MACKAY SULPHATE OF POTASH PROJECT ENVIRONMENTAL REVIEW DOCUMENT

PREPARED FOR AGRIMIN LIMITED

April 2022

Quality Statement

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Document Control

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Stantec have been granted an authority to act on behalf of Agrimin's CEO.

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REVISION SCHEDULE

Rev No.	Date	Description	Prepared by	Checked by	Reviewed by	Approved by
A	28/10/2020	Draft for internal review	Stantec	Peter de San Miguel	Peter de San Miguel	Sarah Osborne
B	2/11/2020	Draft for client review	Stantec	Sarah Osborne	Agrimin	Sarah Osborne
C	5/11/2020	Final draft for internal review	Stantec	Sarah Osborne	Peter de San Miguel	Sarah Osborne
Final Draft	27/11/2020	Final for submission to DWER-EPAS	Stantec	Sarah Osborne	Peter de San Miguel	Peter de San Miguel
Final Draft v2	10/09/2021	Revision 2 for submission to DWER-EPAS	Stantec / Agrimin	Matt Spence	Peter Tapsell	Fiona Taukulis
Final v1	25/11/2021	Final ERD for submission to DWER-EPAS	Stantec / Agrimin	Matt Spence	Peter Tapsell	Fiona Taukulis
Final v2	20/01/2022	Revised Final ERD for submission to DWER-EPAS	Stantec / Agrimin	Paul Bolton	Peter Tapsell	Fiona Taukulis
Final v3	11/04/2022	Revised Final ERD for submission to DWER-EPAS	Stantec / Agrimin	Paul Bolton	Peter Tapsell	Fiona Taukulis

Invitation to Make a Submission

The Environmental Protection Authority (EPA) invites people to make a submission on the environmental review of this Proposal.

Agrimin Limited (the Proponent) proposes to build and operate the Mackay Sulphate of Potash (SOP) Project (the Proposal) located 941 km south of Wyndham.

The Environmental Review Document (ERD) has been prepared in accordance with the EPA's *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual Requirements under the Environmental Protection Act 1986*. The ERD is the report by the proponent on the environmental reviewed which describes this Proposal and its likely effects on the environment. The ERD is available for a public review period of 4 weeks from the **2 May 2022**, closing on the **27 May 2022.**

The Proposal is currently being assessed by way of accredited assessment under the Bilateral Agreement between the Commonwealth and Western Australian governments. In accordance with the Agreement the Western Australian Department of Water and Environmental Regulation will provide the Commonwealth with both a copy and a summary of submissions received during the public comment period. 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 alternative 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, preferable 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 submission is: **27 May 2022**.
- The EPA prefers submission to be made electronically via the EPA's Consultation Hub at: https://consultation.epa.wa.gov.au
- Alternatively, submission can be made by:
  - post: Chairman, Environmental Protection Authority, Locked Bag 10, Joondalup DC WA 6919, or
  - delivery: Environmental Protection Authority, Prime House, 8 Davidson Terrace, Joondalup 6027.
- If you have any questions on how to make a submission, please contact EPA Services at the Department of Water and Environmental Regulation on (08) 6364 7000.

Scoping Checklist

The table below summarises the required work for each of the key environmental factors as discussed in the Environmental Scoping Document (ESD) (Appendix A) and where within this Document they have been adequately addressed.

Task No.	Required Work	Section
Flora and Vegetation		
1	Undertake a desktop review, including database searches, a comprehensive literature review and a likelihood of occurrence assessment for identified significant flora taxa and vegetation communities.	Section 6.3
2	Undertake a dual-phased Detailed Flora and Vegetation Survey of the Development Envelopes in accordance with EPA's Technical Guidance: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment.	Section 6.3
2a	Describe and delineate the vegetation types within the Development Envelopes based on data collected from representative sample sites (quadrats and relevés).	Section 6.4.2.1
2b	Assess and map the vegetation condition within the Development Envelopes.	Section 6.4.2.5
2c	Record the vascular flora species observed within the Development Envelopes.	Section 6.4.3.1
2d	Conduct targeted searches for flora and vegetation of significance, recording the type, condition, population size and locations.	Section 6.3
2e	Identify and map the presence and abundance of weed species within the Development Envelopes.	Appendix F
3	Undertake Riparian Flora and Vegetation Survey in accordance with Technical Guidance: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment. This will include the revisiting established transects (length to be determined in the field), comprising 3 m x 3 m quadrats within the riparian zone, and assessment of diversity, abundance, cover, and health.	Section 6.3
4	Seek clarification from relevant taxonomic experts for any flora taxa which cannot be / have not been readily identified to species level, such as existing tentative identifications of *Tecticornia* specimens (samphires) where clarification will be sought from K. Shepherd from the Western Australian Herbarium (WAH). Submit any new specimens of *Tecticornia* species collected during field surveys to the WAH for identification and vouchering.	Appendix F
5	Undertake a data consolidation of flora and vegetation surveys and vegetation mapping for the Development Envelopes, including a review and reconciliation of vegetation type and vegetation condition mapping across the Development Envelopes to develop one consolidated GIS layer for the Proposal.	Section 6.4.2
6	Provide a figure depicting survey effort applied in relation to the study area and Development Envelope, identifying the direct and indirect impact areas.	Section 6.3
7	Demonstrate how surveys are relevant, representative and demonstrate consistency with current EPA policy and guidance. Ensure database searches and taxonomic identifications are up to date. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys. All surveys should be appended to the environmental review documentation.	Appendix F

