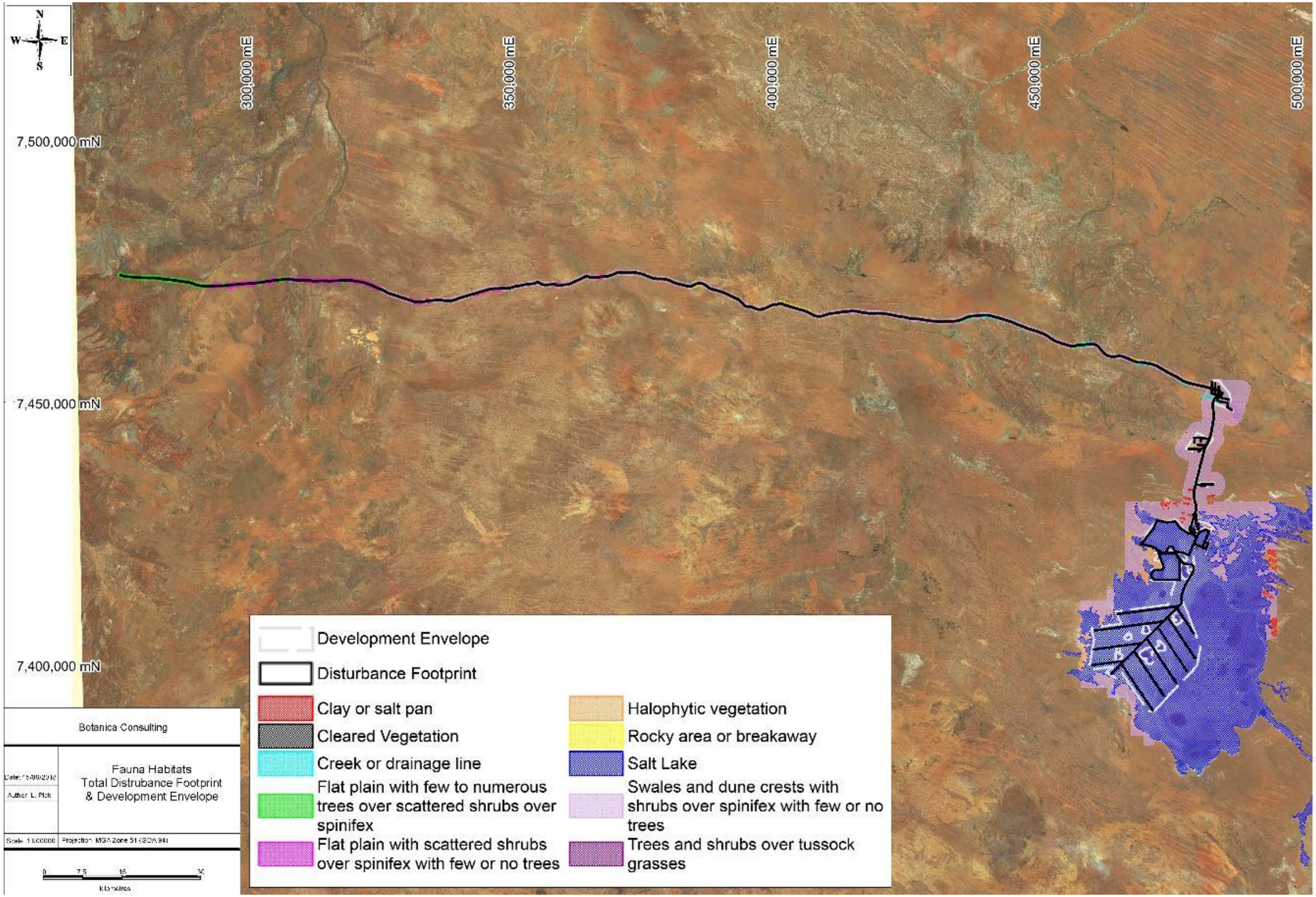


Table 4–44 provides a description of the likely habitat values of each habitat type for fauna of conservation significance.

Table 4–44: Summary of habitat values for conservation significant fauna

Habitat type	Habitat value for conservation significant fauna
Flat plain with few to numerous trees over scattered shrubs over spinifex	This habitat could be used by bilby (*Macrotis lagotis*), great desert skink (*Liopholis kintorei*) and princess parrot (*Polytelis alexandrae*). Night parrots (*Pezoporus occidentalis*) could roost, breed and forage in this habitat if the spinifex is mature, as nest and roosting sites are typically in old circular spinifex hummocks greater than 40 cm high.
Flat plain with scattered shrubs over spinifex with few or no trees	This habitat could be used by bilby (*M. lagotis*) and the great desert skink (*L. kintorei*). Night parrots (*P. occidentalis*) could roost, breed and forage in this habitat if the spinifex is mature, as nest and roosting sites are typically in old circular spinifex hummocks greater than 40 cm high.
Swales and dune crests with shrubs over spinifex with few or no trees	This habitat could be used by bilby (*M. lagotis*), northern marsupial mole (*Notmyctes caurinus*), unpatterned robust lerista (*Lerista macropisthopus remota*), striated grasswren (*Amytornis striatus striatus*) and the great desert skink (*L. kintorei*). Night parrots (*P. occidentalis*) could roost, breed and forage in this habitat if the spinifex is mature, as nest and roosting sites are typically in old circular spinifex hummocks greater than 40 cm high.
Creek or drainage line	This habitat could be used princess parrot (*P. alexandrae*), unpatterned robust lerista (*L. m. remota*) and the great desert skink (*L. kintorei*).
Halophytic vegetation	This habitat could be used by night parrot (*P. occidentalis*) for foraging, and Lake Disappointment dragon (*Ctenophorus nguyarna*) and Lake Disappointment ground gecko (*Diplodactylus fulleri*).
Clay or salt pan mostly devoid of vegetation	Night parrot (*P. occidentalis*) could drink from freshwater clay pans when they contain water.
Rocky area or breakaway	The small extents of these habitats in the project area are unlikely to provide habitat for conservation significant species.
Trees and shrubs over tussock grasses	This habitat could be used by princess parrot (*P. alexandrae*) and bilby (*M. lagotis*).

Species accumulation curves have been calculated for key habitats as a means of assessing the adequacy of the trapping effort and the completeness of the species list for the project area (Thompson & Withers 2003, Thompson & Thompson 2008, Thompson et al. 2007). The results of the species accumulation curve analysis indicate that most of the terrestrial fauna species that were trappable were caught during the surveys in these key habitat types (Figure 4-58 through Figure 4-62).

Figure 4-58: Species accumulation curve for dune crest habitat

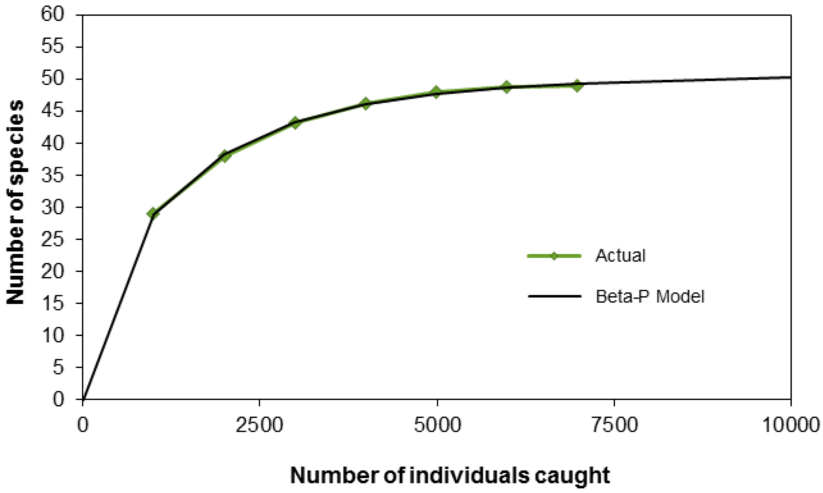


Figure 4-59: Species accumulation curve for swale habitat

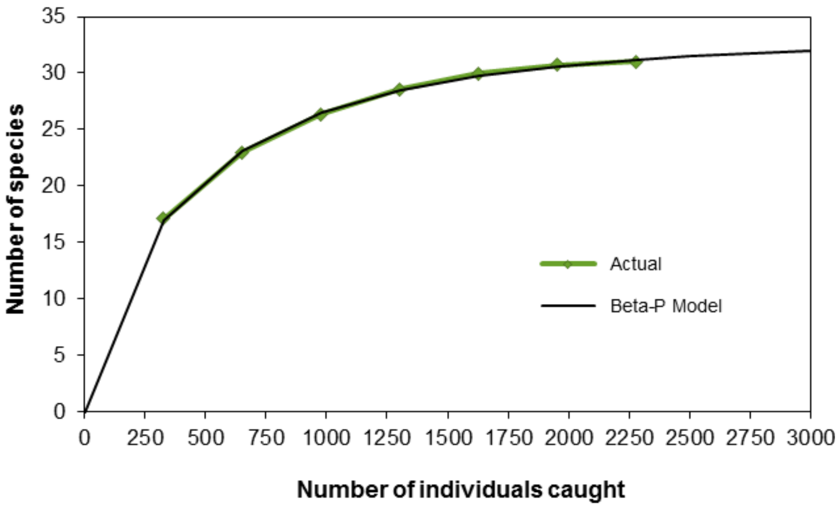


Figure 4-60: Species accumulation curve for riparian (halophytic) habitat

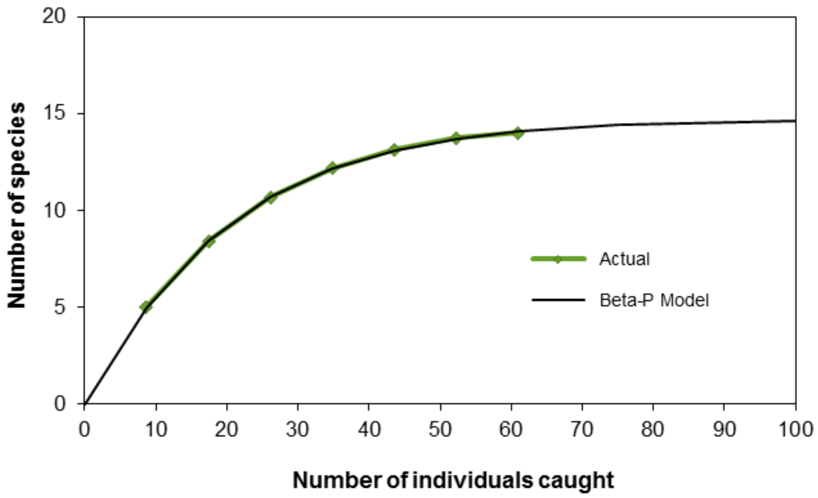


Figure 4-61: Species accumulation curve for creek line habitat

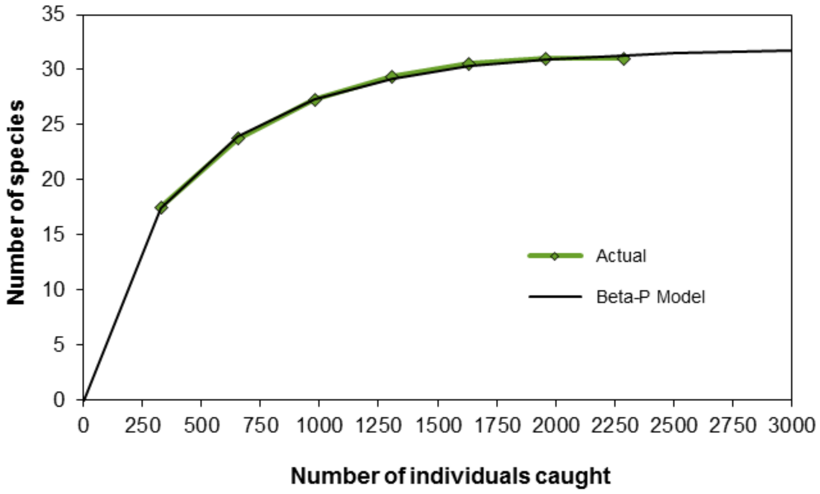
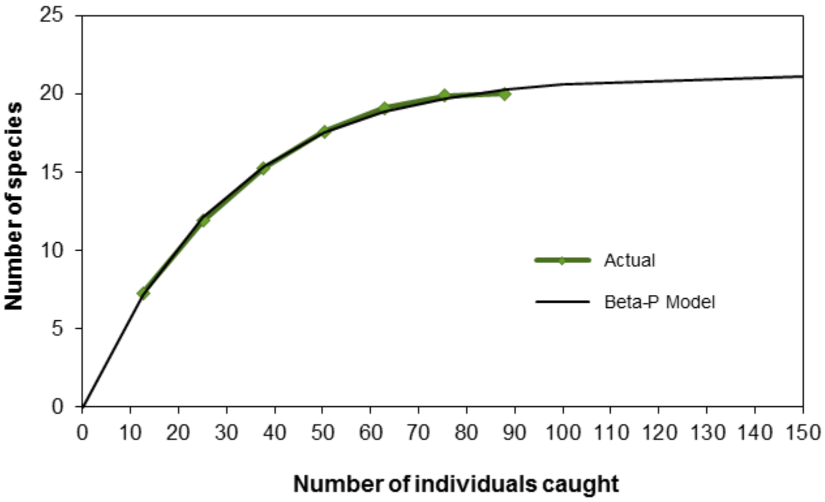


Figure 4-62: Species accumulation curve for drainage line habitat



Terrestrial invertebrates

During the fauna surveys and targeted invertebrate survey carried out in 2013, 55 individual specimens of invertebrate fauna were collected from 59 locations. The sampling locations represented three broad invertebrate habitat types: sand dunes (28 locations), riparian zone (15 locations), and playa edge (16 locations). The specimens collected comprised 14 individually recognised taxa from six orders, nine families and at least ten genera (Appendix G1 in Appendix E4).

None of the invertebrates collected were confirmed as SRE species. However, 18 individuals (33% of the total catch) were considered to represent potential SRE species based on the fact that other members of the same genus are often recognised as SRE species. The putative SRE species included five taxa in four genera from three families and three orders:

- *Aname* sp. indet. (trapdoor spider, family Nemesiidae)
- *Kwonkan* 'disappointment' (trapdoor spider, family Nemesiidae)
- *Urodacus* 'disappointment' (scorpion, family Urodacidae)

- *Urodacus* 'princess pea' (scorpion, family Urodacidae)
- *Buddelundia* '10LD' (slater, family Armadillidae)

Putative SRE species were recovered from seven of the 59 sampling locations. None of the locations at which putative SRE species were observed lie within the proposed project disturbance footprint. Of the five putative SRE species found, four were recovered from three sampling locations inside the project development envelope:

- Two scorpions (*Urodacus* 'disappointment' and *Urodacus* 'princess pea')
- One trapdoor spider (*Kwonkan* 'disappointment') and
- One isopod (*Buddelundia* '10LD').

All five of the potential SRE species collected in the field survey were from sand dune habitat, which is widespread throughout the region. Additional detail on sampling methods and survey design for the baseline investigation of SRE vertebrates is provided in Appendix E4.

Table 4–45: Summary of invertebrate terrestrial species collected during baseline studies

Higher taxonomy	**Lowest identification**	**Playa**		**Samphire**		**Dunes**		**Species notes and review of SRE status (Appendix E3)**
		I	**R**	**I**	**R**	**I**	**R**	
Arthropoda								
Arachnida								
Araneae								
Araneomoprhae								
	Lycosidae sp.		2 (2)			4 (2)		Higher-order identification; not a salt lake specialist
Mygalomoprhae								
Barychelidae	*Synothele* `LD1`					1 (1)		New species; collected in sand dunes; not SRE
	Synothele meadhunteri					2 (1)		Known from across WA; not SRE
Idiopidae	*Idiosoma* `LD1`					5 (1)	6 (1)	New species; collected in sand dunes; not SRE
	Idiosoma `LD2`					2 (1)	1 (1)	New species; collected in sand dunes; not SRE
Nemesiidae	*Aname* sp.					1 (1)		Higher-order identification; collected in sand dunes; not SRE
	Kwonkan `disappointment`					1 (1)	1 (1)	New species; collected in sand dunes; not SRE
	Kwonkan `LD1`					1 (1)		New species; collected in sand dunes; not SRE
Pseudoscorpiones								
Garypidae	*Synsphyronus callus*						1 (1)	Known from across WA; not SRE
Olpiidae	*Beierolpium* 8/2 sp.						1 (1)	Higher-order identification; members of this family in the Pilbara are not typically SRE; collected in sand dunes; not SRE
	Beierolpium sp.						2 (2)	Higher-order identification, likely congeneric with *Beierolpium* 8/2

Higher taxonomy	Lowest identification	Playa I	Playa R	Samphire I	Samphire R	Dunes I	Dunes R	Species notes and review of SRE status (Appendix E3)
	Indolpium `lake disappointment`	1 (1)	1 (1)	1 (1)				A new species, although it closely resembles a Pilbara morphospecies and the two are possibly congeneric; found in playa & samphire habitat, but lacks salt lake specialist morphology suggesting it is probably a wide-ranging species; members of this family from non-typical SRE habitat in the Pilbara are not typically SRE; should not be SRE
Scorpiones								
Buthidae	*Lychas* `099`					7 (3)	4 (1)	New species that has a close relationship with *Lychas* 'annulatus complex', which is known from throughout WA; collected in sand dunes; should not be SRE
	Lychas `adonis` ms					4 (2)		Found in Pilbara and South Coast; Not SRE
	Lychas `annulatus complex`						1 (1)	Known from across WA; should not be SRE
	Lychas `lake disappointment`		5 (3)	1 (1)				New species that has a close relationship with *Lychas* 'annulatus complex', which is known from throughout WA; collected in playa and samphire, but lacks salt lake specialist morphology suggesting it is probably a wide ranging species; should not be SRE
	Lychas `multipunctatus group`					3 (1)		Known from across WA; not SRE
	Lychas `telfer`					12 (6)		Collected from sand dunes and known from Telfer area; not SRE
Urodacidae	*Urodacus* `disappointment`					1 (1)		New species; sand dunes are not SRE habitat, although many taxa from SRE groups (especially scorpions) will occur in this desert habitat; should not be SRE
	Urodacus `princess pea`					2 (2)	1 (1)	As previous (*U.* `disappointment')
	Urodacus `yaschenkoi complex`		4 (2)			4 (1)	2 (2)	Although four species may exist within 'yaschenkoi', it was collected from sand dunes and saline playa and should not be SRE
	Urodacus hoplurus					3 (2)		Known from across WA; not SRE
Crustacea								
Isopoda								
Armadillidae	*Buddelundia* `10LD`					17 (2)		Collected in sand dunes; this species bears a close resemblance to a Pilbara morphospecies (*B.* `10') and the two are possibly congeneric; not SRE
Hexapoda								
Insecta								
Coleoptera								
Scarabidae	*Pseudotetracha murchisona*	2 (2)	6 (6)	2 (1)				Known from across WA; most likely includes the higher-order beetles below; not SRE

Higher taxonomy	Lowest identification	Playa		Samphire		Dunes		Species notes and review of SRE status (Appendix E3)
		I	R	I	R	I	R	
	Pseudotetracha sp./Scarabidae sp.		4 (3)			3 (1)		Higher-order identifications that do not represent a species and are likely congeneric with *P. murchisona*.
Thysanura								
Lepismatidae	Lepismatidae sp.	1 (1)	5 (4)	1 (1)				Higher-order identification; No lepismatids are SRE in Australia; the family Nictoletiidae comprises many troglobitic SRE species
Mollusca								
Pupillidae	*Pupoides adelaidae*						10 (3)	Known from across WA; not SRE

Note: Columns headed 'I' represent results from inside the development envelope. Columns headed 'R' represent results from outside the development envelope. Numbers in parentheses () represent the number of sampling sites.

Terrestrial vertebrates

The surveys at Lake Disappointment have identified approximately 80% of the predicted species considered likely to be present (at least occasionally) in the general project area. Of the 22 state- or federally-listed vertebrate fauna species of conservation significance considered likely to frequent the area at times (albeit some rarely), 15 have been observed/recorded (Table 4–46).

Table 4–46: Summary of potential vs recorded species (Appendix E4)

	Potential species	Recorded species	Species of conservation significance recorded
Amphibians	10	9	0
Reptiles	79 [1]	60 [1]	2
Birds	144	116	11
Non-volant mammals	23 [6]	18 [6]	2
Bats	11	10	0
Total	267	213	15

Note: Superscript numbers represent introduced fauna

Those observed include four specially protected, seven migratory and four priority vertebrate fauna species. The Lake Disappointment dragon is not included in this total, as it is not yet listed by any authority as a threatened or as a priority species. It can, however, be regarded as being of local conservation significance. Birds identified as breeding on islands within Lake Disappointment (primarily the banded stilt) are also considered as being of local conservation significance despite not having any official classification on state, federal or DBCA listings.

In or near the project development envelope, three terrestrial species protected under the WC Act/*Biodiversity Conservation Act 2016* and the EPBC Act have been recorded, as well as six Priority species considered by the DBCA to require on-going monitoring:

- Night parrot (*Pezoporus occidentalis*) – Critically Endangered (WA)
- Bilby (*Macrotis lagotis*) – Vulnerable
- Rainbow bee-eater (*Merops ornatus*) – Migratory (Schedule 5)
- Lake Disappointment dragon (*Ctenophorus nguyarna*) – Priority 1
- Lake Disappointment ground gecko (*Diplodactylus fulleri*) – Priority 1
- Unpatterned robust lerista (*Lerista macropisthopus remota*) – P riority 2
- Northern marsupial mole (*Notoryctes caurinus*) – Priority 4
- Princess parrot (*Polytelis alexandrae*) – Priority 4.

Conservation significant species that were not recorded in the development envelope during baseline investigations, but are considered likely to occur in the locality, include:

- Great desert skink (*Liopholis kintorei*) – Vulnerable
- Peregrine falcon (*Falco peregrinus*) – Other Specially Protected
- Brush-tailed mulgara (*Dasycercus blythi*) – Priority 4.

The likelihood of conservation significant terrestrial vertebrate fauna occurring in or near the project development envelope is summarised in Table 4–47.

This section chiefly presents information about key fauna that:

- Are either known to be present, or are considered likely to be present;
- Are of conservation significance; and
- Have the potential to be significantly impacted by project implementation.

Additional detail on survey methods and fauna assemblages, including fauna that are present but unlikely to be materially affected by project implementation, is provided in the technical reports included in Appendix E.

Table 4–47: Likelihood of conservation significant species in project development envelope

Species	Common Name	*EPBC Act*	*WC Act*	Priority species	Likely presence
Pezoporus occidentalis	Night Parrot	En	Cr		Recorded
Dasyurus hallucatus	Northern Quoll	En	En		Not recorded
Petrogale lateralis lateralis	Black-flanked rock-wallaby	En	En		Not recorded
Leipoa ocellata	Malleefowl	Vu	Vu		Not recorded
Macroderma gigas	Ghost bat	Vu	Vu		Not recorded
Macrotis lagotis	Greater bilby	Vu	Vu		Recorded
Liasis olivaceus barroni	Olive python	Vu	Vu		Not recorded
Liopholis kintorei	Great desert skink	Vu	Vu		Probably present, but not recorded
Polytelis alexandrae	Princess parrot	Vu		P4	Infrequently present
Rhinonicteris aurantia	Pilbara leaf-nosed bat	Vu		P4	Not recorded
Apus pacificus	Fork-tailed swift	IA	IA		Infrequently present
Hirundo rustica	Barn swallow	IA	IA		Not recorded
Motacilla cinerea	Grey wagtail	IA	IA		Not recorded
Motacilla flava	Yellow wagtail	IA	IA		Not recorded
Merops ornatus	Rainbow bee-eater	-[(1)]	IA		Recorded
Peregrinus falco	Peregrine falcon		OS		Recorded nearby
Falco hypoleucos	Grey falcon		Vulnerable		Not recorded
Diplodactylus fulleri	Lake Disappointment ground gecko			P1	Recorded
Ctenophorus nguyarna	Lake Disappointment dragon			P1	Recorded
Lerista macropisthopus remota	Unpatterned robust lerista			P2	Recorded
Typo novaehollandiae	Masked owl			P3	Not recorded
Notoryctes caurinus	Northern marsupial mole			P4	Recorded

Species	Common Name	*EPBC Act*	*WC Act*	Priority species	Likely presence
Dasycercus blythi	Brush-tailed mulgara			P4	Probably present, but not recorded
Dasycercus cristicauda	Crest-tailed mulgara	Vu		P4	Unlikely to be present
Amytornis striatus striatus	Striated grasswren			P4	Recorded
Pseudomys chapmani	Western pebble-mound mouse			P4	Not recorded

Note 1: Incorrectly listed as marine migratory.

Note: Cr – Critically endangered; En - Endangered; Vu - Vulnerable; OS - Other specially protected species; IA – Migratory; P - Priority species recognised by DBCA; 'Not recorded' means no evidence of presence was observed during baseline investigations and no records of presence has been reported in or near the project area in published reports or government databases.

Mammals

Northern marsupial mole (Notoryctes caurinus)

Evidence of the northern marsupial mole (*Notoryctes caurinus*), a DBCA Priority 4 species, was found during the course of baseline fauna surveys at Lake Disappointment (Figure 4-63). This species spends the majority of its life underground and was not directly observed. However, its distinctive tracks, made when making brief short traverses above ground, were recorded at several locations on dune crests. The presence of this species in the project area was established during the targeted survey of Willjabu Track carried out in October 2012. During this survey, two trenches were dug into sand dunes and later assessed for mole activity. Several backfilled tunnels (mole holes) attributed to the northern marsupial mole were identified (Appendix E9).

As part of an approved Conservation Management Plan (Botanica 2015) monitoring program, 20 trenches were dug into dunes along the access track in April 2014. Of these, 19 trenches showed evidence of the northern marsupial mole in the form of backfilled tunnels of various ages. The location of all evidence of marsupial mole activity is shown in Figure 4-64. The mole holes persist in the sand profile for several years and accordingly may not be indicative of recent mole activity at that specific location. Martu Traditional Owners confirm that they are aware of marsupial moles in the general Lake Disappointment area.

Figure 4-63: Northern Marsupial Mole track locations

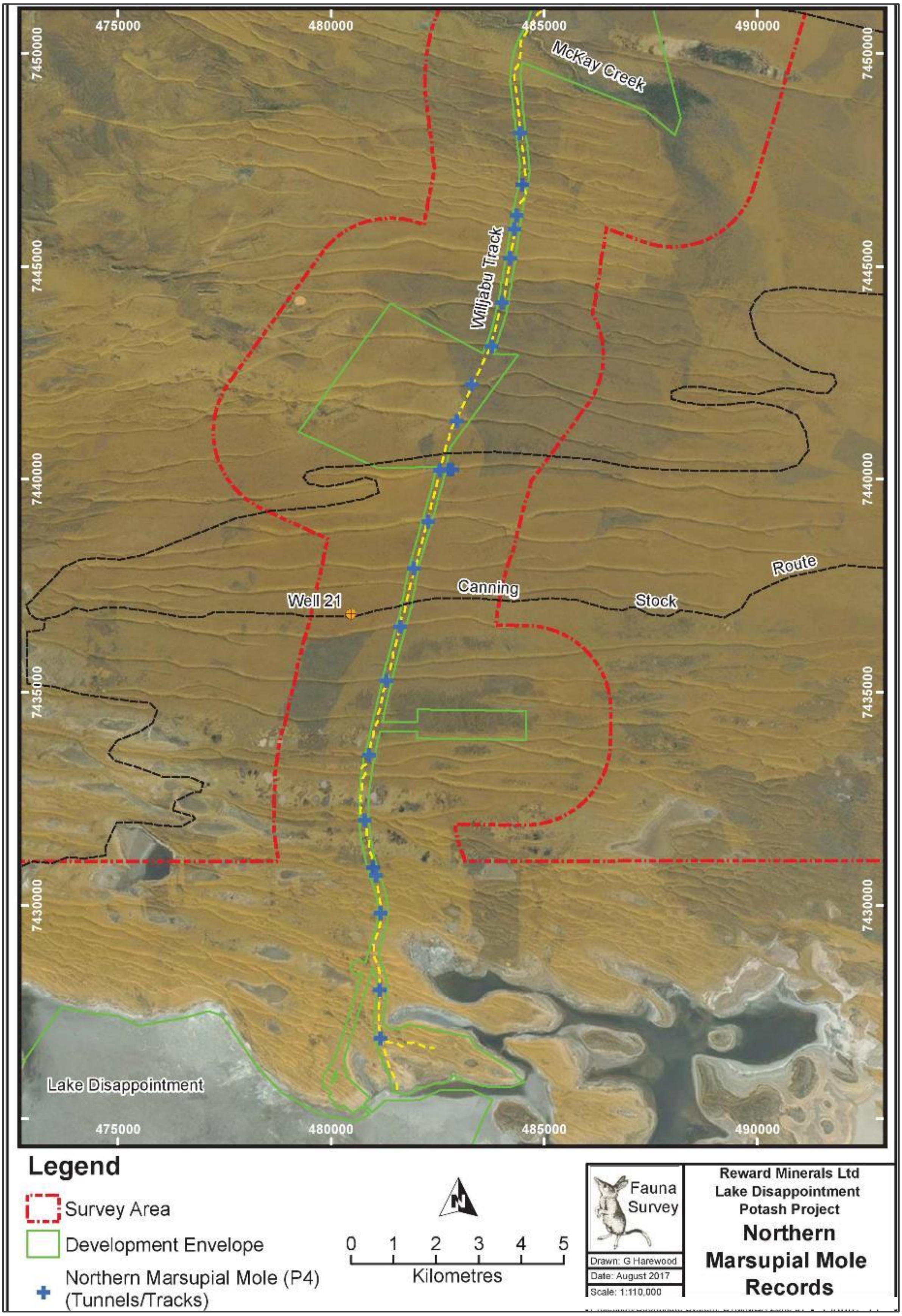
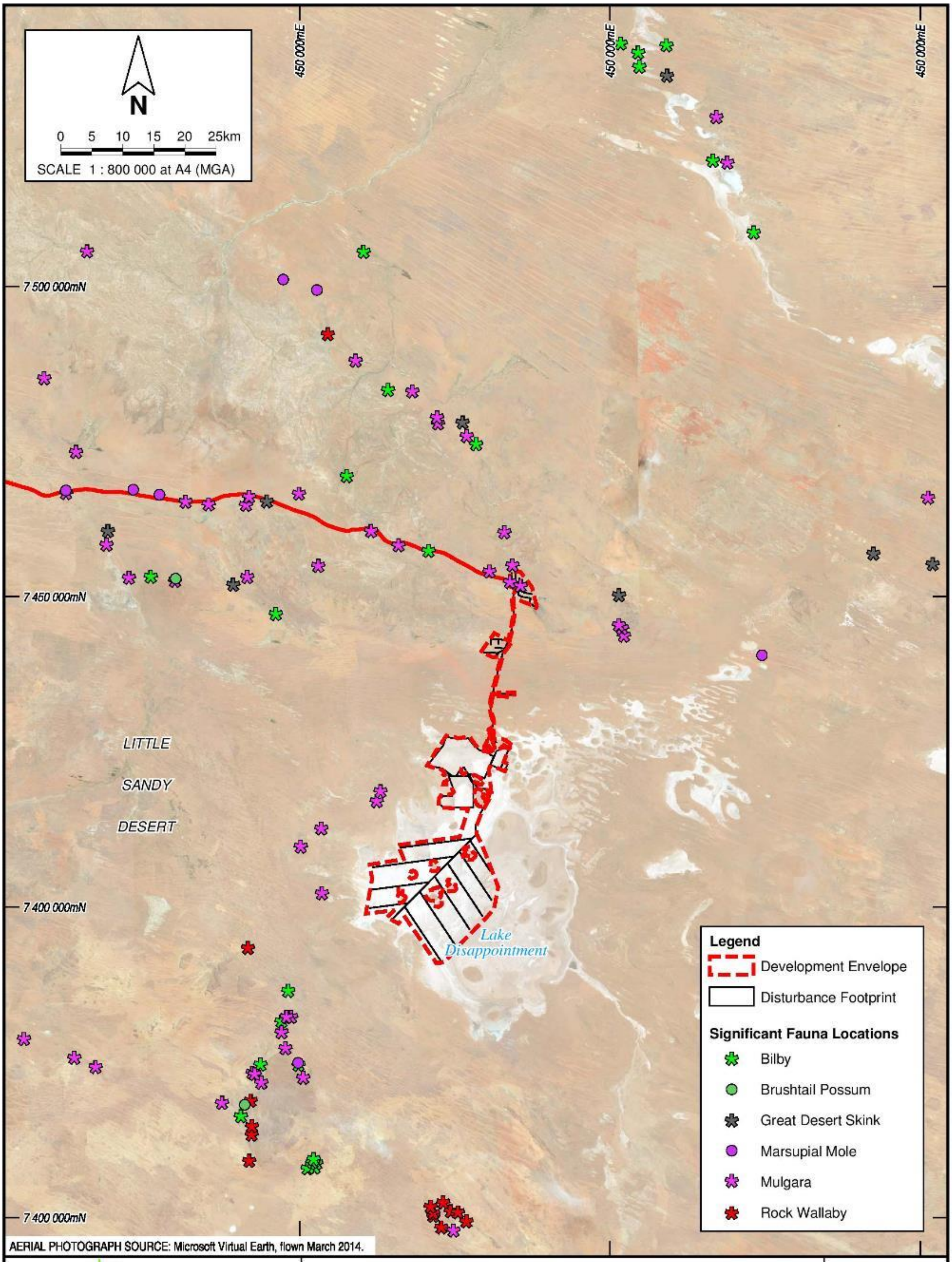


Figure 4-64: Kanyirninpa Jukurrpa fauna observations



Greater bilby (Macrotis lagotis)

Bilbies retreat to burrows during the day and are active at night. They leave characteristic diggings in their search for food under the soil and their scats are easily identified (Thompson & Thompson 2008, Dziminski & Carpenter 2017). The presence of bilbies (and mulgara) is normally determined by systematically searching the entire area for burrows, diggings or scats or undertaking numerous 2 ha plot searches for scats, diggings and burrows (the number of 2 ha plots is not prescribed).

Much of the project area was covered on foot, on all terrain vehicles, in vehicles and by helicopter, and a targeted search for bilbies and several other species was carried out either side of the Talawana Track from the Parnngurr (Cotton Creek) turnoff to the Willjabu Track turnoff in October 2012 (Appendix E9), with subsequent additional surveys in June 2017 along sections of the Talawana Track proposed for realignment/widening. No evidence of bilby diggings, burrows or scats was observed in the areas surveyed. No bilbies were recorded by fauna specialists during multi-season fauna surveys conducted between 2012 and 2017. However, some areas in the development envelope have not been intensively searched for bilbies or mulgara (Appendix E4) and Reward has assumed that some bilbies are likely to be present in the general project locality. There is one anecdotal report by a Reward employee of a night time bilby observation at a location on the Talawana track. Traditional Owners have reported seeing bilbies in the wider Lake Disappointment region, although not specifically within the project development envelope (Figure 4-64).

Brush-tailed mulgara (Dasycerucus blythi)

The only other mammal species of conservation significance that is considered likely to occur in the general Lake Disappointment area (though not necessarily within the project development envelope) is the brush-tailed mulgara (*Dasycercus blythi),* a DBCA Priority 4 species. No evidence of brush-tailed mulgara was observed during baseline investigation for the Lake Disappointment project, including during targeted surveys along the Willjabu and Talawana Tracks. However, Martu (Kanyirninpa Jukurrpa) observers report seeing mulgara in the wider region (Figure 4-64).

Bats

In total, seven of the predicted eight species of bats expected to occur in the Lake Disappointment area were recorded during baseline surveys. All of these species were recorded in May 2013 (Appendix E4). The greatest diversity of bats was observed at the McKay Creek site and at a trap site adjacent to an inundated freshwater clay pan. Only four species of bat were recorded during the October 2013 survey, a consequence of the drier conditions. Most bats were recorded at McKay Creek, presumably due to the abundance of quality daytime refuge sites (i.e. tree hollows) which are limited in other sections of the project area. None of the identified or potential bat species that may occur in the area are listed as threatened, migratory or as DBCA Priority species. Bats are unlikely to be significantly impacted by implementation of the Lake Disappointment project.

Birds

Night parrot

The night parrot is listed as Endangered under the *EPBC Act* and Critically Endangered under the WC Act. The night parrot was probably originally distributed over much of semi-arid and arid Australia (Garnett et al. 2011, Threatened Species Scientific Committee 2016). There have been sightings:

- In the Pilbara in 1980, 2005 and 2017;
- In central WA in 1979;
- In north-eastern South Australia in 1979;

- In western Queensland (including Pullen-Pullen-Mt Windsor-Diamantina population) in 1980, 1990, 1993, 2006 and 2013–17 (Davis & Metcalf 2008, Garnett et al. 2011, Palaszxzuk & Miles 2017); and
- Near Lake Eyre in 2017 (McCarthy 2017).

Kearney et al. (2016) suggests that night parrots can persist on dry seed during winter conditions without exceeding dangerous levels of dehydration, but would need access to water or succulent vegetation during summer. This has significant implications for where night parrot might be found, and its preferred habitat. Recent information indicates the night parrot's preferred habitat is *Triodia* (spinifex) grasslands, chenopod shrublands, shrubby samphire and floristically diverse habitats dominated by large-seeded species (Threatened Species Scientific Committee 2016, McCarthy 2017, Murphy et al. 2017b). The bird nests under *Triodia* and has a runway and a tunnel entrance with an apron of dead *Triodia* sp. leaves. It is thought that breeding generally occurs between April and October (Murphy et al. 2017a). The night parrot is thought to be relatively sedentary and has a low flying habit. As its name suggests, it is chiefly active at night.

Baseline surveys for the Lake Disappointment project initially included three rounds of targeted sampling during which acoustic recorders (ARUs) were deployed at numerous locations in and near the Lake Disappointment development envelope, as well as in regional locations (Appendix E2). Night parrot calls were heard in June 2017 and again in August 2017. All calls were recorded in a single swale between east-west oriented dunes. The habitat from which the calls emanated consisted of mature seeding spinifex interspersed with freshwater clay pans. The ARUs that recorded night parrot calls were spread over approximately 2.5 km. The investigators did not see any night parrots or night parrot nests and no images of night parrots were captured on cameras deployed during the surveys. A redacted version of information presented in the night parrot survey report[20] (Appendix E2) which includes a complete description of the survey methods.

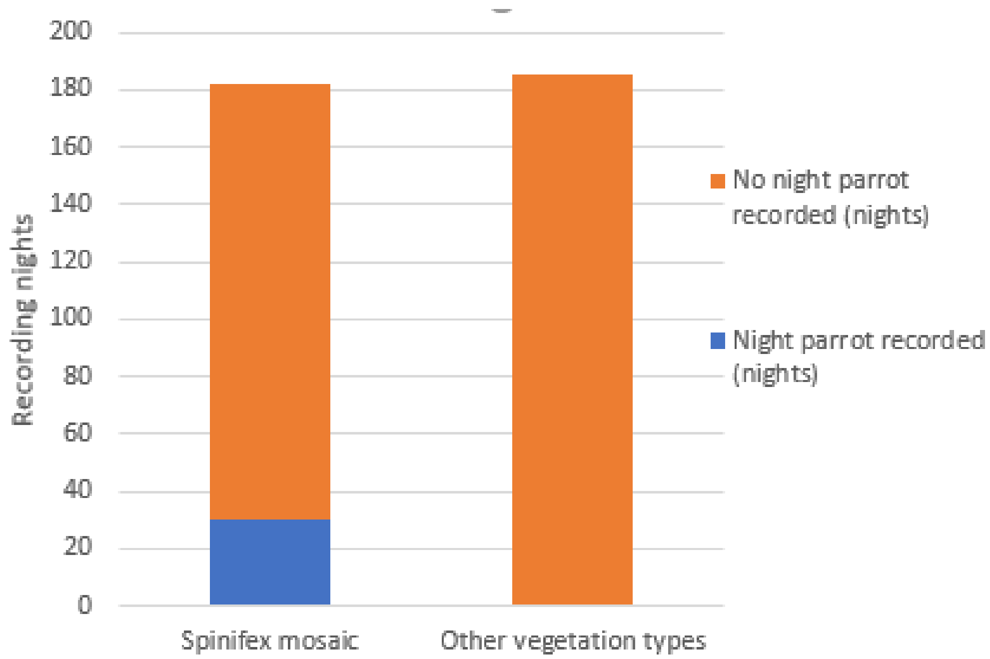
Based on the time of the calls, it appears that the area in which the night parrots were heard calling is both a roosting and a foraging site. Roosting is implied by the calls recorded at around 1700 and 0600, which presumably are made as the birds fly to and from their roosting site. Foraging is implied by the multiple calls recorded throughout the night when night parrots typically feed. The area could also be a nesting site, as calls in the middle of the night may be when parent birds are returning to feed each other or chicks in the nest. The location at which confirmed night parrot calls were recorded was burnt in a bushfire caused by lightning in early December 2017. Night parrot calls were subsequently recorded in the same general area, notwithstanding that much of the area had been burnt.

Reward has recorded more than 4800 recorded hours over 400 nights in the Lake Disappointment area. All of the confirmed night parrot calls have been recorded in the same vegetation type, a mosaic of spinifex-dominated vegetation and other vegetation characteristic of saline claypans (Figure 4-65). This finding is consistent with a report published by Murphy et al. (2017):

> *'This work suggests that the habitat mosaic containing roost sites in close proximity to feeding grounds with key seed-producing species is an important factor, rather than an association with spinifex or samphire alone.'*

[20] It has been necessary to redact the night parrot report to minimise the risk of unauthorised egg collection or poaching of birds

Figure 4-65: Frequency of night parrot calls in different vegetation types



No night parrot calls were recorded by the ARUs placed at regional locations, (Appendix E2)(Harewood 2018). There is a record in the DBCA Threatened Species Database of 12 night parrots at a pool approximately 150 km north-west of the project area in 2003. The confidence level for this sighting is low.

Striated grasswren

The striated grasswren (*Amytornis striatus striatus*) is listed as Priority 4 by DBCA. Its preferred habitat is spinifex meadows with or without low shrubs (*Thryptomene* sp.) or *Acacia* sp. on sandy or loamy substrate. The known distribution of the striated grasswren extends over sandy deserts (Great Victoria, Gibson and Great Sandy) in central and eastern Western Australia (Johnstone & Storr 2004).

The species was provisionally identified from a recording made during baseline surveys at a location north of Lake Disappointment near the Willjabu Track in May 2013. The DBCA Threatened Species Database contains records of the species near Well 24 on the Canning Stock Route, approximately 60 km to the east of the project area.

Rainbow bee-eater

The rainbow bee-eater (*Merops ornatus*), a listed migratory species, was observed on 12 occasions (38 individuals) during baseline surveys at Lake Disappointment, with all but one sighting being at McKay Creek. The rainbow bee-eater is not a threatened species and can be regarded as common. It may be resident in the area and possibly breeds in suitable areas such as the banks of McKay Creek.

Princess parrot

The princess parrot (*Polytelis alexandrae*) is listed as Vulnerable under the EPBC Act and Priority 4 with DBCA. The species is found mostly in the inland arid areas of Australia, and in Western Australia in the Gibson, Little Sandy and Great Victoria Deserts (Johnstone and Storr 1998, Pavey et al. 2014). However, they occasionally occurred in lightly wooded areas adjacent to the sandy deserts (Moriarty 1972).

A single flock of four princess parrots were observed flying overhead during a Phase 1 survey at Lake Disappointment in May 2013 (Appendix E4). Princess parrots are highly nomadic: their frequency of occurrence within the project area is likely to be very low and usually only temporary. The project area offers only marginal habitat for this species, given the lack of large trees princess parrots require for roosting and nesting.

Peregrine falcon

The peregrine falcon (*Falco peregrinus*) was recorded in 2013 outside the project development envelope at a location in the Durba Hills about 15 km south-west of Lake Disappointment (Appendix E4). The species has potential to breed in this location due to the presence of near vertical rocky cliff lines (which are absent from the project development envelope). Individuals of this species have potential to use sections of the project area for foraging, as they have large home ranges. However, they are only expected to be present very occasionally within the project development envelope. Peregrine falcons are listed as Schedule 7 ('Other specially protected fauna') under the WC Act.

Reptiles

Lake Disappointment dragon

The Lake Disappointment dragon (*Ctenophorus nguyarna*) was observed 18 times during a Phase 1 fauna survey at Lake Disappointment. The species was captured on several occasions and it (or its characteristic burrows) was observed at various other locations around the playa shore line within its preferred habitat, samphire. It was recorded an additional 10 times during the Phase 2 fauna survey. Up until the Phase 1 survey completed by Reward at Lake Disappointment, there were only 13 records of the species in the DBCA database. The locations of the observations of the Lake Disappointment dragon (i.e. Reward surveys and DBCA records) are shown in Figure 4-66. The results suggest the species is likely to be found almost anywhere around the playa edge and possibly on islands within the playa wherever suitable samphire habitat is present.

Lake Disappointment ground gecko

The Lake Disappointment ground gecko (*Diplodactylus fulleri*) is listed as Priority 2 by DBCA and was captured a total of six times over both survey periods, all at Trap Site 2 (Appendix E4). The species is nocturnal and does not make distinctive burrows, hence the lack of observations outside the main trapping area. Like the Lake Disappointment dragon, this species appears to be confined to the samphire habitat bordering the lake (and possibly on islands where suitable samphire habitat is present). The locations of the observations (i.e. this survey and DBCA records) of the Lake Disappointment ground gecko are shown in Figure 4-67.

Unpatterned robust lerista

During the Phase 2 survey, four individuals of unpatterned robust lerista (*Lerista macropisthopus remota*), a Priority 2 lizard species, were captured within the sand dunes north of Lake Disappointment (Figure 4-67). There are no other nearby records within the DBCA database. These observations appear to represent a significant eastward range extension for the species.

Figure 4-66: Locations of Lake Disappointment dragon

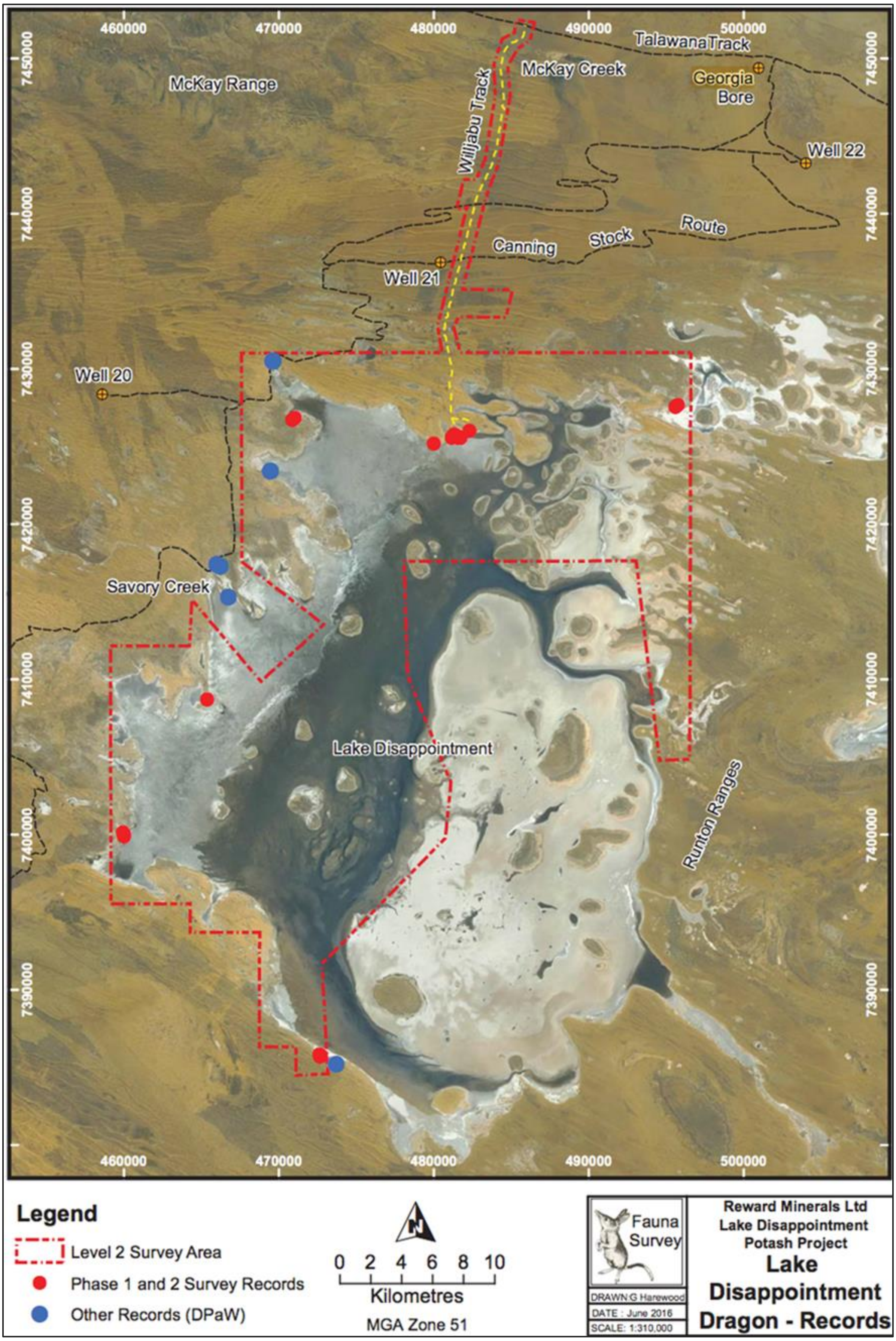
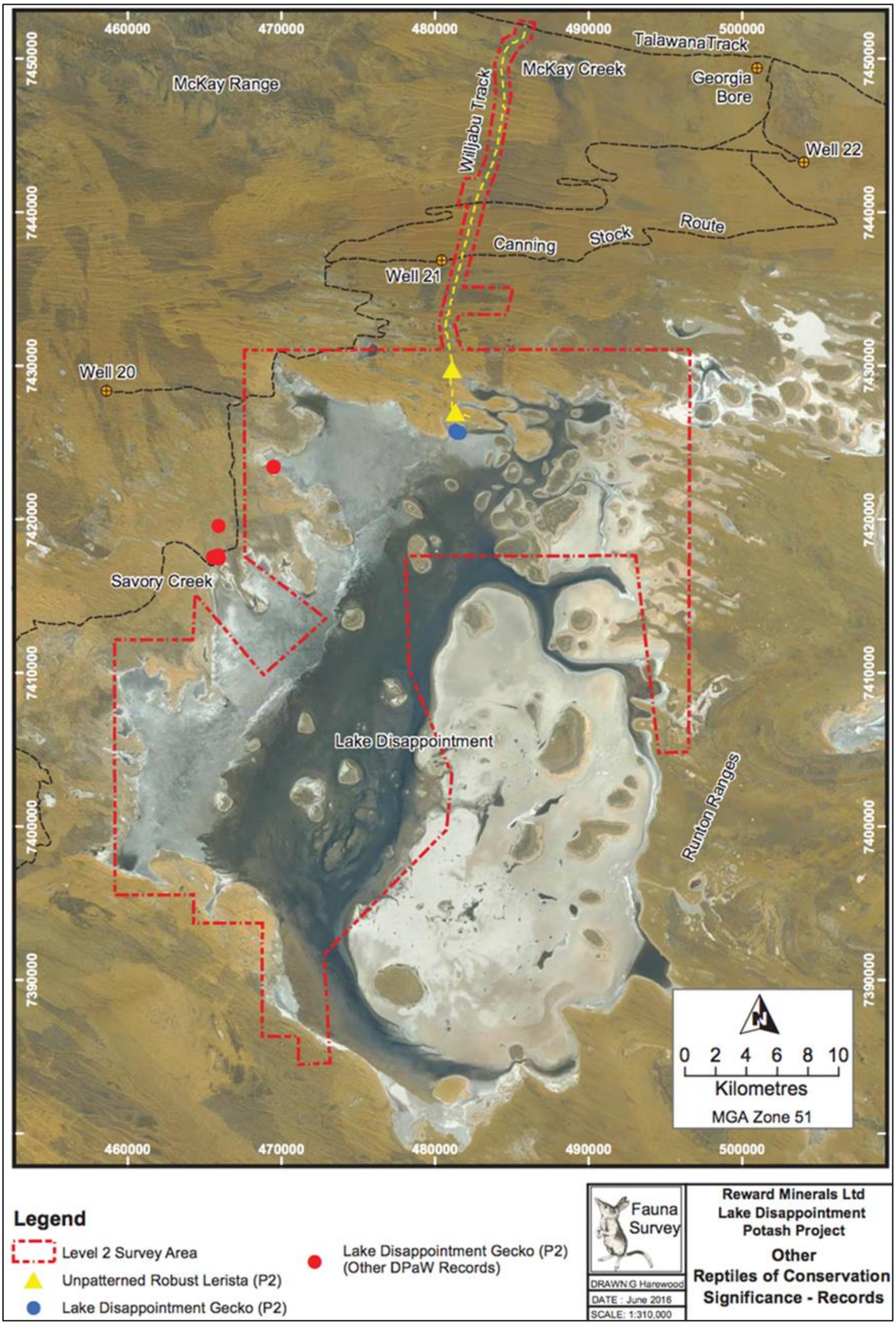


Figure 4-67: Locations of other reptiles of conservation significance



Great desert skink

The great desert skink (*Liopholis kintorei*) is a large social lizard that lives in an underground burrow complex and accumulates scats in latrine sites near burrow entrances. They seldom venture large distances from their burrows, so they are unlikely to be caught in pit and funnel traps, unless these traps are placed near their burrows, but they can be located by searching appropriate habitat for burrows and latrines.

The great desert skink is listed as Schedule 3 and Vulnerable under state and federal legislation. This species is considered likely to occur in the general project locality, as suitable habitat (sand plains and sand dunes vegetated with spinifex) exists in some parts of the development envelope. However, no evidence of its presence was found in the areas investigated during baseline surveys.

Introduced fauna

During the field survey, seven introduced vertebrate animal species were identified as being present. These were: the camel (*Camelus dromedaries*), cat (*Felis catus*), fox (*Vulpes vulpes*), house mouse (*Mus musculus*), European cattle (*Bos taurus*), rabbit (*Oryctolagus cuniculus*) and the Asian house gecko (*Hemidactylus frenatus*).

Aquatic invertebrates

In 2017, at least 193 species of aquatic invertebrate were collected from the overall Lake Disappointment system (including the surrounding clay pans, where nearly all the species richness was found). The number of species recorded in the Lake Disappointment system results from a combination of factors, including high survey effort and expertise, favourable rainfall, and a suite of surrounding clay pans of varying salinities (Table 4–48). It is consistent with the picture provided by waterbird data that the Lake Disappointment system is a biologically rich arid zone wetland (Appendix E6).

Of the aquatic invertebrate species recorded at Lake Disappointment and surrounding claypans, 18 are known only from this area (Table 4–49). All 18 'new' species were found outside the lake development envelope. The ostracod *Heterocypris* sp. BOS898, which occurred in Savory Creek as well as in clay pans, was the only new species recorded in the development envelope (as well as outside the development envelope). Given that the potential hydrological changes associated with project development will be restricted to the main saline playa (in which the lake development envelope lies), it is very unlikely that the conservation status of any of these species will be affected by project development, despite the species being known only from the local area.

Table 4–48: Aquatic invertebrate species richness – various inland Australian lake systems

System	Location	No. of species		Salinity range, EC (µS/cm)	Sites	Samples
		Overall	Main saline playa			
Lake Disappointment	Pilbara, WA	195	14	66–99,300 (8)	51	52
Lake Carey (1)	Goldfields, WA	107	10	313–83,300	31	66
Lake Wells (2)	Goldfields, WA	53	10	48–195,200	9	9
Lake Torrens (3)	SA	27	27	20,300–427,500	5	25
Lake Eyre (4)	SA	17	17	39,100–422,000	1	15
Lake Weelarrana (5)	Pilbara, WA	14	14	59,400	1	1
Lake Cowan (6)	Wheatbelt, WA	7	6	184,000–234,000	4	4
Lake Way (7)	Goldfields, WA	3	3	Dry (hatching expt)	6	18

Sources: 1. Timms et al. 2006; 2. Appendix E6; 3.Williams et al. 1998; 4. Williams and Kokkinn 1988; 5. Pinder et al. 2010; 6. Appendix E7; 7. Bennelongia 2017b

Note 8: The salinity values shown for Lake Disappointment (but not necessarily other wetlands) represent salinities immediately following significant rainfall events. Electrical conductivity values in playa water during drier periods would typically be considerably higher (in the order of 400,000 µS/cm).

Table 4–49: Aquatic invertebrates known only from Lake Disappointment area

Higher classification	Species	Recorded locations	
		Habitat(s)	Sites
Conchostraca			
Cyzicidae	*Eocyzicus* nr *argillaquus*	Turbid claypan, tannin-stained claypan	REM038
	Eocyzicus sp. B02	Claypan fringed by samphire	REM051, REM055, REM056
	Eocyzicus sp. B04	Turbid claypan, tannin-stained claypan	REM039, REM052, REM054, REM057, REM059, REM060, REM062, REM063
	Ozestheria sp. B01	Claypan fringed by samphire	REM051, REM055
Limnadiidae	*Eulimnadia* nsp. B01	Turbid claypan	REM038
	Paralimnadia sp. B01 (nr *flava*)	Tannin-stained claypan	REM057

Higher classification	Species	Recorded locations Habitat(s)	Sites
Cladocera			
Moinidae	*Moina* sp. B01	Turbid claypan	REM039
Anostraca			
Thamnocephalidae	*Branchinella* sp. B02 (nr *proboscida*)	Turbid claypan	REM017
	Branchinella sp. B03	Turbid claypan	REM039, REM060, REM062, REM063
Ostracoda			
Cyprididae	*Bennelongia* sp. BOS565	Turbid claypan, tannin-stained claypan	REM017, REM038, REM039, REM040, REM057
	Cypretta sp. BOS902	Tannin-stained claypan	REM057
	Cypricercus sp. BOS843	Turbid claypan	REM039
	Cyprinotus sp. BOS899	Claypan fringed by samphire	REM055
	Cyprinotus sp. BOS946	Tannin-stained claypan ringed by *Melaleuca*	REM057
	Heterocypris sp. BOS898	Savory Creek, claypan fringed by samphire	REM050, REM055
	Strandesia sp. BOS914	Turbid claypan	REM039
Limnocytheridae	?*Limnocythere* sp. BOS901	Claypan fringed by samphire	REM055
	Limnocythere sp. BOS900	Claypan fringed by samphire	REM055

Wetland vertebrates

Information on the occurrence of waterbirds at Lake Disappointment was sparse prior to the surveys undertaken as part of baseline studied conducted for the Lake Disappointment potash Project. Early information on avifauna of the Lake Disappointment region (Calaby, Buller, Butler, Fuller, Gard) was summarised by Lane et al (1993) but this work is virtually unobtainable. However, the early information is summarised in Table 4–50, up to Clarke et al.'s (2004) account of their visit to Lake Disappointment. The proximity of John Calaby's records to Lake Disappointment is unclear.

Table 4–50: Documented records of waterbirds at, or near, Lake Disappointment prior to 2004

Species	Date	Observer: record	Location
Australian wood duck	Pre-1942	Gard: several	Savory Creek
Australian shelduck	1955	Calaby: some	Savory Creek
Grey teal	Pre-1942	Gard: small numbers	? at Lake Disappointment
Black swan	1955	Calaby: some	Savory Creek
Little pied cormorant	Pre-1942	Gard: unknown number	Savory Creek pool
Great egret	1942	Buller: 1	Savory Creek pool
Eurasian coot	1955	Calaby: many	Savory Creek
Banded stilt	Pre-1942; 1955; 1971	Gard, Calaby: breeding Butler: breeding	Savory Creek and Lake Disappointment
Red-necked stint	Pre-1942	Gard: unknown number	Savory Creek pool
Wood sandpiper	1991	Fuller: 6	Savory Creek

Based on the available information in Jaensch and Lane (1993) and Clarke et al. (2004), Lake Disappointment would be considered to have low waterbird values other than some importance for breeding by banded stilt. The significance of the lake for banded stilt, even in 2004, was unclear. However, the records of Clarke et al. (2004) combined with a recent study by Pedler et al. (2014) and the initial baseline fauna survey work at the project by Greg Harewood, led Bennelongia (2016 – Appendix E7) to conclude that:

> *'…the lake appears to be part of a national network of arid zone lakes important for the banded stilt and, perhaps, other species. This is best illustrated by a recent study in which a banded stilt released at Lake Eyre in 2012 travelled through Lake Disappointment on its way to south-west WA … (Pedler et al. 2014). In terms of its standalone characteristics and values, Lake Disappointment is perhaps best equated with one of the large natural salt lakes in the south-west. The occasional breeding events by banded stilts on islands in the lake, which complements its network role, appears to be its highest value.'*

Heavy rain at the start of 2017 enabled better assessment of waterbird values than had been possible during an earlier baseline survey by Bennelongia in 2016. Aerial survey of Western Desert lakes by Bennelongia (Appendix E6) for DBCA and indigenous land councils showed extensive breeding by banded stilt, with Lake Disappointment being the site with the largest colonies. The results of a baseline survey during an exceptional large flooding event in early 2017, which is likely to have shown maximal waterbird use of Lake Disappointment in the following months, showed that six waterbird species bred on the main saline playa in March 2017. Banded stilt accounted for 99% of nesting activity, although there was also significant breeding by red-necked avocet, gull-billed tern and grey teal).

In surveys of the whole Lake Disappointment system, 35 species of waterbird (including the swamp harrier, which is treated here as wetland-dependent) have been recorded. Potentially, some other birds may occur, but all species using the system regularly are likely to have been recorded. The count of 109,812 waterbirds (mostly banded stilt) at the saline playa and surrounding clay pans in March 2017 (Appendix E6) represents a significant concentration of waterbirds. Previously,18 other

Australian arid zone wetland systems have been identified as supporting >100,000 waterbirds at any time (Kingsford and Halse, 1998).

During baseline surveys, 7 species listed under the EPBC Act, as well as one 'otherwise significant' waterbird species, were recorded at or near Lake Disappointment:

- Marsh sandpiper (*Tringa stagnatilis*) – Migratory (Schedule 5)
- Common greenshank (*Tringa nebularia*) – Migratory (Schedule 5)
- Pectoral sandpiper (*Calidris melanotos*) – Migratory (Schedule 5)
- Sharp-tailed sandpiper (*Calidris acuminata*) – Migratory (Schedule 5)
- Red-necked stint (*Calidris ruficollis*) – Migratory (Schedule 5)
- Gull-billed tern (*Gelochelidon nilotica*) – Migratory (Schedule 5)
- Eastern great egret (*Ardea modesta*) – Migratory (Schedule 5)
- Banded stilt (*Cladorhynchus leucocephalus*) – Otherwise significant.

An additional four listed waterbird species (wood sandpiper, common sandpiper, curlew sandpiper and Caspian tern) may occasionally occur in the project area, but are unlikely to be discernibly impacted by project implementation.

The Lake Disappointment/Savory Creek system has national value for migratory shorebirds on one criterion, namely that more than 0.1% of the flyway population of a species is present for at least part of the year. An estimated 0.4% of the flyway population of the sharp-tailed sandpiper was present at Lake Disappointment in March 2017 (Table 4–51). The on-playa development envelope, which is too saline to be regularly used by sharp-tailed sandpiper in isolation of other areas (Higgins and Davies 1996), had approximately 0.2% of the flyway population at the time of the March 2017 survey. The Lake Disappointment/Savory Creek system does not meet the other two criteria of national importance, namely that >15 shorebird species are present (only five species were recorded) or that >2000 shore individuals are present (a maximum of 388 birds was recorded at any one time).

Table 4–51: Listed waterbirds occurring, or possibly occurring, at Lake Disappointment

Common name	Species	WC Act	EPBC Act (1)	No.	Flyway (2)	%
Recorded during surveys						
Marsh sandpiper	*Tringa stagnatilis*	S5	B, C, J, R	3	130000	<<0.1
Common greenshank	*Tringa nebularia*	S5	B, C, J, R	4	110,000	<<0.1
Pectoral sandpiper	*Calidris melanotos*	S5	B, J, R	1	c. 1,500,000	<<0.1
Sharp-tailed sandpiper	*Calidris acuminata*	S5	B, C, J, R	354	85,000	0.4
Red-necked stint	*Calidris ruficollis*	S5	B, C, J, R	26	475,000	<<0.1
Gull-billed tern	*Gelochelidon nilotica*	S5	C	823	-	-
Great egret	*Ardea modesta*	S5	-	1	-	-

Common name	Species	WC Act	EPBC Act [1]	No.	Flyway [2]	%
Possibly present occasionally						
Wood sandpiper	*Tringa glareola*	S5	B, C, J, R	-	130,000	-
Common sandpiper	*Actitis hypoleucos*	S5	B, C, J, R	-	190,000	-
Curlew sandpiper	*Calidris ferruginea*	S5	B, C, J, R	-	90,000	-
Caspian tern	*Sterna caspia*	S5	J	-	-	-

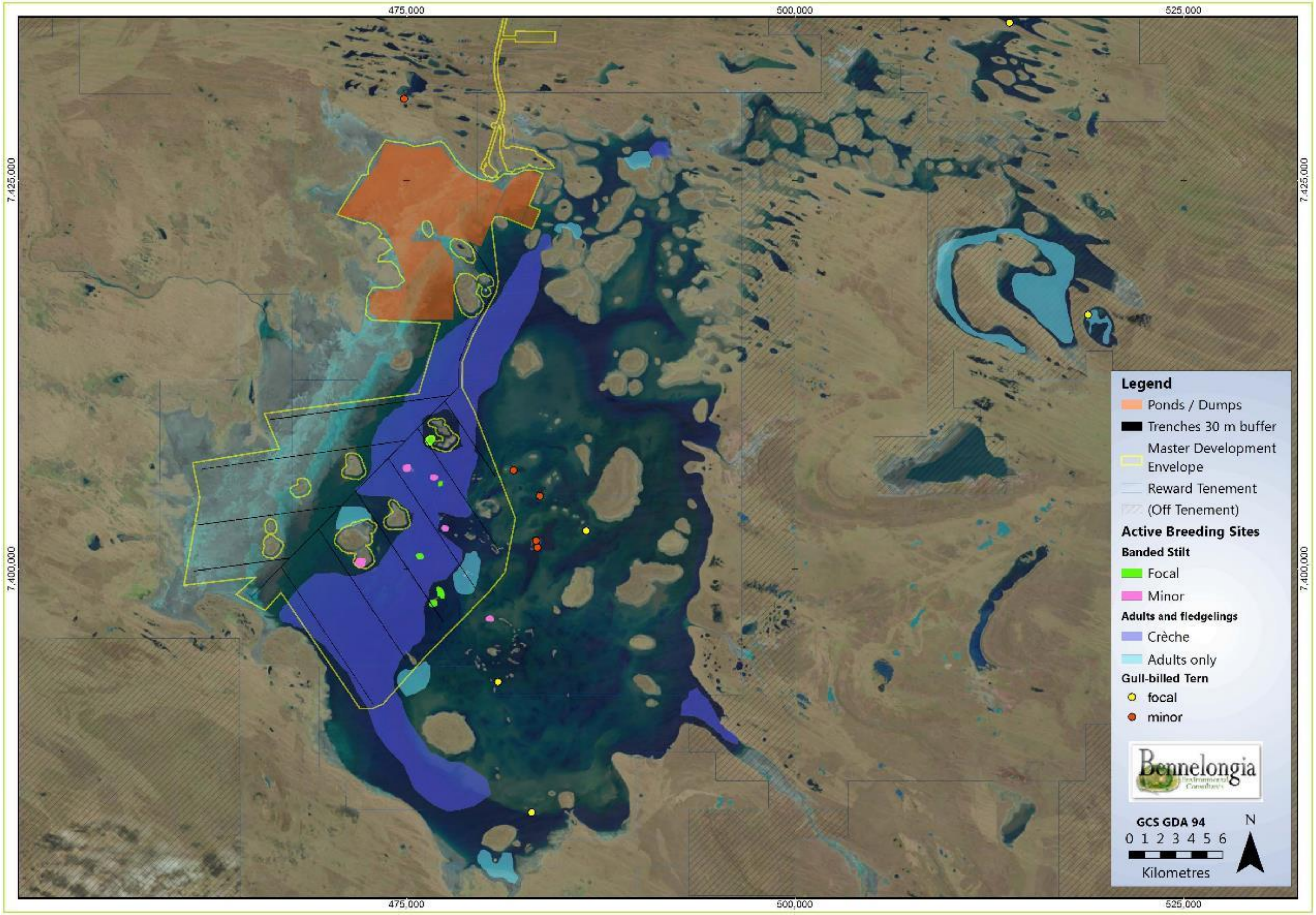
Note 1: B – Bonn Convention; J – Japanese Australia Migratory Bird Agreement; C – Chinese Australia Migratory Bird Agreement; R – Republic of Korea Australia Migratory Bird Agreement

Note 2: http://www.environment.gov.au/biodiversity/migratory-species/migratory-birds

The one otherwise significant bird species recorded at Lake Disappointment is the banded stilt, an Australian shorebird that occasionally breeds on the main saline playa at Lake Disappointment. While not formally listed as a species of conservation significance, a March 2017 survey by Bennelongia at Lake Disappointment (Appendix E6) recorded 94,046 adult birds, 49,321 nests on 10 islands, and 7388 young chicks on the main playa (Figure 4-68). Most of the nests were on five islands (Figure 4-69). These observations align closely with the 93,455 adult banded stilt observed at Lake Disappointment (mostly at eight nesting colonies) in February 2017 (Appendix E6). These numbers represent more than 46% of the entire species' population, based on Watkins' (1993) estimate of 206,000 birds, or approximately 25% of the population based on more recent estimates (Wetlands International 2017).

Figure 4-68: Banded stilt nests at Lake Disappointment, 2017 (photo by Bennelongia)

Figure 4-69: Banded stilt and gull-billed tern observations – March 2017



4.6.4 Potential impacts

Potential impacts on fauna which may result from project implementation are related to:

- Habitat loss or degradation: partial or total clearing;
- Ongoing mortality: roadkill, animals striking infrastructure (e.g. fences) and entrapment in trenches or ponds;
- Habitat fragmentation: includes roads, pipes and drainage channels;
- Alteration of hydrological processes: changing water flow frequency, duration or extent; establishment of permanent water impoundments (evaporation ponds, process water ponds);
- Alteration of hydrological processes: effects on vegetation health/occurrence resulting from reduction in groundwater levels;
- Anthropogenic activity: dust, noise, light and general disturbance;
- Changed fire regimes: more frequent or less frequent fires;
- Edge effects, affecting habitat and predation;
- Greater access of introduced feral and pest fauna;
- Contamination of surface water or groundwater;
- Attraction of wildlife to new habitat areas (salt ponds); and
- Weed invasion or the introduction of pathogens.

These potential impacts must be considered in a context of existing (non-project) threatening factors, for example predation of native fauna by introduced species, ecosystem effects associated with climate change or modified fire regimes, vegetation and habitat impacts caused by introduced herbivores.

Not all fauna likely to occur in the project locality are equally vulnerable to project-related impacts and other threatening processes. A detailed discussion of potential fauna impacts is provided in Appendix E1.

The key terrestrial and wetlands fauna of concern—and the threatening processes related to these fauna—are summarised in Table 4–52. No aquatic invertebrate fauna are included in Table 4–52. This is because the baseline surveys conducted at Lake Disappointment have not found any conservation-significant aquatic invertebrates to be restricted to the project development envelope and it is unlikely that implementation of the Lake Disappointment project will significantly impact local populations of aquatic invertebrate fauna.

Terrestrial invertebrate fauna also do not appear in Table 4–52. Although five putative SRE invertebrates were recorded at seven locations during baseline surveys, none of the locations at which the inferred SRE species were found intersect the proposed disturbance footprint. All were found in habitats that are common in the locality and regionally extensive. Accordingly, it is unlikely that these terrestrial invertebrates or their habitats will be significantly impacted by project implementation.

Table 4–52: Threatening processes – vertebrate fauna

Species	Key threatening processes	Other threatening processes
Night parrot (*Pezoporus occidentalis*)	Habitat loss (vegetation clearing, fire) Predation by cats and foxes Vehicle strike	Avian disease Entrapment in fences Loss/degradation of water sources Illegal collection of eggs/disturbance by collectors
Bilby (*Macrotis lagotis*)	Habitat loss (vegetation damage or clearing, fire) Predation by cats and foxes Vehicle strike	Herbivore competition (rabbits)
Great desert skink (*Liopholis kintorei*)	Predation by cats and foxes	Vegetation clearing Damage to burrows (rabbits)
Princess parrot (*Polytelis alexandrae*)	Vegetation clearing (nesting trees)	
Lake Disappointment ground gecko (*Diplodactylus fulleri*)	Predation by cats and foxes	Vegetation clearing
Lake Disappointment dragon (*Ctenophorus nguyarna*)	Predation by cats and foxes	Vegetation clearing
Northern marsupial mole (*Notoryctes caurinus*)	Predation by cats and foxes Earthworks	Vegetation clearing
Brush-tailed mulgara (*Dasycercus blythi*)/Crest-tailed mulgara (*D. cristicauda*)	Predation by cats and foxes	Vegetation clearing
Banded stilt (*Cladorhynchus leucocephalus*)	Altered hydrology (reduction in duration or extent of flooding during large flooding events) Predation (silver gulls or introduced predators)	Disturbance (human presence on/near playa)
Gull-billed tern (*Gelochelidin nilotica*)	Disturbance of habitat (clay pans/playa)	Altered hydrology (reduction in duration or extent of flooding during large flooding events) Predation (silver gulls or introduced predators)

4.6.5 Impact assessment

The potential impacts listed in Table 4–52 may be additive and rarely act in isolation on receptor species. Accordingly, this section seeks to provide a holistic assessment of multiple stressors on specified target organisms which may be significantly affected (i.e. affected to a non-trivial extent) by project implementation. Species affected to a trivial extent include those that have not been recorded in surveys, where available evidence indicates that there is at most a minor possibility that they may occur. When it is likely the species could occur, even if the species was not recorded during baseline investigations, potential impacts are considered. A discussion of how impacts would be avoided, mitigated and managed is provided in Section 4.6.6.

Fauna habitats

At a local scale (calculating direct project disturbance relative to the extent of fauna habitat recorded during baseline surveys of the project area), the maximum percentage of fauna habitat loss is approximately 0.95% of creek or drainage line habitat. The estimated direct disturbance areas associated with this fauna habitat in the project disturbance footprint is 10 ha (Table 4–53). At a regional scale, the percentage reduction in each fauna habitat is much smaller (well below 0.5% of each vegetation type/ pre-European vegetation association) (Table 4–54).

Table 4–53: Direct impacts on fauna habitat (local scale)

Habitat description	Development envelope (ha)	Disturbance footprint (ha)	Survey area (ha)	% local habitat (survey area) intersected by development envelope	% local habitat (survey area) proposed to be impacted – disturbance footprint
Halophytic vegetation	56	0	5,501	1.02	0.00
Clay or salt pan mostly devoid of vegetation	10	0	1246	0.80	0.00
Swales and dune crests with shrubs over spinifex with few or no trees	3519	379	52,870	6.66	0.72
Trees and shrubs over tussock grasses	106	1	611	17.35	0.16
Creek or drainage line	107	10	1049	10.20	0.95
Rocky area or breakaway	59	2	771	7.65	0.26
Flat plain, few to numerous trees, scattered shrubs over spinifex	7	7	2,153	0.33	0.33
Flat plain, scattered shrubs over spinifex, few or no trees	11	11	3,441	0.32	0.32
Cleared vegetation	168	168	0	N/A	N/A
Salt lake	35,934	7198	134,521	26.71	5.35

Table 4–54: Direct impacts on fauna habitat (regional scale)

Habitat description	Development envelope (ha)	Disturbance footprint (ha)	Pre-European vegetation	Extent in PIL1 subregion (ha)	Extent in PIL2 subregion (ha)	Extent in LSD1 subregion (ha)	Extent in LSD2 subregion (ha)	Regional habitat intersected by development envelope (%	Regional habitat proposed to be impacted (disturbance footprint) (%)
Halophytic vegetation	56	0	Little Sandy Desert 125-Bare areas; salt lakes			979.85	225,060.80	0.0248	0.0000
Clay or salt pan mostly devoid of vegetation	10	0	Little Sandy Desert 134-Mosaic: hummock grasslands, open low tree steppe; desert bloodwood and feathertop spinifex (on) sandhills/hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills	828.54	99.81	10,003.11	7,363,935.12	0.0001	0.0000
Swales and dune crests with shrubs over spinifex with few or no trees	3519	379	Little Sandy Desert 194-Hummock grasslands, tree steppe; desert oak & hard spinifex between sandhills				59,063.95	5.9579	0.6417
			Little Sandy Desert 134-Mosaic: hummock grasslands, open low tree steppe; desert bloodwood and feathertop spinifex (on) sandhills/hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills	828.54	99.81	10,003.11	7,363,935.12	0.0477	0.0051
			Little Sandy Desert 158-Hummock grasslands, shrub steppe; kanji over *Triodia basedowii*			178,188.03	49,274.46	1.5471	0.1666
			Abydos Plain – Chichester 111-hummock grasslands, shrub steppe; *Eucalyptus gamophylla* over hard spinifex	80,894.59	24,482.23			3.3394	0.3597
			Little Sandy Desert 99-Hummock grasslands, shrub steppe; *Acacia coriacea* & *Hakea* over hard spinifex *Triodia basedowii*			398,672.56	65,175.27	0.7587	0.0817

Habitat description	Development envelope (ha)	Disturbance footprint (ha)	Pre-European vegetation	Extent in PIL1 subregion (ha)	Extent in PIL2 subregion (ha)	Extent in LSD1 subregion (ha)	Extent in LSD2 subregion (ha)	Regional habitat intersected by development envelope (%	Regional habitat proposed to be impacted (disturbance footprint) (%)
Trees and shrubs over tussock grasses	106	1	Little Sandy Desert 99-Hummock grasslands, shrub steppe; *Acacia coriacea* & *Hakea* over hard spinifex *Triodia basedowii*			398,672.56	65,175.27	0.0229	0.0002
Creek or drainage line	107	10	Little Sandy Desert 99-Hummock grasslands, shrub steppe; *Acacia coriacea* & *Hakea* over hard spinifex *Triodia basedowii*			398,672.56	65,175.27	0.0231	0.0022
			Little Sandy Desert 117-Hummock grasslands, grass steppe; soft spinifex			191412.37	95838.81	0.0372	0.0035
			Little Sandy Desert 134-Mosaic: hummock grasslands, open low tree steppe; desert bloodwood and feathertop spinifex (on) sandhills/hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills	828.54	99.81	10,003.11	7,363,935.12	0.0015	0.0001
Rocky area or breakaway	59	2	Little Sandy Desert 99-Hummock grasslands, shrub steppe; *Acacia coriacea* & *Hakea* over hard spinifex *Triodia basedowii*			398,672.56	65,175.27	0.0127	0.0004
			Little Sandy Desert 134-Mosaic: hummock grasslands, open low tree steppe; desert bloodwood and feathertop spinifex (on) sandhills/hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills	828.54	99.81	10,003.11	7,363,935.12	0.0008	0.0000
			Abydos Plain – Chichester 111-Hummock grasslands, shrub steppe; *Eucalyptus gamophylla* over hard spinifex	80,894.59	24,482.23			0.0560	0.0019

Habitat description	Development envelope (ha)	Disturbance footprint (ha)	Pre-European vegetation	Extent in PIL1 subregion (ha)	Extent in PIL2 subregion (ha)	Extent in LSD1 subregion (ha)	Extent in LSD2 subregion (ha)	Regional habitat intersected by development envelope (%	Regional habitat proposed to be impacted (disturbance footprint) (%)
Flat plain, few to numerous trees, scattered shrubs over spinifex	7	7	Little Sandy Desert 99-Hummock grasslands, shrub steppe; *Acacia coriacea* & *Hakea* over hard spinifex *Triodia basedowii*			398,672.56	65,175.27	0.0015	0.0015
			Little Sandy Desert 134-Mosaic: hummock grasslands, open low tree steppe; desert bloodwood and feathertop spinifex (on) sandhills/hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills	828.54	99.81	10,003.11	7,363,935.12	0.0001	0.0001
Flat plain, scattered shrubs over spinifex, few or no trees	11	11	Little Sandy Desert 158-Hummock grasslands, shrub steppe; kanji over *Triodia basedowii*			178,188.03	49,274.46	0.0048	0.0048
			Little Sandy Desert 99-Hummock grasslands, shrub steppe; *Acacia coriacea* & *Hakea* over hard spinifex *Triodia basedowii*			398,672.56	65,175.27	0.0024	0.0024
			Little Sandy Desert 134-Mosaic: hummock grasslands, open low tree steppe; desert bloodwood and feathertop spinifex (on) sandhills/hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills	828.54	99.81	10,003.11	7,363,935.12	0.0001	0.0001
Cleared vegetation	168	168	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Salt lake	35,934	7198	Little Sandy Desert 125-Bare areas; salt lakes	N/A	N/A	979.85	225,060.80	15.8971	3.1844

Terrestrial invertebrates

Level 2 surveys for SRE invertebrate fauna near Lake Disappointment identified five potential SRE taxa in the project locality. None were recovered from locations within the proposed project disturbance footprint. Of the putative SRE fauna, three (*Urodacus* 'disappointment', *Urodacus* 'princess pea' and *Buddelundia* '10LD') were recovered from locations within the project development envelope. All putative SRE invertebrates were recovered from sand dune habitat, which is regionally extensive. The risk of significant impacts to SRE fauna as a result of land clearing and/or habitat fragmentation associated with project activities is considered low (Appendix G1 in Appendix E4).

Terrestrial vertebrates

In the absence of effective avoidance, mitigation and management actions, implementation of the Lake Disappointment project has the potential to significantly impact four terrestrial fauna:

- Night parrot (*Pezoporus occidentalis*)
- Bilby (*Macrotis lagotis*)
- Northern marsupial mole (*Notoryctes caurinus*)
- Great desert skink (*Liopholis kintorei*).

The project activities that drive the risks to these species are:

- Clearing of vegetation and/or earthworks, which may directly impact nests/burrows; and
- Vehicular traffic.

General loss of vegetation/habitat is not a major risk factor, as the habitats required by the at-risk species are widespread and extensive in the project locality, and the proposed clearing footprint (410 ha) is very small in comparison with the extent of suitable habitat.

Implementation of the Lake Disappointment project has the potential to cause local-scale impacts on three conservation-significant species chiefly through vegetation clearing: Lake Disappointment dragon (*Ctenophorus nguyarna*), Lake Disappointment ground gecko (*Diplodactylus fulleri*) and brush-tailed or crest-tailed mulgara (*Dasycercus blythi/Dasycercus cristicauda*).

Night parrot

Threats to the night parrot identified by the Threatened Species Scientific Committee (2016) and Murphy et al. (2018) include:

- Predation by feral cats and foxes
- Loss of habitat due to feral herbivores, fire or erosion
- Degradation/reduction of watering points
- Fences (entrapment/collision).

The main potential threats to night parrots from project activities are:

- Loss of viable eggs or chicks in a nest during vegetation clearing or due to fire; and
- Bird strike by vehicles on access/haul road (particularly at night) and during vegetation clearing.

In the Lake Disappointment area, these threats are probably less significant than predation by cats, foxes and other predators, which are known to be abundant in the area. If a significant program of feral animal control is implemented in combination with the other management actions proposed by

Reward (Section 4.6.6), the net impact of project implementation on night parrots (relative to a 'no-project' option) is expected to be positive (Appendix E1). Additional detail on Reward's proposed fauna management program is provided in Appendix L4.

Bilby

Bilby numbers in Western Australia appear to be in significant decline, with only a few small scattered populations existing in the Pilbara and in the adjacent sandy desert areas. A recovery plan published over 10 years ago (Pavey 2006) identified various potential threats, including:

- Predation, particularly of juveniles, by foxes, feral cats and wild dogs;
- Competition with herbivores, in particular rabbits;
- Habitat degradation and destruction, especially vegetation clearing, where bilbies are killed in their burrows; and
- Vehicle strikes.

The relevant recommended recovery actions for bilbies are:

- Control of predators;
- Monitoring of predators and bilbies at priority sites; and
- Re-introduction of Bilbies into predator-free or predator-controlled sites.

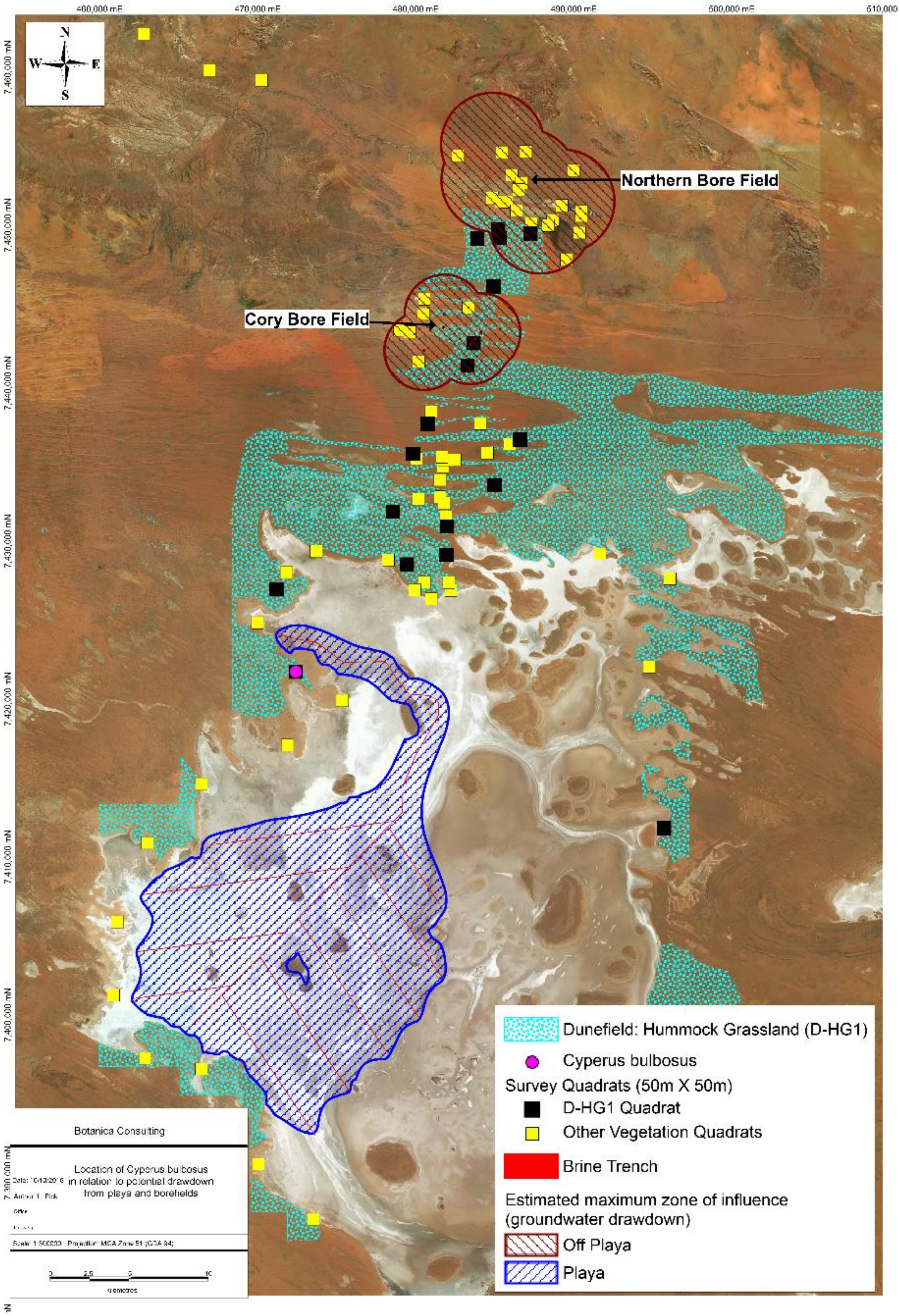
No bilbies or evidence of significant bilby populations (scratchings, burrows, scats) have been recorded in the Lake Disappointment project area during baseline fauna surveys between 2012 and 2017. However, Traditional Owners report the presence of bilbies in the region and one anecdotal report of a bilby on the Talawana Track has been made by a Reward employee.

Overall, the potential for project-related impacts as a result of traffic movements and off-playa vegetation clearing is probably less significant than the threat currently posed by predation by cats and foxes, and by competition with introduced herbivores. If a significant program of feral animal control is implemented in combination with the other management actions proposed by Reward (Section 4.6.6), the net impact of project implementation on bilbies (relative to a 'no-project' option) is expected to be positive (Appendix E1). Additional detail on Reward's proposed fauna management program is provided in Appendix L4.

Australian Government regulators have asked whether extraction of groundwater has the potential to affect plants (*Cyperus bulbosis* – yalka or 'bush onion') which may form part of the diet of the omnivorous bilby. It is unlikely that extraction of brine or fresher groundwater for the Lake Disappointment potash project will have a significant impact on the health or occurrence of this potential food source, for the following reasons:

- *Cyperus bulbosis* is not groundwater dependent;
- Only one confirmed observation of *C. bulbosis* has been recorded during baseline flora and vegetation surveys of the project area conducted between 2012 and 2017, and that occurrence does not lie within the estimated zone of hydrological impact of the project (Figure 4-70); and
- The vegetation unit within which *C. bulbosis* was observed (hummock grassland, 'D-HG1') is widespread within the project locality, including at locations outside the project disturbance footprint and zone of hydrological impact (Figure 4-70).

Figure 4-70: Occurrence of *Cyperus bulbosis* and hummock grassland vegetation



Northern marsupial mole

The northern marsupial mole is known to occur in the Great Sandy Desert, Little Sandy Desert and the northern Section of the Gibson Desert. Its listing under the EPBC Act was changed in 2015 from 'endangered' to 'data deficient' (Threatened Species Scientific Committee 2015). Mole tunnels have been observed in the Lake Disappointment project area, but it is not possible to say conclusively how old the tunnels are and whether marsupial moles are currently present or whether they moved through the area at an earlier time.

The main project activity that threatens the northern marsupial mole (if present) is land clearing and earthworks for the proposed upgrade of the Talawana and Willjabu Tracks. Such activities could damage tunnels and/or directly injure or kill moles and/or drive moles into open country where they are at increased risk from predators. Most project-related impacts can be avoided or mitigated using the strategies described in Section 4.6.6. Coupled with a program of feral animal control, the net impact of project implementation on the northern marsupial mole is likely to be neutral to positive.

Great desert skink

The great desert skink is listed as Vulnerable under the EPBC and WC Acts. The species was not recorded during baseline fauna surveys in the project area, but may occur within the development envelope, as some of the habitat in the development envelope would be suitable for the species. Pearson (2001) reported that in the 1930s Otto Lipfert collected six specimens along the Canning Stock Route that runs along the western edge of Lake Disappointment. The Kanyirninpa Jukurrpa organisation has indicated that it knows of great desert skinks to the west, north and east of the project area. The DBCA Threatened Species Database indicates there are multiple records east of Lake Dora, which is approximately 130 km to the north of the project area.

Moore et al. (2015) reported that the great desert skink is adversely affected by fire and predation (including by dingoes, foxes and cats). The (now outdated) recovery plan (McAlpin 2001) for the great desert skink indicated the key threats to the species are:

- Cessation of traditional land management practices, and particularly the creation of new fire regimes;
- Predation by foxes and feral cats; and
- Rabbits destroying and occupying burrow systems.

The main project-related risk to the great desert skink is direct damage to burrows during off-playa land clearing.

Overall, the inherent risk of significant impact to the great desert skink from project implementation is considered moderate to low: the distinctive burrows of the species are readily identified and would be apparent during pre-clearing inspections. If present, the species can be re-located via a 'soft-release' program (refer to Section 4.6.6 and the FMP in Appendix L4). When combined with a feral animal control program, the overall impact on the great desert skink of implementing the Lake Disappointment Potash Project is likely to be neutral to positive.

Crest-tailed mulgara and brush-tailed mulgara

The crest-tailed and brush-tailed mulgara are listed as Priority 4 by DBCA and *D. cristicauda* is listed as Vulnerable under the EPBC Act. Both species have a wide and overlapping distribution in arid Australia. Woolley et al. (2013) indicated that both *D. blythi* and *D. cristicauda* had been caught along the Canning Stock Route in the vicinity of the project area. The records for *D. cristicauda* in the DBCA Threatened Species Database along the Canning Stock Route are all from 1930 or earlier.

The Kanyirninpa Jukurrpa organisation has said that it has records of mulgara to the north-east, west and south-west of the project area.

Although neither of the two mulgara species were caught during the fauna surveys in the project area, based on the available information, it is possible that one or both species are present in the spinifex sand plain surrounding Lake Disappointment. If present, the main existing threat to mulgara in the project area would be predation by introduced fauna. Proposed off-playa vegetation clearing for implementation of the Lake Disappointment project could slightly increase pressure on the species through the risk of direct impacts on active burrows during clearing. Overall, the residual risk of significant project impacts to mulgara is considered low. Proposed avoidance, mitigation and management actions are described in Section 4.6.6.

Lake Disappointment ground gecko and Lake Disappointment dragon

All known records of the Lake Disappointment ground gecko are from the periphery of Lake Disappointment. The actual size of the population is not known, but even if it is only found on the margins of Lake Disappointment, the proposed project will impact less than 1% of the available habitat for this species.

All known records for the Lake Disappointment dragon are from the periphery of Lake Disappointment. Cogger (2014) reports it is primarily found in the saline samphire surrounding the lake edge and Doughty et al. (2007) reported it excavates its burrow below the salt crust. Burrow entrances are typically adjacent to vegetation. Males are often observed perched on the crowns of clumps of vegetation, while females are active on the ground running from one clump of vegetation to another. The size of Lake Disappointment dragon population is uncertain. However, even if it is only found on the margins of Lake Disappointment, the proposed project will impact less than 1% of the available fauna habitat for this species.

Overall, the risk of significant impacts on the Lake Disappointment ground gecko and the Lake Disappointment dragon as a result of project activities is low. Proposed avoidance, mitigation and management actions are described in Section 4.6.6.

Aquatic invertebrates

The ten aquatic invertebrate species found in the main saline playa, where some hydrological changes may occur, comprised:

- Two semi-aquatic beetle species on the shoreline (including the widespread *Megacephala murchisona*);
- Four widespread, described species of rotifers, copepod and brine shrimp, as well as a juvenile copepod probably belonging to a widespread described species;
- A widespread undescribed ostracod species; and
- A fly larva and a nematode that were not identifiable to species level, but which are likely to be widespread, based on the life history characteristics of these groups.

It is either known, or highly likely, that all aquatic or semi-aquatic invertebrate species in the main saline playa are widespread, so that any changes in lake hydrology are unlikely to affect the conservation status of the saline playa species (Appendix E6). As shown by Knight Piésold (Appendix H3), it is expected that any changes to lake hydrology will be small and of a nature that is unlikely to affect invertebrate persistence. Accordingly, significant adverse impacts on aquatic invertebrate species are considered unlikely.

Wetland vertebrates

Banded stilt

Lake Disappointment is one of a number of arid-zone wetlands that provide important breeding habitat for the banded stilt (the key others being Lake Torrens and Lake Eyre North in South Australia and Lakes Barlee, Ballard and Marmion in Western Australia). Major breeding events mostly occurring at intervals of between one and three times per decade (Appendix H1). Breeding events are not always successful: based on data in Marchant and Higgins (1993), the period required by banded stilt to pair up, find a nest site, lay eggs, incubate them and for the chicks to fledge is about 80 days. A flooding period of more than 80 days is probably necessary to ensure most young birds survive. There must be plenty of water present even as fledging occurs to ensure food remains plentiful. Under natural conditions banded stilts often begin breeding events when water will not last this long and, in such cases, very high chick mortality can occur. A number of unsuccessful breeding events have been recorded at Lake Disappointment (and other lakes) in recent years.

The major threats to banded stilt breeding success centre around water persistence, water depth, water quality and predation. Banded stilts require an ephemerally flooded, hypersaline wetland to provide abundant brine shrimp and ostracod food sources. The wetland must have islands for breeding colonies to form, presumably to isolate the breeding colony from surrounding land where terrestrial predators occur and perhaps to assist in keeping breeding birds cool. The depth of water after flooding must be sufficient to keep the island isolated until after hatching. Parts of the wetland must be flooded deeply enough to produce brine shrimp and ostracods until the young have fledged and have sufficient body reserves to move to the coast.

Control of predation is also important. It has been shown both anecdotally and through management intervention in South Australia that predation by silver gulls frequently causes breeding failure of banded stilt colonies (Pedler et al. 2017). Small numbers of silver gulls were recorded at Lake Disappointment in 2017 (Appendix E6). Although the number of birds was too few to affect the very large stilt colonies present, any establishment of silver gulls around project infrastructure and fresh water supplies would increase the threat to banded stilt breeding success.

Disturbance from people moving about on the playa has the potential to threaten breeding success, but this will not occur when the Lake Disappointment playa is flooded, because it will not be trafficable under flood conditions.

None of the islands in Lake Disappointment known to support breeding colonies of banded stilt will be directly disturbed by the proposed development of the potash project.

Lake water salinity and quality will be unaffected by project operations (Appendices G7 and H3), so that the abundance and composition of brine shrimp and ostracod food sources during flooding events should remain unchanged.

The establishment of bunds along the network of drainage channels could, however, result in significant impact on the breeding success of banded stilts in the saline playa due to altered surface water flow and flooding patterns across the lake. Additionally, the rapid recharge of initial flood waters into the lakebed to replace groundwater removed by the brine collection trenches could reduce the duration of flooding by reducing the amount of water available for surface ponding

(Appendix H1).[21] This effect may be reduced if small rainfall events occur prior to the major flood event. Modelling conducted to assess the potential impacts of brine abstraction on ponding duration has generally concluded that the larger flood events required for successful banded stilt recruitment are not likely to be affected by brine abstraction.

In the absence of effective mitigation measures, there is a moderate risk that the frequency of unsuccessful breeding events at Lake Disappointment will increase as a result of hydrological changes on the playa, with the result that overall recruitment to the national population of banded stilts may be commensurately lower. The environmental risk assessment conducted for the Lake Disappointment project (Appendix L2) has classified the inherent risk of adverse impacts on banded stilts as a result of hydrological changes associated with project implementation as 'High'. With the implementation of proposed mitigation and management measures described in Section 4.6.6, the residual risk of impact reduces to 'Medium'. Overall, the risk of significant project impacts on breeding success of the banded stilt during infrequent, high rainfall flood events is considered 'Medium'. Additional detail on how impacts on banded stilts will be avoided, mitigated and managed is provided in the FMP (Appendix L4).

The salinity of water in the evaporation ponds will mostly be near 300 ppt (i.e. TDS values in the order of 300,000 mg/L or approximately ten times as salty as seawater). This is far beyond a salinity able to be tolerated by any terrestrial birds, reptiles, mammals and amphibians. It is therefore highly unlikely that terrestrial birds, reptiles, mammals and amphibians will be attracted to the evaporation ponds, and in doing so become entrapped or injured by drinking the brine. The ponds will, in any event, be shallow (ponding depth typically less than 500 mm). Egress ramps are not required because the embankment slopes will be relatively flat and the slopes will not be fitted with slippery HDPE liners (which offer little traction to help fauna escape).

It is possible, however, that the migratory and shorebirds that currently access Lake Disappointment from time to time will make use of the salt ponds for feeding and roosting. This phenomenon has been observed at the Ridley (Dry Creek) salt fields in South Australia. The nominal 4000 ha pond network at the Dry Creek salt works (first established in 1936) is well documented as an important habitat for shorebirds and waterbirds, including banded stilts and a number of species protected under state and federal legislation (Purnell et al. 2017). The extent to which the Lake Disappointment pond complex will evolve as a wetland habitat cannot be reliably predicted at this stage of project development. However, Reward considers that ongoing habitat use is a possible closure scenario that will have to be considered in the project's Mine Closure and Rehabilitation Plan. The conceptual Mine Closure Plan (Appendix K) has identified the ecological value of the pond complex as an information gap that will have to be remedied through planned observations and research throughout the life of the project.

Management action will be required to prevent the build-up of silver gull numbers at Lake Disappointment. If numbers do increase, approval will be sought from DBCA to cull the birds.

Gull-billed tern

The gull-billed tern is listed as an EPBC migratory species, with the Chinese Australian Migratory Bird Agreement cites as the reason (www.environment.gov.au/cgi-bin/sprat/public/publicshowmigratory.pl). However, the gull-billed tern does not appear to be included in this agreement.

[21] Reward has estimated that the reduction in the volume of water available for ponding may be up to 7% of usual inflow during major flow events.

Two subspecies of gull-billed tern occur in northern Australia. These are the resident *Gelochelidon nilotica macrotarsa* and the migratory *G. n. affinis* from northern Asia. All birds recorded at Lake Disappointment during baseline surveys would have been the Australian resident *G .n. macrotarsa* (Rogers et al. 2005). A total of 823 birds were recorded in 2017, with 214 nests and 93 chicks recorded on 10 small islands, in both the saline playa and associated claypans of varying salinity. This represents a significant concentration of breeding gull-billed terns although, by way of context, 6590 birds and an estimated 1750 nests were recorded at Mandora Marsh, north of Port Hedland, in the winter of 2000 (Halse et al. 2005) and 1537 birds were recorded in Lake Blanche in February 1991 (with 50 nests in December), after flooding of Cooper Creek (Kingsford et al. 1999). Gull-billed terns were also recorded breeding at Lakes Percival (three colonies of 6, 100, 35 nests), Mackay (one colony of 125 nests) and Dora (one colony of 50 nests) in February 2017 (Appendix E6).

Much of the feeding of the gull-billed tern, as well as a significant proportion of the nesting, probably occurs in and near the clay pans surrounding the main Lake Disappointment playa. While reductions in water depth during flood events within the project impact area may potentially reduce breeding effort in that part of the lake, breeding near the clay pans is unlikely to be affected. The inherent risk of adverse impacts on the gull-billed tern arising from project activities is difficult to quantify, but it is considered to be moderate at most. The avoidance and mitigation measures proposed by Reward to limit impacts on the banded stilt (Section 4.6.6 and FMP (Appendix L4)) should also reduce any impact of development on the gull-billed tern.

Sharp-tailed sandpiper

The sharp-tailed sandpiper is a common species in fresh and moderately saline wetlands in Australia. The estimated size of the Australasian flyway population has halved during the last 20 years. In comparison with the count of 10,000 sharp-tailed sandpiper in March 1988 (Halse et al. 1998), the maximum count of 364 birds at Lake Disappointment in 2017 is small, but it represents approximately 0.4% of the flyway population and, thus, Lake Disappointment may be classified as a nationally important site for this listed species under EPBC Policy 3.21.

About half the birds observed in 2017 were within the on-playa project development envelope; the remainder were at surrounding clay pans. In October 2013, 15 birds were seen in freshwater clay pans and in 2016, a single bird was seen at a clay pan. Nationally important levels of use of the Lake Disappointment playa by the sharp-tailed sandpiper are likely to be infrequent and project implementation is unlikely to significantly alter the habitat used by this shoreline-feeding bird. Consequently, project development is unlikely to have any impact on species abundance.

4.6.6 Management and mitigation measures

A number of key management strategies are proposed to limit adverse impacts on terrestrial fauna:

- Siting project infrastructure on existing cleared areas or areas devoid of vegetation, to the extent practicable;
- Adopting designs and operational practices (such as stacking of halite) to minimise the overall project disturbance footprint;
- Conducting pre-clearing inspections of proposed disturbance areas to check for the possible presence of nests, burrows and conservation-significant fauna;
- Implementing feral animal control programs to reduce predation and competition pressures that threaten native fauna.

Proposed management and mitigation strategies to limit impacts on particular species are summarised below. The Fauna Management Plan (Appendix L4) provides additional detail of proposed fauna management actions, including metrics by which the effectiveness of management actions will be assessed.

Night parrot

There is still much to learn about night parrots in and adjacent to the project area and in the surrounding region. It is not known whether the night parrots recorded near Lake Disappointment are permanently present in the area, although positive acoustic records have now been recorded in June, August and December 2017 and in March/April and August/September 2018. While positive recordings have only occurred in one habitat type, some aspects of the birds' habitat preferences are not clear: for example, the importance of free water in determining where they forage, nest and roost is not known. Addressing at least some of the remaining knowledge gaps is important if night parrots are to be adequately protected in the project area through the implementation of appropriate management actions. Reward has proposed a program of further night parrot surveys, which is described in the FMP (Appendix L$).

Prior to vegetation clearing, all mature spinifex and chenopod shrubland within the proposed clearing footprint will be surveyed to determine whether it is possible that night parrots are nesting under the vegetation. This will be done by deploying ARUs for a period of at least six nights within two weeks of the scheduled vegetation clearing program to determine if night parrots are in the area. All recordings will be examined by a person knowledgeable in the night parrot calls. If calls are recorded, then a thorough search of the area will be undertaken to determine whether nests are present. If nests are present, then all habitat within 300 m of the nest will not be disturbed until the chicks have fledged. Eastern ground parrot egg incubation is 21–24 days, and fledging takes another 23–25 days to leave the nest, but can range from 18–28 days (McFarland 1991), so it is likely to be similar for night parrots. The chair of the Night Parrot Recovery Team will be notified of the presence of night parrot nests, eggs or chicks.

Reward proposes to implement a fox and feral cat reduction program to reduce predation on night parrots, their eggs and chicks. A complementary large feral herbivore control and management program will be undertaken to reduce the impacts of habitat degradation.

Bilby, mulgara, great desert skink

All areas of spinifex scheduled for vegetation clearing will be searched for bilby, mulgara and great desert skink burrows by a zoologist immediately before vegetation clearing. Ideally, areas supporting bilbies will not be cleared until bilbies have left the area. However, if the area must be cleared, then the bilbies will be caught and relocated into a soft-release enclosure.

Project personnel will be advised of the possible presence of bilbies on roads at night and encouraged to adopt driving practices to allow avoidance of bilbies (without putting people's lives at risk). All observations of bilbies will be recorded.

Where practicable, areas supporting great desert skinks will be avoided and not cleared. If an area supporting the great desert skink must be cleared, then the skinks will be captured and relocated using a soft-release technique. The soft-release method in this case involves relocating the skinks to suitable habitat that is fenced to exclude predators and to stop the skinks escaping. When the skinks have dug an appropriate burrow system and the population has become stable, the fence is removed. The success of all relocations will be monitored and reported.

Mulgara can be caught and relocated to suitable habitat away from the disturbance area.

A feral cat and fox reduction program will be implemented throughout the project area.

Northern marsupial mole

A zoologist will be present during vegetation clearing to catch and relocate any marsupial moles disturbed during the clearing and earthworks.

Banded stilt and gull-billed tern

The key management control required for the protection of banded stilts is the implementation of engineering works described in Section 4.2.6 to minimise changes in playa surface hydrology. Reward proposes to establish a network of pipes and culverts to enable incoming flood waters to pass through the bunded drainage channel system. This will maintain the existing hydrological regime (and periods of inundation) around the banded stilt breeding islands, protecting the colonies against predation by terrestrial species, and more widely across the saline playa, providing an abundance of brine shrimp and ostracod food sources (Appendix H3). If required, alterations will be made to the preliminary design of trenches, pipes and culverts to ensure that appropriate hydroperiods, water depths and salinities are maintained through an adaptive management process. For example, it is already recognised that the eastern drainage channels may need to be shortened to ensure there is no compartmentalisation of flooding around islands (refer to Appendix H3).

No on-playa infrastructure will be sited within 200 m of any island on the Lake Disappointment playa. The 200 m exclusion zone has been established primarily to comply with terms agreed with Traditional Owners of the Lake Disappointment area under an ILUA. The exclusion zone will also serve to ensure no people or mechanical plant disturb areas used by banded stilts for breeding and nesting. The exclusion zone will also mean that project works will not modify playa surface levels close to the islands in a way that could alter ponding regimes or facilitate movement of predators.

Reward will conduct regular (at least two-yearly) reviews and updates of hydrological modelling, incorporating results of local meteorological monitoring and groundwater level data. If groundwater drawdown effects are greater than predicted, then Reward will implement an intermittent brine pumping strategy (cycling between different parts of trench network) to minimise effects on surface ponding in banded stilt creche areas.

On-playa operations will cease following major rainfall events (≥150 mm in under a week) to allow for bird nesting and breeding.[22]

Management controls will be implemented to prevent feral animal and silver gull access to food waste from the camp. Netting or other bird deterrents will be provided to limit silver gull access to fresh water sources in the project operations area.

4.6.7 Predicted outcomes

Terrestrial vertebrates

For each of the conservation significant species potentially impacted by the proposed project, a numerical rating has been provided of project related impacts, considered in the context of proposed project related minimisation and mitigation strategies. Full details of the numerical rating system are provided in Appendix E3. The assessment of impacts on terrestrial fauna takes account of the potential for harm minimisation and mitigation strategies to partially reduce the effect of a project impact or to alleviate the adverse effects of existing non-project threatening processes. For example, a feral and pest animal reduction program targeting foxes and feral cats can result in increased abundance of native fauna and, in particular, conservation significant fauna increasing

[22] The likelihood of exceeding 150 mm of rain in a one-week period in any given year is about 10%.

beyond predevelopment levels. This increase in a population as a direct result of management actions by Reward would be considered as a net positive impact. The proposed actions to combat existing threatening processes within the project development envelope have been treated as mitigation actions, rather than offsets, in keeping with current Western Australian offset policy (EPA, 2014). Actions to combat existing threatening processes in areas near to the Lake Disappointment project, but outside the development envelope, are presented as offset actions in Section 5.3 and Appendix L4.

Overall, the impact of project implementation is expected to result in a neutral or positive impact on terrestrial vertebrate fauna (Table 4–55).

Table 4–55: Predicted outcome of fauna management actions – terrestrial vertebrates

Species	Status	Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
Night parrot (*Pezoporus occidentalis*)	En/Cr	Vegetation clearing	-1	Preclearing surveys	+1	
		Vehicle strikes	-1			
				Fox and feral cat reduction program	+3	
	Risk: Moderate (likelihood = 3; consequence = D); **Residual risk: +ve outcome with mitigation**					**+2**
Bilby (*Macrotis lagotis*)	Vu	Vegetation clearing	0	Trapping and relocation plan prior to and during vegetation clearing	0	
		Vehicle collisions on the haul road	-1			
				Fox and feral cat reduction program	+2	
	Risk: Moderate (likelihood = 3; consequence = C); **Residual risk: +ve outcome with mitigation**					**+1**
Great desert skink (*Liopholis kintorei*)	Vu	Vegetation clearing	0	Trapping and relocation plan prior to and during vegetation clearing	0	
				Fox and feral cat reduction program	+1	
	Risk: Moderate (likelihood = 3; consequence = C); **Residual risk: +ve outcome with mitigation**					**+1**
Lake Disappointment ground gecko (*Diplodactylus fulleri*)	P1	Vegetation clearing	0			
				Fox and feral cat reduction program	+1	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: +ve outcome with mitigation**					**+1**

Species	Status	Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
Lake Disappointment dragon (*Ctenophorus nguyarna*)	P1	Vegetation clearing	0		0	
				Fox and feral cat reduction program	+1	
		Risk: Low (likelihood = 5; consequence = A); **Residual risk: +ve outcome with mitigation**				**+1**
Northern marsupial mole (*Notoryctes caurinus*)	P4	Vegetation clearing	0	Relocating individuals during the vegetation clearing program.	0	
		Grading tracks	-1			
				Fox and feral cat reduction program	+1	
		Residual risk: Moderate (likelihood = 5; consequence = B); **Residual risk: neutral outcome with mitigation**				**0**
Brush-tailed mulgara (*Dasycercus blythi*)/crest-tailed mulgara (*D. cristicauda*)	P4/Vu	Vegetation clearing	0	Searching for burrows, and trapping and relocating individuals before clearing	0	
				Fox and feral cat reduction program	+1	
		Risk: Low (likelihood = 5; consequence = A); **Residual risk: +ve outcome with mitigation**				**+1**
Generic fauna assemblage		Vegetation clearing	-1			
		Vehicle collisions	-1			
				Fox and feral cat reduction program	+2	
		Risk: Low (likelihood = 5; consequence = A); **Residual risk: neutral outcome with mitigation**				**0**

Migratory birds

There is limited capacity to assess impacts of project implementation on breeding of banded stilts in a quantitative way and the values below should be treated as indicative and precautionary. In the absence of any control measures, altered surface flow patterns at Lake Disappointment may have the potential to reduce breeding success of banded stilt through reduced flooding (and a shorter period of inundation) by more than 75%. However, this level of impact would probably be confined to years when flooding resulted only from a large summer rainfall event. When single large rainfall events occur during summer—even under natural (no development) conditions—the Lake Disappointment playa infrequently retains water long enough for successful fledging, so breeding success is very sensitive to flood volume and the way water is retained in the playa. However, in years of multiple inflow events or when major flooding occurs during cooler months, water is retained longer and breeding success is less sensitive to hydrological changes.

Reduced groundwater level associated with brine abstraction (independent of the effects of altered surface flow) may also contribute to changes in the extent or duration of ponding on the playa and may accordingly affect breeding success (Appendix H1). The reduction in breeding success will perhaps be 10–25% in years when there have been no smaller rainfall events prior to the one causing major flooding and subsequent breeding. If there has been prior rainfall before the major flood event, the lakebed is likely to be saturated and there will be no impact on breeding success. This assessment does not take account of the apparent increase in large rainfall events in the past two decades (Appendix H1), that have occurred possibly as a result of climate change.

Breeding of banded stilts could be adversely affected by increased silver gull predation (50–75%). Without mitigation and management, the impact on banded stilts could be high or even extreme, depending on the importance of Lake Disappointment breeding for maintenance of the species' population. Banded stilts should be regarded as having a national population rather than a series of regional ones; work by Pedler et al. (2017) has shown that there is a single Australia-wide population that moves between wetlands to breed and that this national population breeds at a number of arid zone wetlands.

When the proposed mitigation and management actions are taken into account, the residual impact of project implementation on the banded stilt is likely to be considerably less. Given that failure of banded stilt to breed in large numbers is a common event under natural conditions, the resultant reduction on in the population size of the species will usually be low. It would only be after many years of no successful breeding anywhere in Australia that failure of a breeding event at Lake Disappointment would be likely to have a substantial reduction (25–50%) in the regional or national population. Consequently, the calculated residual risk of impact of the project on banded stilt is considered moderate.

The potential changes in numbers of listed migratory sharp-tailed sandpiper at Lake Disappointment as a result of project development are considered to be inconsequential (<10%). The residual risk of project impacts on sharp-tailed sandpiper is considered low (Appendix E1).

The types of potential effects on breeding success of listed migratory gull-billed tern are similar to those for the banded stilt, but the percentage reduction in breeding would be considerably lower because not all gull-billed tern colonies at Lake Disappointment are on the playa and all breeding off-playa occurs outside the development envelope. The calculated residual risk of the project for gull-billed tern is low (Appendix E1).

4.7 Key factor 5: Subterranean fauna

4.7.1 EPA objectives

To protect subterranean fauna so that biological diversity and ecological integrity are maintained.

In the context of subterranean fauna, 'ecological integrity' means the composition, structure, function and processes of subterranean ecosystems, and the natural range of variation of these elements.

4.7.2 Policy and guidance

Table 4–56: Relevant policies, guidelines & standards – subterranean fauna

Environmental factor	Relevant policies, guidelines, and standards
Subterranean fauna	EPA, 2016d. *Environmental factor guideline – subterranean fauna* EPA, 2016m. *Technical guidance – subterranean fauna survey* EPA, 2016n. *Technical guidance – sampling methods for subterranean fauna survey*

4.7.3 Receiving environment

This section provides an overview of subterranean fauna values in the Lake Disappointment project area. The information presented in this section draws on baseline studies commissioned by Reward (Table 4–57). Copies of the baseline technical studies are appended to this ERD (Appendices F and I).

Table 4–57: Summary of investigations relevant to subterranean fauna impact assessment

Study reference	Description
Appendix F1: Bennelongia Environmental Consultants, 2018. Stygofauna Values at the Lake Disappointment Potash Project	Presents results of a field survey involving collection of 22 samples from nine wells in the proposed borefield and five wells in the surrounding region; the study confirmed the occurrence of stygofauna in the project area: 16 out of 22 samples and 12 out of 14 wells yielded stygofauna; includes preliminary assessment of potential impacts of water abstraction on subterranean fauna values
Appendix F2: Bennelongia Environmental Consultants, 2016. Lake Disappointment - Subterranean Fauna Desktop Assessment	Presents the results of a desktop review conducted to assess the likelihood of subterranean fauna occurring in the project area; database searches covered a search area of 100 km by 100 km around the project
Appendix F3: Harewood, G, 2016. Stygofauna Survey (Level 1) - Lake Disappointment Potash Project	Reconnaissance level field and desktop study conducted in October 2016; 6 process water bores, located within the 2 proposed borefield areas, and 2 regional water bores located about 16 km from the Northern Borefield were sampled; no invertebrate specimens of any type were found in samples collected from the 6 process bores; samples collected from the regional bores yielded specimens from 3 crustacean orders: Amphipoda, Cyclopoida and Ostracoda; some some of the

Study reference	Description
	amphipods specimens had affinities with stygofauna species known from other parts of the Pilbara
Appendix I2: SRK Consulting, 2018. Technical memorandum: Lake Disappointment Groundwater Review	Independent technical review of previous hydrogeological assessment of proposed Cory Borefield and Northern Borefield; includes comments on potential impacts on subterranean fauna habitats
Appendix I3: Strategic Water Management, 2017. Lake Disappointment - Hydrogeological Assessment of the Impact of Process Water Abstraction from the Cory Borefield, an H2 Level Assessment for 1.5 GL/year	Hydrogeological assessment of the Cory Borefield area; outlines the hydrogeological investigation program and presents the results from the analysis of test pumping and analytical modelling of the capacity to supply 1.5 GL/a from the Gunanya Sandstone fractured rock aquifer
Appendix I4: Strategic Water Management, 2018. Lake Disappointment - Hydrogeological Assessment of the Impact of Process Water Abstraction from the Northern Borefield, an H2 Level Assessment for 2 GL/year	Hydrogeological assessment of the Northern Borefield area; outlines the hydrogeological investigation program and presents the results from the analysis of test pumping, analytical and numerical modelling of the capacity to supply 2 GL/a from the Tertiary aquifer

Potential subterranean fauna habitats in the vicinity of the Lake Disappointment project include shallow, unconfined alluvial and colluvial sediments, unconfined fractured sandstone systems and confined fractured rock aquifers. The sediments beneath the Lake Disappointment playa are generally considered unsuitable to support subterranean fauna because:

- The depth to groundwater is too shallow to provide suitable habitat for troglofauna
- Groundwater salinity is above the range normally tolerated by stygofauna
- Playa sediments lack fissures and voids typically associated with stygofauna habitat.

The hydrogeological conditions in the vicinity of the proposed Cory and Northern Borefields were described in Sections 4.3.3 and 4.4.3. In summary:

- The Cory Borefield will target the Gunanya Sandstone fractured rock aquifer. Groundwater quality in the target aquifer is slightly alkaline and brackish, with a typical TDS of 2500 mg/L.
- The Northern Borefield will target a confined aquifer comprising a sequence of Tertiary age sands, clays and sandy clays overlying the Proterozoic rock basement. Groundwater will be drawn from a nominal depth of approximately 75 m to 100 m below the ground surface. Groundwater quality in the target aquifer is slightly alkaline and brackish to saline with a TDS range from 2200 mg/L to 17000 mg/L.
- Regional calcretes will not be targeted for groundwater abstraction and are unlikely to be affected by project implementation. No occurrence of calcrete has been intersected by Reward in the course of its exploration drilling or baseline hydrogeological assessments.

A summary of subterranean fauna sampling conducted to date in the project area is provided in Table 4–58. The locations sampled during the baseline subterranean fauna investigations are shown in Stygofauna were recovered from 16 out of 30 samples and 13 out of 15 sites. Major groups recorded were oligochaetes, amphipods, syncarids, cyclopoid and harpacticoid copepods and ostracods. One troglofaunal species, the dipluran *Projapygidae* sp. B20, was recorded as a singleton at LDRC1601 in Round 3. This specimen is not considered likely to indicate the presence of a significant troglofauna assemblage.

Average stygofauna abundances per sample were 16.43 ± 8.74 in regional bores and 19.14 ± 10.37 in the proposed Cory Borefield, compared with just 3.19 ± 1.94 in the proposed Northern Borefield. It is unlikely that sampling methods (pump vs net) significantly affected yields.

Sites with the highest number of recorded species were LDRC1602 (Cory Borefield) and Georgia Bore (regional), which each had four species. Average species richness per site was two at both regional sites and within the Cory Borefield and one in the Northern Borefield.

Additional information on where particular species were found is provided in Figure 4-72.

In total, 44 samples have been recovered from 15 locations: ten bores in the proposed borefields and five regional (reference) bores were sampled (Figure 4-71); some bores were sampled on more than one occasion. A total of 432 specimens belonging to at least 15 species of stygofauna were recorded in the four sampling events, with 198 specimens from nine species recorded in Rounds 1 and 2, 102 specimens from eight species recorded in Round 3 and 132 specimens from 12 species recorded in Round 4 (Table 4–58).

Table 4–58: Subterranean fauna sampling effort

Sampling round	Proposed borefields		Regional bores		
	Net	Pump	Net	Pump	Total
Round 1 – Northern Borefield (October 2016)	4	0	0	2	8
Round 1 – Cory Borefield (October 2016)	2	0			
Round 2 – Northern Borefield (March 2017)	6	0	0	0	8
Round 2 – Cory Borefield (March 2017)	2	0			
Round 3 – Northern Borefield (June 2017)	6	0	2	3	14
Round 3– Cory Borefield (June 2017)	2	1			
Round 4 – Northern Borefield (October 2017) (1)	6	0	1	4	14
Round 4 – Cory Borefield (October 2017) (1)	2	1			
Total	30	2	3	9	44

Note 1: Results from Round 4 sampling were received after completion of the subterranean fauna impact assessment report and are not included in that report (Appendix F1). A spreadsheet with the results of the October 2017 sampling event is provided in Appendix F3.

Stygofauna were recovered from 16 out of 30 samples and 13 out of 15 sites. Major groups recorded were oligochaetes, amphipods, syncarids, cyclopoid and harpacticoid copepods and ostracods. One troglofaunal species, the dipluran *Projapygidae* sp. B20, was recorded as a singleton at LDRC1601 in Round 3. This specimen is not considered likely to indicate the presence of a significant troglofauna assemblage.

Average stygofauna abundances per sample were 16.43 ± 8.74 in regional bores and 19.14 ± 10.37 in the proposed Cory Borefield, compared with just 3.19 ± 1.94 in the proposed Northern Borefield. It is unlikely that sampling methods (pump vs net) significantly affected yields.

Sites with the highest number of recorded species were LDRC1602 (Cory Borefield) and Georgia Bore (regional), which each had four species. Average species richness per site was two at both regional sites and within the Cory Borefield and one in the Northern Borefield.

Figure 4-71: Subterranean fauna sampling locations (October 2016 – June 2017)

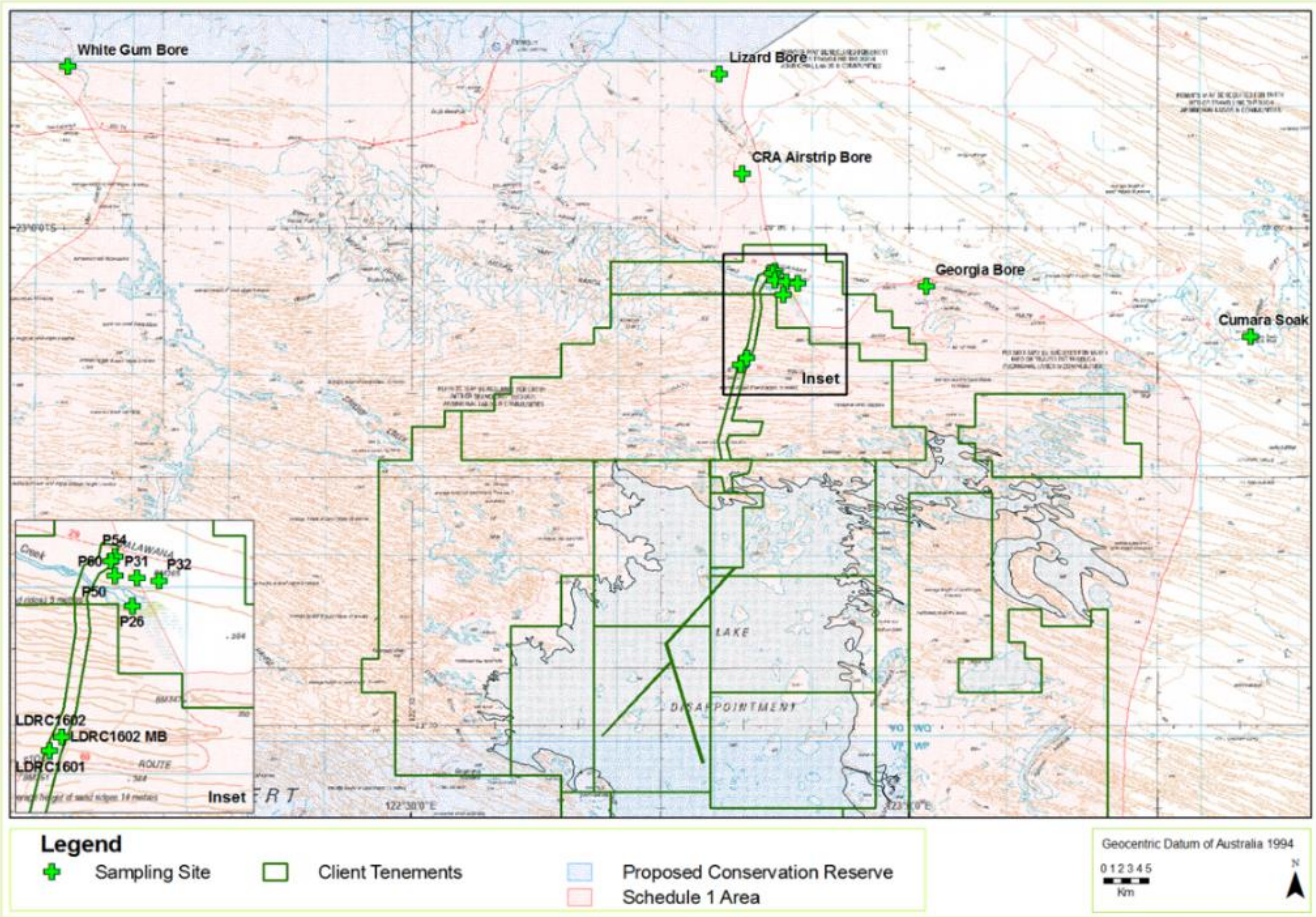
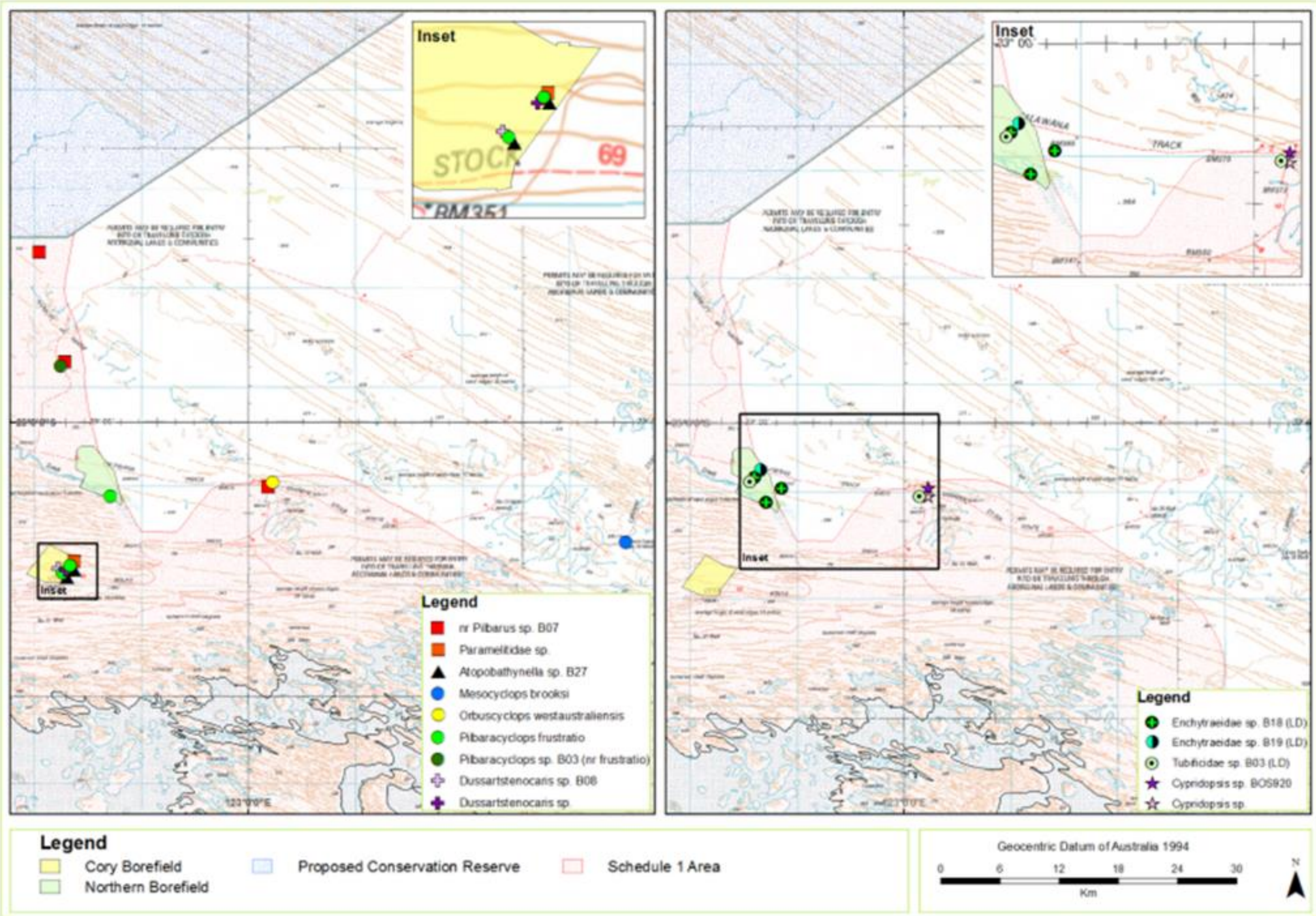


Figure 4-72: Locations of stygofauna collected in 2016 and 2017



It appears that the Cory Borefield hosts a richer and more abundant stygofauna community than the Northern Borefield. It is likely that the assemblages in each borefield are distinct from one another, with only one species, *Pilbaracyclops frustratio*, which is widespread outside the survey area, recorded in both borefields. The presence of distinct assemblages is consistent with the low level of hydraulic connectivity between the proposed borefields as inferred from test pumping.

Overall, the documented stygofauna community at Lake Disappointment is modest compared with many areas of the Pilbara and Yilgarn. Baseline characterisation of subterranean fauna in the general project area has concluded that the stygofauna community at Lake Disappointment does not appear to be notably speciose (Appendix F1). Results from the two proposed borefields suggest that the Cory Borefield (and possibly the wider Gunanya Sandstone) contains a modest stygofauna community, while the Northern Borefield is less prospective. Sampling at the limited number of regional sites that were available also produced low to moderate yields.

Potential stygofauna habitat in the Northern Borefield consists of the upper aquifer in surficial alluvial and colluvial deposits, which likely extends beyond the proposed borefield in association with McKay Creek. The collection locations of this species suggest habitat continuity between the Northern Borefield and wider regional areas. The relatively large linear range of *Tubificidae* sp. B03 (LD) and inferred habitat connectivity further suggest that both enchytraeid species are also likely to be widespread.

While a considerable proportion of stygofauna species in the Lake Disappointment area are known to be widespread and have been recorded elsewhere in the Pilbara, neighbouring regions or across the continent, some specimens collected during baseline studies appear to belong to new species that have not been recorded elsewhere. Of these species, three are crustaceans and belong to groups with adequate taxonomic frameworks for the recognition of species. The other three species are oligochaetes that belong to groups with relatively poorly developed frameworks for recognising species in a consistent way. Based on available hydrogeological information, it is considered likely that all six new species have at least locally extensive ranges around Lake Disappointment.

4.7.4 Potential impacts

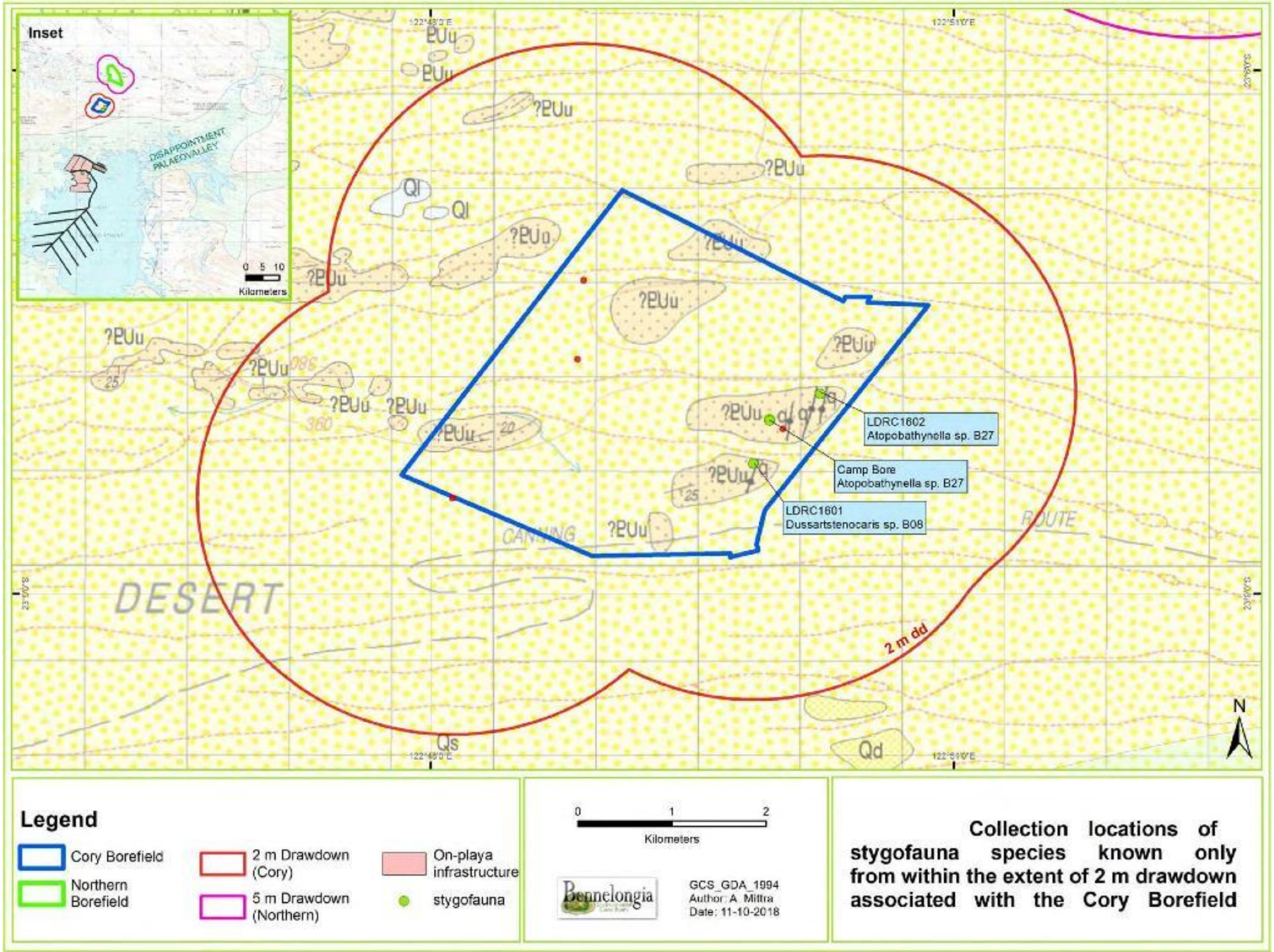
The main threat to subterranean fauna from project implementation is the potential loss of subterranean fauna habitat as a result of groundwater abstraction from the proposed process water borefields. Unlike many resource projects, the activities proposed by Reward do not include removal of habitat through the creation of open pits or underground voids extending below the water table.

4.7.5 Impact assessment

Species that are restricted to area(s) of groundwater drawdown face potential extinction.
Four species are known only from locations inside the proposed borefields and/or inside the areas of drawdown predicted by hydrogeological modelling (Appendices I3 and I4):

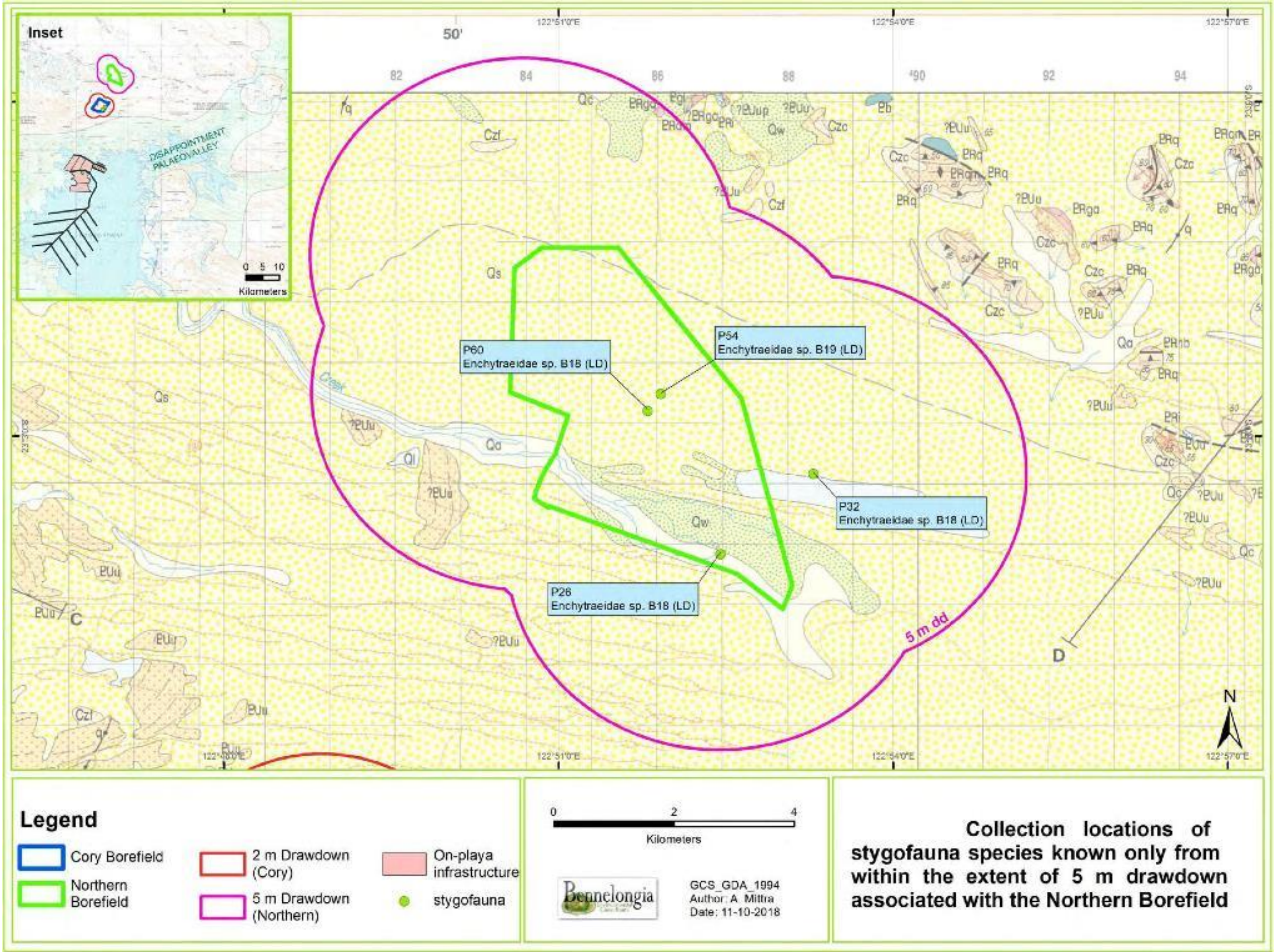
- *Atopobathynella* sp. B27 and *Dussartstenocaris* sp. B08 in the Cory Borefield (Figure 4-73); and
- *Enchytraeidae* sp. B18 (LD) and *Enchytraeidae* sp. B19 in the Northern Borefield (Figure 4-74).

Figure 4-73: Stygofauna occurrence in context of proposed Cory Borefield



Note: Descriptions of the geological units shown in this figure are provided in Figure 2-24.

Figure 4-74: Stygofauna in context of proposed Northern Borefield



Note: The 5m drawdown contour shown in Figure 4-74 is the drawdown estimated for the confined aquifer, not the unconfined alluvial aquifer. Descriptions of the geological units shown in this figure are provided in Figure 2-24.

The actual distributions of both *Atopobathynella* sp. B27 and *Dussartstenocaris* sp. B08 are considered to be greater than shown by field survey because of:

- The likely connectivity of available stygofauna habitat throughout the Gunanya Sandstone, and
- The locally extensive ranges of other stygofauna species recorded during survey.

Sampling effort was relatively low owing to the limited availability of bores throughout the study area. Increased sampling over a larger area could result in range extensions for these species beyond the influence of predicted drawdown.

The two enchytraeid species known only from in and around the Northern Borefield (*Enchytraeidae* sp. B18 (LD) and *Enchytraeidae* sp. B19) are probably more widespread than shown by collections to date. The connectivity of suitable habitat outside the Northern Borefield has been demonstrated by both hydrogeology and the ranges of other species. Further sampling would be likely to increase known ranges for these species, although the occurrence of another oligochaete, *Tubificidae* sp. B03 (LD), both inside the Northern Borefield (including the same collection location as *Enchytraeidae* sp. B18 (LD)) and 15 km to the east at Georgia Bore, is considered to be an adequate indication of larger ranges for both enchytraeid species. Regardless of species ranges, information in the borefield assessment suggests that minimal drawdown of primary stygofauna habitat will occur in the upper aquifer associated with McKay Creek and therefore the level of impact of groundwater abstraction on stygofauna is likely to be low.

No overlapping or additive effects of drawdown are expected to result from interaction of groundwater abstraction from the two proposed borefields. No cumulative effects on subterranean fauna populations from groundwater use by other users is likely, as there are no other significant water users in the district.

4.7.6 Management and mitigation measures

Baseline hydrogeological and subterranean fauna studies provide a basis for Reward's proposed management of potential impacts on subterranean fauna habitats. The management and mitigation measures that will be implemented to prevent or minimise adverse impacts on stygofauna include:

- Screening of production bores in the Northern Borefield only in the deeper confined aquifer, to avoid producing groundwater drawdown in the more prospective shallow groundwater aquifer associated with McKay Creek.
- Establishment of distributed production bore networks with some redundancy so that selected bores can be temporarily shut off if unacceptable drawdown effects become apparent during borefield operation.
- Operation and monitoring of both the Cory and the Northern Borefields in accordance with groundwater operating strategies approved by the DWER. The operating strategies will include specific trigger values to support an adaptive management framework aimed at minimising impacts on subterranean fauna habitat. Provisional trigger values have been nominated in this ERD (refer Section 4.3.6).
- Updating/recalibration of the groundwater models at least three-yearly, based on input of actual monitoring and abstraction data. This will allow comparison of predicted and actual groundwater drawdowns and will enable the stygofauna impact assessment to be updated.

4.7.7 Predicted outcomes

The documented stygofauna community at Lake Disappointment is modest compared with many areas of the Pilbara and Yilgarn. While four species are so far known only from inside the proposed borefields and/or zones of predicted drawdown, it is likely that they also have more extensive ranges because of likely habitat connectivity. The locally extensive ranges of *Tubificidae* sp. B03 (LD) and nr *Pilbarus* sp. B07 support the notion that other species are also likely to be widespread.

Implementation of the Lake Disappointment project is unlikely to compromise the EPA's objective of subterranean fauna diversity and the structure, function and processes of subterranean ecosystems in the Lake Disappointment area. The means by which subterranean fauna and habitat objectives will be achieved and the evidence by which outcomes will be demonstrated are summarised in Table 4–59.

Table 4–59: Summary of impact assessment – subterranean fauna

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
Abstraction of brine from trenches	None	None required: no stygal community present	Not required: subsurface environment not suitable for subterranean fauna (low porosity, extremely high salinity)
Abstraction of groundwater from Cory Borefield	Reduction in volume of saturated habitat available to stygofauna as a result of groundwater drawdown	Water abstraction network to be designed and operated to limit groundwater drawdown in locations where stygofauna species of restricted distribution have been identified Installation and continuous logging of water levels in a monitoring bore network approved under the borefield operating strategy Implementation of adaptive management approaches to limit groundwater drawdown Three-yearly review and update of hydrogeological models and stygofauna impact assessment	Routine monitoring and annual reporting on groundwater levels, water abstraction and water quality Exception reporting in case of trigger exceedance (1.5 m drawdown at 2 km radius from borefield centroid) Three-yearly review and recalibration of groundwater model Results of follow-up subfauna monitoring when additional bores (groundwater monitoring network) are available
Abstraction of groundwater from Northern Borefield	Reduction in volume of saturated habitat available to stygofauna as a result of groundwater drawdown	Production bores will be screened only in the confined aquifer; monitoring bores will be provided in both the confined and superficial aquifers Water abstraction network to be designed and operated to limit groundwater drawdown in locations where stygofauna species of restricted distribution have been identified Installation and continuous logging of water levels in a monitoring bore network approved under the borefield operating strategy	Routine monitoring and annual reporting on groundwater levels, water abstraction and water quality Exception reporting in case of trigger exceedance (0.5 m drawdown relative to average end of dry season levels in superficial aquifer) Three-yearly review and recalibration of groundwater model Results of follow-up subfauna monitoring when additional bores (groundwater monitoring network) are available

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
		Implementation of adaptive management approaches to limit groundwater drawdown. Three-yearly review and update of hydrogeological models and stygofauna impact assessment	

4.8 Key factor 6: Social surroundings - heritage values

4.8.1 EPA objectives

To protect social surroundings from significant harm.

In the context of the Lake Disappointment project, the most important 'social surroundings' consideration relates to Aboriginal heritage and cultural associations. Potential impacts on local amenity—for example visual amenity impacts that could be experienced by travellers on the Canning Stock Route—are addressed in Section 5.

4.8.2 Policy and guidance

Table 4–60: Relevant policies, guidelines & standards – social surroundings (heritage values)

Environmental factor	Relevant policies, guidelines, and standards
Social surroundings	EPA, 2016b. *Environmental factor guideline – social surroundings* EPA, 2004. *Guidance statement No. 41 – assessment of Aboriginal heritage* DAA, 2013. *Guidelines for preparing Aboriginal heritage survey reports* DAA & DPC, 2013*. Aboriginal Heritage Due Diligence Guidelines*

4.8.3 Receiving environment

Aboriginal culture and heritage

Lake Disappointment lies in the north-western part of the Western Desert lands traditionally occupied by the Martu people. Aboriginal occupation of the area pre-dates the last glacial maximum (18,000 to 24,000 years before present) and may date back more than 30,000 years (McDonald and Veth 2012). The intensity and character of traditional cultural activity in the Western Desert, including in the region near Lake Disappointment, appears to have varied over time, in part reflecting availability of resources, especially (but not only) reliable supplies of fresh water (Veth et al., 2001).

Published archaeological research of rock shelters in the small rocky uplands to the south and south-east of Lake Disappointment (Durba Springs, Calvert Ranges) have encountered a range of rock art (paintings and engravings), stone artefacts, ochre and faunal remains, suggesting that the uplands areas have been used for periodic gatherings or possibly as refuge areas. The use of the small ranges to the south of Lake Disappointment, which are characterised by springs or other water sources, appears to have increased from about 1500 years before present (McDonald and Veth, 2012).

In contrast to the uplands sites at Durba Springs and the Calvert Ranges, the intervening sandy country (including the project area) offers less in the way of water and stone resources, although parts of the landscape (not including the lake itself) would have been (and still are) a source of seeds, wood and other plant resources.

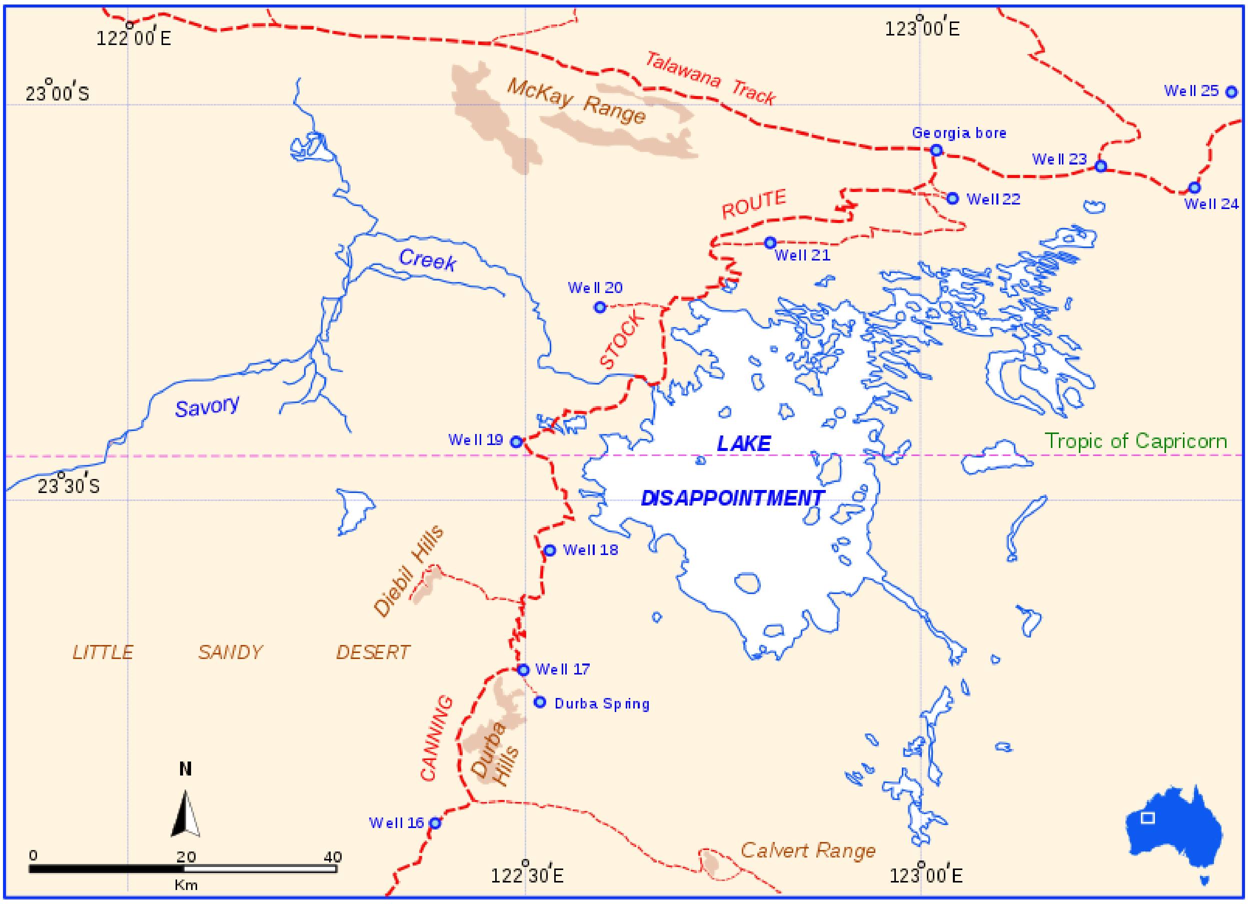
In addition to supporting customary uses such as foraging and hunting, parts of the Lake Disappointment area have significant spiritual/religious values for the Traditional Owners (Wright

2006)[23]. Lake Disappointment itself and parts of the surrounding area are registered with the Department of Planning, Lands and Heritage (DPLH) as a 'ceremonial/mythological' site (ID #12103). The site is classified as a 'closed site', meaning that more specific information about the site and its heritage values is only available to, or with the express permission of, the original providers of the information or their descendants.

Other social and heritage values

Lake Disappointment lies to the south and east of the Canning Stock Route, an historic pastoral route established in 1908 to support the movement of cattle from Halls Creek in the Kimberley to Wiluna in the northern goldfields, to supply meat for the booming resources sector in the early 20th century. The 8 km wide surveyed corridor traverses the Great Sandy, Little Sandy and Gibson Deserts, passing through the traditional lands of Birriliburu, Martu and Walmajarri peoples (McDonald et al. 2014). Approximately 50 wells, many of which correspond to water sources used by the traditional owners, occur along the route. At its nearest point, the Canning Stock Route passes within approximately 4 km of Reward's proposed on-playa facilities (Figure 4-75).

Figure 4-75: Canning Stock Route in the Lake Disappointment area



Source: https://upload.wikimedia.org/wikipedia/commons/b/be/Lake_Disappointment_0417.svg

[23] Ethnographic and archaeological survey reports prepared in connection with the Lake Disappointment project are not appended to the ERD at the request of Traditional Owners. Information contained in the reports is confidential.

Although some droving occurred along the route in the early part of the 20th century (Figure 4-76), the track is no longer used for this purpose; the last cattle drive along the Canning Stock Route is reported to have occurred in 1959 (Grimwade, 1998). The Canning Stock Route (Place No. 05518) is included in the municipal inventory of the Shire of Wiluna and was classified by the National Trust in July 2000.

Figure 4-76: A view of Lake Disappointment recorded by Eileen Lanagan (1940)

State Library of Western Australia

The route has become a popular four wheel drive track. Notwithstanding that permits are required to travel along the route, there are no readily available statistics on the number of tourists who use the Canning Stock Route each year. In the late 1990s, an estimated 1000 people travelled the route each year, with most traffic occurring in the winter months (Grimwade, 1998). Information provided to Reward recently by a Parnngurr community member (email to D Tenardi, 13 July 2018) suggests that that numbers of recreational travellers may now be somewhat greater than in the 1990s (possibly in the order of 1100 vehicles per year). The route is also used regularly by small numbers of local residents and service providers. Together, travel by the local community and those providing goods and services to the local community may account for around 800 vehicle movements per year (over and above tourism-related traffic).

4.8.4 Potential impacts

The implementation of the Lake Disappointment project has the potential to impact culturally important values and recreational uses of the Canning Stock Route by:

- Allowing access to areas which, under customary Law, have restricted access;
- Causing ground disturbance to known or unknown Aboriginal heritage sites;
- Limiting access to land required by Traditional Owners for customary purposes;
- Visual impacts discernible to tourists and other travellers along the Canning Stock Route; and
- Introducing potential for conflict between mine traffic and tourists or other users of the Canning Stock Route (e.g. by Aboriginal rangers who manage and maintain the route).

The potential for impacts of the Lake Disappointment project on water wells along the Canning Stock Route was addressed in Section 4.3.6.

4.8.5 Impact assessment

Aboriginal heritage values

Between 2006 and 2013, four heritage surveys (archaeological and/or ethnographic assessments) of the project area were carried out, with the participation of Traditional Owner representatives (AHMS 2013, Anthropos Australis 2008, de Gand 2012, Wright 2006). Aerial surveys were conducted of the Lake Disappointment playa because the surface is generally not trafficable by vehicles or on foot. The survey confirmed that there is very low potential for archaeological material to be present on the playa surface, because it is bare of vegetation and has no stone resources (AHMS, 2013).

The most recent heritage assessment of the project area (AHMS, 2013) identified seven registered heritage sites, one site for which insufficient information is available to allow assessment and two sites for which information was lodged with the DAA (Figure 4-77). All of the registered sites have 'restricted access', meaning that exact coordinates of the heritage feature and specific details of the heritage values are not available without permission from the informants. For this reason, it is not known whether the reported sites actually lie within the proposed disturbance footprint of the Lake Disappointment Potash Project. Sites requiring clearance will be disclosed in conjunction with further heritage survey requests.

The Lake Disappointment playa is a mythological and ceremonial site (Site ID 12103). Some Martu people will not set foot on the salt lake surface because it is deemed to be 'dangerous'. The lake is home to cannibal beings (Ngayurnangalku) who live under the surface of the lake (National Museum of Australia 2008). Martu consultants involved in surveys of the project area advised that all islands within the Lake Disappointment registered heritage site should never be disturbed (de Gand 2012, Anthropos Australis 2008).

The dune fields and sandy plains surrounding the lake were considered to have low potential for significant archaeological material, due to the general absence of surface stone and rocks. A number of artefact scatters were identified in proximity to ephemeral drainage lines associated with McKay Creek. These consisted of flakes, grindstones and grindstone fragments and mullers (stone tools used for grinding plant matter or ochre). Martu consultants who participated in surveys of the project area advised that their ancestors camped along the creek and that the surrounding area was used for hunting. Although the McKay Creek is associated with the 'Two Men Dreaming Track', the Martu advised that there are no culturally sensitive stories or places associated with the creek itself (Anthropos Australis 2008).

Figure 4-77: Locations of registered Aboriginal heritage sites in or near the project area

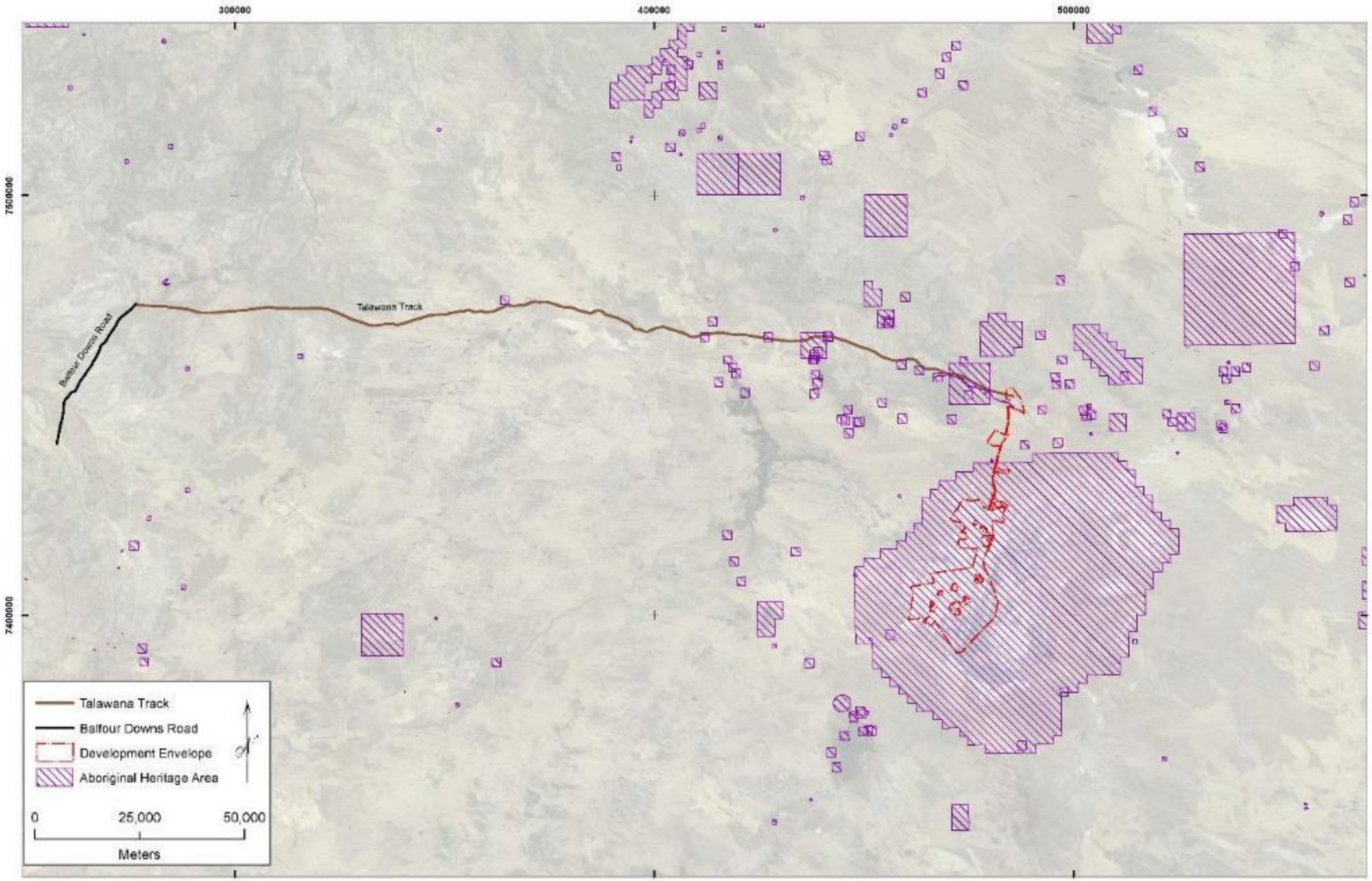


Table 4–61: Summary of registered Aboriginal heritage sites in or near the project area

Site ID	Site name	Status	Access	Site type	Additional
11580	Ngurawadi Gudjara-Gu	R	Restricted	Mythological	
11583	Bungali West	R	Restricted	Mythological	
11584	Bungali	R	Restricted	Mythological	
11787	Bilbadjarra Creek	R	Restricted	Mythological	
11531	Bungali Ngulu	R	Restricted	Mythological	
9734	Mudilya complex	Lodged, but not registered		Mythological	
7099	McKay Range	Not registered – insufficient information		--	Camp, rock shelter
7100	Winakarugina Cave	R	Restricted	Artefacts/scatter	Archaeological deposit, plant resource, camp, water source
26858	McKay Creek	Lodged, but not registered		Mythological	Camp, hunting place, natural feature
12103	Gumbubindil/Lake Disappointment	R	Restricted	Ceremonial, mythological	

Visual impacts

The proposed on-playa ponds and salt stockpiles are located on the north-western section of the Lake Disappointment playa. At maximum extent, the on-playa infrastructure will occupy an area of approximately 7190 ha or slightly less than 5% of the playa surface area. At its nearest point, the Canning Stock Route passes within approximately 4 km of the proposed on-playa facilities (Figure 4-78).

Figure 4-78: View east along Savory Creek 4 km from Lake Disappointment (latitude -23.34; longitude 122.64)

The visual impact of the height of the salt stockpiles was assessed for two heights using a basic viewshed analysis (Figure 4-79). The first height modelled was 8 m (shown in red on figure) and the second height was 13.4 m (shown in blue).

The modelling shows that while the halite stockpile is visible from the playa surface, away from the playa the surrounding ground surface limits the visibility of the halite. Only on high ridge areas can the halite stockpile be seen from areas off the lake. When constructed to full height, the halite stockpiles will be visible to travellers on the Canning Stock Route over two sections of road, each approximately 5 km in length. On this basis, a maximum salt stockpile height of 13.4 m (after 20 years of operations) was considered acceptable.

Figure 4-80 shows a view of how the salt stacks will look closer to the playa. Figure 4-81 shows the appearance of a brine trench and pond assemblage at an existing Western Australian solar salt operation.

Figure 4-79: Viewshed analysis – halite stockpiles (Knight Piésold 2016)

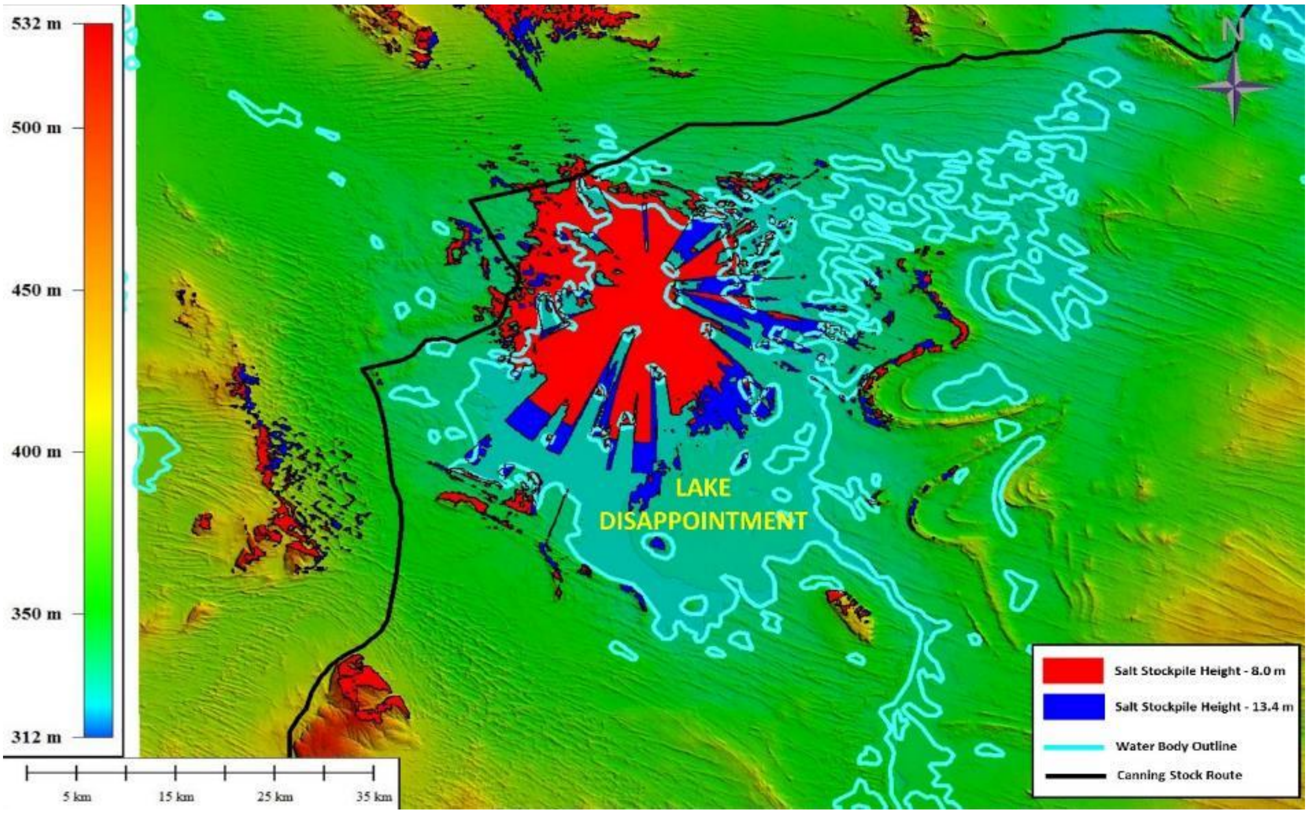


Figure 4-80: Typical halite stockpile (photo from Moreton salt works, Inagua, Bahamas)

Figure 4-81: Brine trench and ponds at operating salt works (Shark Bay Salt, WA)

Traffic impacts – Canning Stock Route

The proposed Lake Disappointment project will not make use of the Canning Stock Route and it will not be necessary for travellers on the Canning Stock Route to interact with mining vehicles. The mine access road along the upgraded Willjabu Track will intersect the Canning Stock Route at two locations. The northern intersection will occur at approximately 23° 8'45.28'S, 122°49'47.67'E and the southern intersection at approximately 23°10'31.22'S, 122°49'18.06'E. Both intersections pass to the north of the mining operations areas, so there will be less likelihood of general mine traffic traversing the intersections (e.g. at shift change during working days). The nearest proposed mine infrastructure to the Canning Stock Route intersections is the proposed airstrip (approximately 2.8 km south of the southern intersection) and Cory Borefield (which will have very limited surface disturbance), approximately 6 km to the north of the proposed airstrip and just to the north of the northern intersection.

The intersections will be upgraded to improve lines of site and trafficability. Signage will be provided, with Canning Stock Route traffic having the right-of-way. Overall, the implementation of the Lake Disappointment project will have very limited impact on travellers along the Canning Stock Route. In emergency situations, there may be an opportunity for use of Reward's airstrip (or other facilities) to assist in medical evacuations.

4.8.6 Management and mitigation measures

Reward recognises the central importance of Traditional Owners in the ongoing use and management of land in Lake Disappointment area and entered into an ILUA with the Martu Traditional Owners in December 2012 (Lake Disappointment Project Mining and Indigenous Land Use, WI2012/009). Copies of publicly available elements of the ILUA are provided in Appendix J1.

The approaches adopted by Reward to avoid and minimise impact on Aboriginal heritage and culture values are:

- Avoid, to the extent practicable, culturally significant areas identified in consultation with Traditional Owners;
- Formally recognise agreed exclusion areas through land use agreements;
- Seek advice on heritage matters from Traditional Owners on an ongoing basis through the implementation of cultural heritage management plans;
- Conduct targeted surveys of proposed disturbance areas before finalising infrastructure design;

- Actively encourage Traditional Owner participation and input throughout the operating life of the project and in the post-closure period; and
- Where project activities cannot avoid heritage sites, seek formal consents to access/disturb the site under Section 18 of the *Aboriginal Heritage Act 1972*.

In order to give practical effect to the intentions of the ILUA (which is a document that is not generally available to all), Reward will establish an operations Aboriginal heritage management framework, developed in consultation with the Traditional Owners. The operations heritage management framework will provide necessary information about operation and monitoring requirements/procedures for:

- Operating near heritage sites;
- Discovery and management of 'chance finds';
- Incident reporting; and
- A governance system for assessing and periodically reporting on compliance with ILUA requirements.

Additionally, the operations heritage management framework will support delivery of the ILUA by identifying:

- Opportunities for collaboration with the Traditional Owners in the environmental management of land within and surrounding the project area (including, but not limited to, 'caring of country initiatives' such as fire management, weed control and feral animal management); and
- Opportunities for training and capacity building for Aboriginal people in the project area.

Management requirements for specific heritage places and sites will be addressed in a Cultural Heritage Management Plan (CHMP). The plan will be prepared in close consultation with the Traditional Owners and will include:

- Protocols for Traditional Owners to access and care for sacred sites;
- Descriptions of management requirements for specific sites and places with important Aboriginal heritage values (e.g. control of access);
- Identification of environmental management measures linked to Aboriginal cultural values (e.g. avoiding disturbance to claypans or soaks, maintaining hydrologic flow regimes along drainage lines); and
- Development of cultural awareness and understanding of Aboriginal heritage legal compliance requirements for all project participants.

Potential impacts on users of the Canning Stock Route will be managed as follows:

- Mine vehicles will not use the Canning Stock Route for movement about the mine tenements, for ore haulage, for transport of materials and equipment or other operational purposes. A separate network of mine access and haulage routes will be established and maintained. The exception to this is the occasional use by mine environmental staff and contractors who may need to access the Canning Stock Route for monitoring, survey or other compliance purposes.
- Appropriate speed limits will be established and maintained on mine access and haul roads and at intersections with the Canning Stock Route.
- Where mine roads cross the Canning Stock Route, signage will be provided at intersections to control traffic flow. Mine traffic will give way to Canning Stock Route traffic.

- Site inductions will include specific information about the road rules relating to use (or non-use) of the Canning Stock Route and the need to give way to Canning Stock Route traffic at intersections.
- Reward will consult with the Traditional Owners (e.g. the Kuju Wangka management group) about project interactions with the Canning Stock Route.
- Signage will be provided to ensure that tourists and other users of the Canning Stock Route do not accidentally access mine roads.

4.8.7 Predicted outcomes

It is evident that Lake Disappointment and the surrounding area have strong and long-established cultural heritage values. The most appropriate way to avoid and mitigate impacts on significant heritage and cultural features is through direct engagement with the Traditional Owners at a local scale and the establishment of binding agreements with the Traditional Owners and their representative bodies. Reward has taken an important first step in this process by entering into the Lake Disappointment ILUA in 2012. Further development of management frameworks to give practical effect to the ILUA intention will be delivered through the implementation of an operations heritage management framework and CHMP. With careful management, the Lake Disappointment project can be implemented in a way that is consistent with the EPA objectives and beneficial to the interests of the Traditional Owners. Little, if any, impact is expected in relation to users of the Canning Stock Route. Some improvement in public safety may result through the availability of mine infrastructure (airstrip, telecommunications, medical/mines rescue facilities) in the event of a serious road emergency incident.

The means by which the EPA objectives for Aboriginal and other heritage aspects of the factor 'social surroundings' will be achieved and the evidence by which outcomes will be demonstrated are summarised in Table 4–62.

Table 4–62: Summary of impact assessment – Aboriginal heritage

Aspect	Potential impact	Mitigation/management	Evidence that EPA objectives are met
Ground disturbance for establishment of project infrastructure	Disturbance to known or unknown heritage sites	Comply with ILUA Pre-disturbance surveys of all proposed disturbance areas, in consultation with Aboriginal advisors Identify and comply with heritage exclusion zones, in consultation with Traditional Owners Implementation of heritage management framework and CHMP Participation by Aboriginal monitors during any ground disturbing works Compliance with S18 consents	Results of pre-disturbance surveys Periodic ILUA compliance reports Induction and cultural awareness training records Incident reports
Movement of people within mining tenements for operational purposes (including non-destructive activities, such as environmental monitoring)	Unauthorised access to culturally sensitive locations		
Establishment and use of project infrastructure	Constraints on access to or use of land for customary purposes		
Mine-related traffic	Conflict with other road users, including Aboriginal rangers and other travelers along the Canning Stock Route	Active engagement with Kuju Wangka management committee Install signage at intersections with Canning Stock Route Induct all project participants in road rules governing interactions with public track Maintain emergency response capability	Records of engagement with Kuju Wangka Signage in place and maintained Induction records Incident reports
Storage of halite in stockpiles	Impact on visual amenity	Stockpile height will be limited to no more than 13.4 m	Views as assessed from nearest point to mine along Canning Stock Route, photographic records

5 OTHER ENVIRONMENTAL FACTORS OR MATTERS

5.1 Conservation reserves and protected areas

5.1.1 Environmental context

A 4.4 km portion of the Talawana Track intersects the most southern boundary of the Karlamilyi National Park (i.e. 4.4 km of the development envelope is located within the National Park). However, no clearing is required within the National Park, the existing Talawana Track will be used by project vehicles.

Approximately 7019 ha of the development envelope and 67.2 ha of the disturbance footprint is located within the proposed Lake Disappointment Nature Reserve (listed under the EPA Red Book recommendations for Conservation Reserves 1975–1993) which covers an area of 366,700 ha (Figure 5-1). All of the proposed disturbance footprint which intersects the proposed reserve is on unvegetated parts of the playa surface and represents parts of the proposed brine trench network. The Lake Disappointment Nature Reserve was first listed in the EPA Red Book as an area of proposed conservation and proposed in the DPaW Goldfields, Regional Management Plan 1994–2004. However, the recommendation was for the proposal to be deferred and addressed in the Pilbara Regional Management Plan. To date this proposed reserve has not been gazetted. Reward has been unable to discover the specific conservation reasons for which the Lake Disappointment reserve was proposed.

Approximately 36,100 ha of the project development envelope and 7229 ha of the disturbance footprint is located in an Environmentally Sensitive Area (ESA). Section 51B of the EP Act allows the Minister to provide a higher level of protection to specified areas or to certain categories of land by declaring them to be ESAs. The land in and around the Lake Disappointment playa attracts an ESA classification because it is a 'defined wetland' (a nationally important wetland as defined in *A Directory of Important Wetlands in Australia* (Environment Australia 2001)).

5.1.2 Policy setting

A critical environmental attribute of Lake Disappointment and its surrounds is its ecological and cultural function as a wetland. EPA's current assessment framework, as articulated in its *Statement of Environmental Principles, Factors and Objectives* (EPA 2016j) no longer includes explicit mention of 'wetlands'. The guidance formerly provided under EPA Position Statement 4 (EPA 2004) is now distributed between several Factor Guidelines: Flora and vegetation, Hydrological processes, Inland waters environmental quality and Terrestrial fauna. These factors have been addressed in Sections 4.2 through 4.6 of this ERD.

Although there is no EPA factor guideline specifically for wetlands, two Government of Western Australia policies and one Australian Government policy are relevant in the consideration of proposed development at Lake Disappointment:

- Wetlands Policy of the Commonwealth Government of Australia (1997)
- Wetlands Conservation Policy for Western Australia (1997)
- Corporate Policy Statement No. 31 - Terrestrial Conservation Reserve System (DPaW, 2015).

Figure 5-1: Declared and proposed conservation areas in project locality

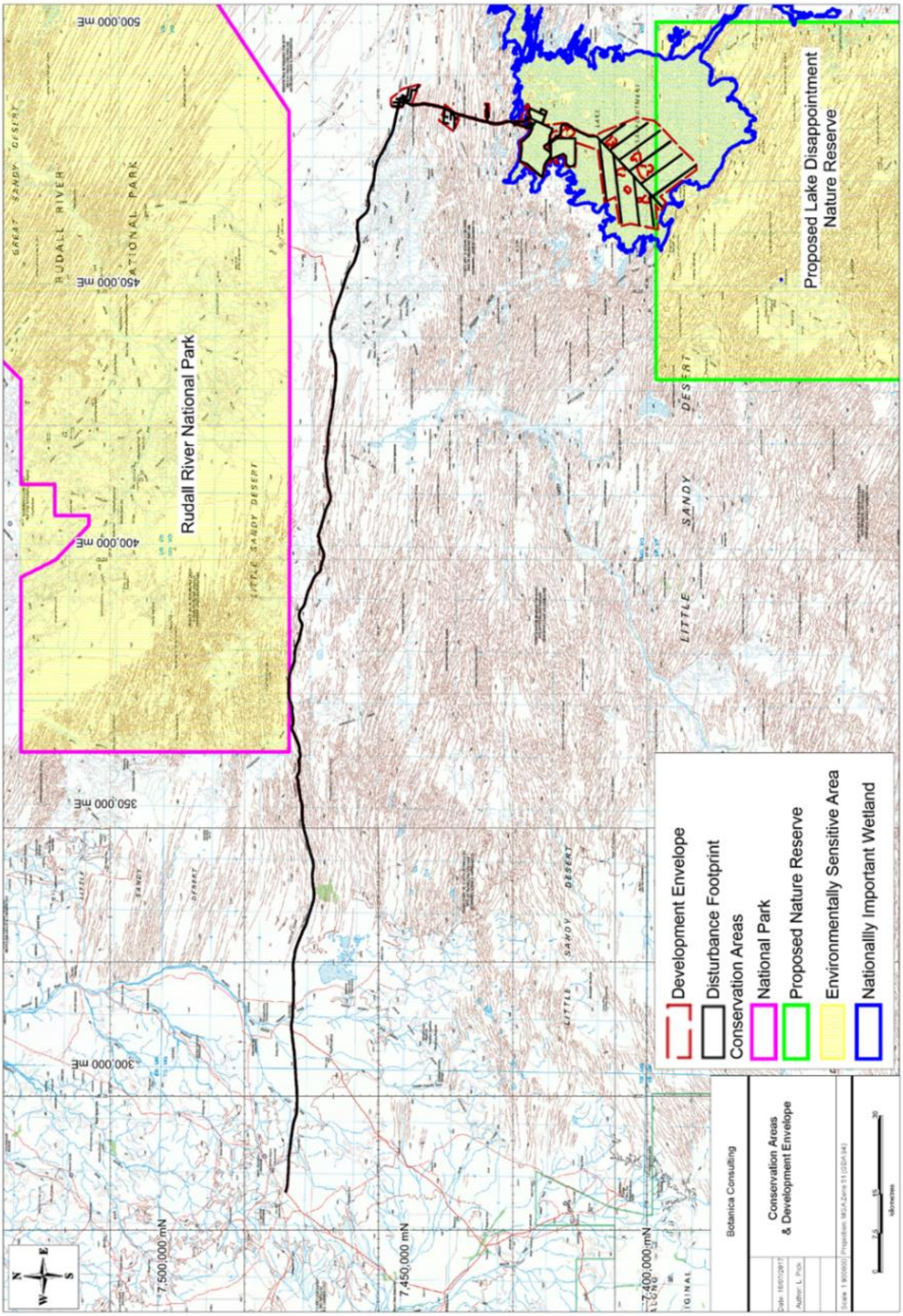


Table 5–1: Wetland policy objectives: relevance to Lake Disappointment project

Policy objective	Application to Lake Disappointment project
To prevent the further loss or degradation of valuable wetlands and wetland types, and promote wetland conservation , creation and restoration	ERD specifically considers risk of significant impairment of wetland functions and biological/cultural values
To include viable representatives of all major wetland types and key wildlife habitats and associated flora and fauna within a statewide network of appropriately located and managed conservation reserves which ensure the continued survival of species, ecosystems and ecological functions	Project design has taken in account locations of existing and proposed conservation reserves in the general project locality
To maintain, in viable wild populations, the species and genetic diversity of wetland-dependent flora and fauna	The character and distribution of wetland dependent biota and the risk of project impacts on these have been considered in this ERD
To maintain the abundance of waterbird populations, particularly migratory species	The potential impacts of project implementation on migratory waterbirds are addressed in Section 4.6
To greatly increase community awareness and appreciation of the many values of wetlands, and the importance of sound management of the wetlands and their catchments in the maintenance of those values	Through the publication of the Lake Disappointment ERD and—if implemented—performance/ compliance reports and monitoring information, there is potential for increased public awareness and appreciation of Lake Disappointment. The offsets proposed by Reward will make a substantial contribution to the state of knowledge concerning the ecological functioning of large salt lake systems.

Neither the state nor the federal wetlands policies call for a prohibition of resource extraction in wetlands. Rather, both policies are underpinned by the 'wise use' principle. The concept of 'wise use' has been defined as the:

> *'… sustainable utilisation [of wetlands] for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem.'* (UNESCO 1971)

The national wetlands policy also recognises the possibility of multiple concurrent or sequential uses of wetland systems:

> *'Wetland functions and values should be conserved within a context of integrated natural resource and land-use management regimes which may include multiple and sequential land use principles.'* (Commonwealth Government of Australia 1997)

The EPA's position statement on wetlands made the point that:

> *'An ecosystem management approach does not mean that wetlands should not be protected for a range of environmental values nor that they cannot support a variety of beneficial uses'.* (EPA, 2004)

5.1.3 Potential impacts

The following potential impacts of project implementation on conservation reserves and protected areas were considered:

- Loss of conservation significant flora, vegetation or habitat
- Fauna injury or death as a result of vehicle strike
- Public safety impacts or constraints on access
- Visual impacts
- Increased fire risk.

5.1.4 Management and mitigation measures

Impacts on vegetation, flora and habitats within existing or proposed reserves will be avoided by adopting the following measures:

- No road upgrades or clearing will be carried out within the boundaries of the Karlamilyi National Park; project traffic will travel along the existing Talawana Track; and
- No off-playa disturbance and no clearing in riparian zones will be carried out within the proposed (but not gazetted) Lake Disappointment Nature Reserve.

No part of the potash operations will be visible from the Karlamilyi National Park. The potash operations will not be visible from off-playa parts of the proposed nature reserve (and on-playa parts of the proposed reserve are largely inaccessible to people, except by helicopter). Project implementation will not affect access of the general public or the Traditional Owners to the National Park. The potential for conflict between project vehicles and other road users will be managed by implementing a driver code of conduct to which all project personnel will be required to adhere. The code of conduct will be developed and implemented in consultation with the Traditional Owners, Main Roads WA and the Shire of East Pilbara. Project vehicles will not travel on the Canning Stock Route.

The risk of occasional fauna death by vehicle strike cannot be entirely eliminated. However, in the six years that Reward has been conducting exploration and survey work in the Lake Disappointment region, such events are extremely rare. Any vehicle interactions with fauna will treated as an environmental incident and reported through the project incident reporting system.

Lightening strike is by far the most common cause of bush fires in the project area. The increased presence of people and machinery carries with it some increased risk of fire and the ignition of fires could affect conservation areas. Reward proposes the following measures to manage bush fire risk:

- A hot work permit system will be developed and implemented.
- In consultation with the Traditional Owners, a program of bush fire risk reduction will be planned and implemented.
- Firefighting equipment will be located on site and project personnel will be trained in fire response.
- Lightning protection equipment will be installed, where required, as part of project implementation.
- Telecommunications systems will be established and maintained in operations areas and in areas accessed by the mobile fleet, so that observations of bush fires can be reliably and promptly communicated.

5.1.5 Predicted outcomes

The risk of significant impacts on existing or proposed conservation areas is very low. Road safety along the Talawana Track may improve as a result of improved communications systems and road upgrades in areas outside the Karlamilyi National Park.

The extent of project disturbance within the Lake Disappointment wetland is a small proportion of the wetland and is unlikely to materially alter wetland function – additional information on hydrological impacts is provided in Section 4.2 On-going ecological research and monitoring during the life of the project will almost certainly contribute to a better understanding of the hydrological and ecological functioning of Lake Disappointment.

5.2 Rehabilitation and decommissioning

Reward has committed to the implementation of a Mine Closure and Rehabilitation Plan to ensure that premises are decommissioned and rehabilitated in an ecologically sustainable manner. A key consideration for rehabilitation works is the potential for the on-playa pond assemblage to be used by shorebirds and water birds for feeding and roosting. Monitoring will be required during the operational phase of the project to assess the level of usage of on-playa infrastructure by birds. A draft closure plan has been provided in Appendix K.

5.3 Offsets

The EPA's objectives in relation to environmental offsets are to counterbalance any significant residual environmental impacts or uncertainty through the application of offsets. The impact assessments conducted in accordance with requirements set out in the Lake Disappointment project ESD have not identified any significant residual impacts that would justify the application of environmental offsets. However, the scientific uncertainties around the occurrence and ecology of two fauna populations seemed to Reward sufficient to cause concern amongst stakeholders and therefore to warrant offset actions aimed at reducing uncertainty.

Two areas of significant uncertainty have been identified:

- The ecological functioning of Lake Disappointment and its importance in the life cycle of migratory birds, including the banded stilt; and
- The ecology and habitat requirements of the night parrot.

An initial offset proposal has been developed and is presented in Appendix M. Reward has requested that details of the proposed offset package should not be made publicly available, pending further consultation with regulators and stakeholder groups, and the development of governance structures for the implementation of offset actions. The preliminary offset proposal has been provided to the EPA for the purpose of demonstrating Reward's good faith and providing an indication of the resources that Reward is prepared to commit to offset actions. A general description of the principles guiding Reward's proposed offset program follows.

5.3.1 Night parrot offsets

The offset actions proposed in relation to night parrots has been strongly influenced by conservation actions proposed under the IUCN Red List (2018). The proposed offset activities include:

1. Targeted feral animal (cat and fox) control in areas of suitable habitat;
2. Fire management in areas of known extant populations;
3. Establishment of protocols to limit access to land known to host extant populations;
4. Promotion of opportunities to undertake or participate in survey and monitoring in suitable habitat areas, in collaboration with the Traditional Owners and conservation management organisations associated with the area of the extant subpopulation; and
5. Implementation of a research plan which includes a communications strategy that contributes to reducing the risk associated with illegal and bird watching activities, increases the effectiveness of survey and monitoring programs, and promotes collaboration.

Reward's baseline studies have positively identified night parrot calls at more than a dozen locations between June 2017 and April 2018. Implementation of a program of feral animal control, fire management and targeted research near Lake Disappointment provides an opportunity to achieve significant conservation gains for the endangered night parrot.

5.3.2 Offsets for banded stilts and other migratory birds

EPBC listed species

The Lake Disappointment system has national value for migratory shorebirds on one criterion (namely >0.1% of the flyway population of a species present). In March 2017, an estimated 364 sharp-tailed sandpipers were observed near Lake Disappointment, which approximates to 0.4% of the flyway population. About half of the birds observed were at locations in or near the project development envelope; the rest were near surrounding clay pans that lie outside any proposed project development areas. The on-playa project development areas are too saline to be regularly used by sharp-tailed sandpiper in isolation of other freshwater bodies.

The Lake Disappointment/Savory Creek system does not meet the other two criteria of national importance, namely that >15 shorebird species are present (only five species were recorded) or that >2,000 shore individuals are present (a maximum of 388 birds were recorded at any one time).

Nationally important levels of use by the sharp-tailed sandpiper are likely to be infrequent and the activities proposed as part of the Lake Disappointment project are unlikely to materially alter the habitat used by this shoreline-feeding bird. Consequently, project development is unlikely to have any impact on species abundance. The residual risk of project impacts on sharp-tailed sandpiper is considered low (Appendix E1).

Locally important species

Although banded stilts are not formally listed as a species of conservation significance, it is clear from observations during baseline studies for the Lake Disappointment project that a substantial percentage of the national banded stilt population occasionally visits Lake Disappointment. The occasional breeding events by banded stilts on islands in the lake may represent the highest wetland value of the Lake Disappointment playa.

Although the assessment of potential project impacts on banded stilt populations has concluded that significant impacts are unlikely, Reward is mindful of the iconic status of the species for some stakeholders and is aware of the remaining scientific uncertainty around the ecology of the banded stilt. Accordingly, the Company proposes to resource a 10-year research program (with potential for extension, subject to 5-yearly progress reviews), with a strong emphasis on citizen science. The research program will enable ongoing surveillance of water bird use of the Lake Disappointment system. It will also serve both to provide independent observations on the effectiveness of Reward's environmental management and to advance understanding of the interplay between climate, arid zone hydrology and the life cycles of nomadic water birds.

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6 INTEGRATED IMPACT ASSESSMENT – SUMMARY AND CONCLUSIONS

The Australian agricultural sector is currently almost entirely reliant on imported sources of potassium sulfate (potash). Reward proposes to establish a domestic source of potash by abstracting and purifying naturally enriched potassium brine from sediments beneath the Lake Disappointment playa. The 20-year project has been designed to minimise the need for the clearing of native vegetation by making use of existing cleared areas and by siting project infrastructure on unvegetated parts of the playa. Only 410 ha of the approximately 7776 ha project disturbance footprint will require vegetation clearing; this includes the access road to the site.

The greater part of the project disturbance footprint (over 90%) is located on the Lake Disappointment playa, an ephemeral wetland. The project footprint will occupy less than 5% of the 150,000 ha playa surface. Exclusion areas have been agreed through an ILUA with Martu Traditional Owners to ensure that no project development occurs on culturally significant areas in or near the playa. The exclusion areas prohibit disturbance of any of the islands within the playa and also restrict development near the mouth of Savory Creek. Reward has established a 200 m offset between on-playa infrastructure and the playa riparian zone (including islands), as a means of reducing the risk of impact to riparian vegetation or to locally significant fauna (Lake Disappointment ground gecko, Lake Disappointment dragon) that live within the riparian zone.

No threatened flora species, vegetation assemblages or ecological communities recognised under the EPBC Act have been recorded within the proposed project development envelope. No Threatened Ecological Communities (TEC) or Threatened Flora listed under the EP Act and WC Act have been recorded within the project development. No Priority Ecological Communities (PEC) as listed by the DBCA have been recorded within the development envelope. The nearest PEC is the Priority 3 Ecological Community 'Riparian vegetation including phreatophytic species associated with creek lines and watercourses of Rudall River', which is located approximately 20 km north of development envelope (Northern Borefield). No ecosystems listed under the IUCN Red List (2018) of ecosystems occur within the development envelope.

A number of conservation-significant fauna are known to exist in or near the project development envelope. An occurrence of the Endangered night parrot was confirmed near Lake Disappointment during baseline surveys by means of audio recordings. Follow-up surveys have recorded night parrots in the same general locality at which positive identifications were first recorded, but have failed to record night parrots at regional locations. So far, ARUs deployed at 18 monitoring locations within a nominal 600 ha area have recorded night parrot calls between December 2017 and September 2018. None of the locations at which calls were recorded are within the project development envelope. The main potential source of off-playa project-related impacts on terrestrial fauna is harm arising from land clearing or earthworks, which could damage burrows of bilbies, mulgara, great desert skinks or night parrot nests (if present) or accidental vehicle strike of conservation significant fauna along project access or haul roads.

No evidence of significant populations of bilbies, mulgara or great desert skinks was recorded during baseline fauna surveys conducted between 2012 and 2017, but it is nonetheless possible that some or all of these species are present in the area. In addition to implementing project-specific management control to avoid or mitigate impacts to conservation-significant fauna, Reward has committed to implementing a whole-of-project feral animal control program through the project area. The proposed feral animal control program will serve to reduce threats posed by feral predators and herbivores which are currently abundant in the area and constitute the most significant risk to continuing viability of threatened native fauna.

The key biodiversity risks associated with project implementation relate to:

- Potential impacts on banded stilt breeding success as a result of changes in surface hydrology (duration/depth/extent of flooding) on Lake Disappointment; and
- Potential impacts on stygofauna as a result of groundwater abstraction from the proposed Cory and Northern Borefields.

Preliminary hydrological modelling conducted as part of the Environmental Impact Assessment indicates that implementation of engineered drainage controls will minimise changes to flooding on Lake Disappointment. However, given the potential sensitivity of banded stilts to reductions in flood duration or extent during summer breeding events, Reward has committed to an additional program of works to support an adaptive management approach to its surface water management. Details of the additional works are described in the Fauna Management Plan (Appendix L4). Overall, the management controls proposed under the Fauna Management Plan are expected to result in neutral or positive impacts on the diversity and ecological integrity of terrestrial fauna populations in the Lake Disappointment area. Notwithstanding the conclusion that significant adverse residual impacts are unlikely to result from project implementation, Reward has proposed a program of biodiversity offsets to address environmental values with significant levels of uncertainty, as provided for under the WA Environmental Offsets Guidelines (EPA 2014).

A number of subterranean fauna species have been collected within the estimated zone of influence of the proposed borefields, but have not yet been observed elsewhere in the region. Although the risk of significant impacts on subterranean fauna is relatively low, given the size of the aquifers from which water would be abstracted, further sampling and implementation of the management controls described in the Subterranean Fauna Management Plan (Appendix L3) will be required.

The Lake Disappointment playa is a registered heritage site and there are numerous places of cultural significance to the Martu Traditional Owners in and near the project development envelope. Reward has committed to a range of actions under the ILUA entered into with the Martu People in December 2012. Management of cultural and social aspects of Reward's activities at Lake Disappointment will continue to be administered under the ILUA.

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