Task No.	Required Work	Section
8	Provision of relevant Index of Biodiversity Surveys for Assessment (IBSA) data package in accordance with the Instructions and Form: IBSA Data Packages for all flora and vegetation surveys.	IBSA data submitted (IBSA Number: IBSA-2021-0386)
9	Identify and characterise the flora and vegetation of areas that may be directly or indirectly impacted by the Proposal in accordance with Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment. Surveys should be designed to inform local and regional context.	Section 6.4
10	Determine whether any flora species recorded are significant and provide an analysis of local and regional context (refer to Environmental Factor Guideline – Flora and Vegetation for definition of significant flora).	Section 6.4.3.1
11	Determine whether any vegetation identified is significant including groundwater dependence of riparian vegetation, and provide an analysis of local and regional context, (refer to *Environmental Factor Guideline – Flora and Vegetation* for definition of significant vegetation).	Section 6.4.2.4
12	Provide figures depicting the recorded locations of flora and vegetation in relation to the Development Envelope in accordance with Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment.	Figure 6-4 Figure 6-5 Figure 6-6 Figure 6-7
13	Assess the potential direct and indirect impacts of the construction and operational elements of the Proposal on the flora and vegetation environmental values within the Development Envelopes. Describe and assess the extent of cumulative impacts as appropriate.	Section 6.6
14	Provide a quantitative assessment of impact. For significant flora, this includes:	Section 6.6
14a-i	• number of individuals and populations in a local and regional context;	Section 6.6.2
14a-ii	• numbers and proportions of individuals and populations directly or potentially indirectly impacted; and	Section 6.6.2
14a-iii	• numbers/proportions/populations currently protected within the conservation estate (where known).	-
14b	For all vegetation units (noting threatened and priority ecological communities and significant vegetation) this includes;	-
14b-i	• area (in hectares) and proportions directly or potentially indirectly impacted; and	Section 6.6.1
14b-ii	• proportions/hectares of the vegetation unit currently protected within conservation estate (where known).	Section 6.6.1
15	Provide figures of the proposed clearing and predicted direct and indirect impacts to flora, vegetation and significance flora and vegetation taxa.	Table 6-17 Table 6-19
16	Describe elements of the Proposal which affect the environment (e.g. temporary construction versus operation, impacts/pressures from the Proposal etc.) for use in the flora and vegetation risk and impact assessments.	Section 6.5
17	Develop a flora and vegetation risk assessment to assist in predicting inherent and residual impacts from the Proposal's activities before and after applying the mitigation hierarchy (avoid, minimise, manage, monitor, rehabilitate).	Section 6.5
18	Discuss and quantify the potential indirect impacts to flora and vegetation (in particular *Tecticornia* species) from the mobilisation of waste salts and dust emissions from clearing, construction and operational activities.	Section 6.5 Table 6-17 Table 6-19

Task No.	Required Work	Section
19	Describe the application of the mitigation hierarchy in the Proposal design, construction, operation and closure. Detail actions undertaken to avoid, minimise and mitigate Proposal impacts. Include management and/or monitoring plans to be implemented pre- and post-construction to demonstrate that residual impacts are not greater than predicted. Management and/or monitoring plans are to be presented in accordance with EPA Guidance Instructions on how to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans and EPA instructions.	Section 6.5 Table 6-16
20	Identify any limitations associated with the flora and vegetation survey data or existing knowledge and discuss their implications for the impact assessment.	Section 6.3.1.2
21	Determine and quantify any significant residual impacts to flora and vegetation in accordance with *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) by applying the Residual Impact Significance Model (page 11) and WA Offset Template, and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).	Section 6.7 Section 13
22	If significant residual impacts to flora and vegetation remain after applying the mitigation hierarchy an appropriate offset strategy developed, in consultation with the Tjamu Tjamu (Aboriginal Corporation) RNTBC and other relevant stakeholders for the Proposal. The offset package will be developed in accordance with the *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012) and include reference to the *Offsets Assessment Guide* for use in determining offsets under the EPBC Act. Spatial data defining the area of significant residual impacts for each environmental value should also be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat).	Section 6.7
23	If an offset strategy is required, Agrimin will use its best endeavours to ensure that any offsets are directed towards matters that are relevant to and benefit the Kiwirrkurra People, particularly through support for the Kiwirrkurra Indigenous Protected Area program and its land management activities.	Section 13
24	Prepare a Mine Closure Plan (MCP) including site specific rehabilitation requirements consistent with the Department of Mines, and Petroleum (DMIRS) Mine Closure Plan Guidance (DMP and EPA 2015).	Appendix D
25	Within the ERD demonstrate how Proponent considers the EPA's objectives for this factor have been addressed.	Section 6.7
Terrestrial Fauna		
	Provision of relevant Index of Biodiversity Surveys for Assessment (IBSA) data package in accordance with the Instructions and Form: IBSA Data Packages for all terrestrial fauna and SRE surveys	IBSA data submitted (IBSA Number: IBSA-2021-0388 & IBSA-2021-0385)
26	In accordance with the requirements of EPA Guidance conduct a desktop study to identify and characterise the fauna and fauna habitats to inform local and regional context; and based on the results of the desktop study:	Section 7.3
26a	• conduct a Basic (Level 1) survey and fauna habitat assessment; and/or	Section 7.3.1
26b	• conduct a Detailed (Level 2) survey; and/or	Section 7.3.1
26c	• conduct targeted surveys for significant fauna that may be directly or indirectly impacted.	Section 7.3.1

Task No.	Required Work	Section
27	Migratory waterbird survey of Lake Mackay and periphery wetlands and claypans (to be undertaken as part of the aquatic ecology investigation by a relevant technical specialist).	Section 7.3.1 Appendix G.1
28	Fauna, fauna habitat and SRE survey of lake islands in accordance with EPAs Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna (if required, based on results of hydrogeological investigation and internal risk assessment).	Section 7.3 Appendix G.1 Appendix G.2
29	Undertake a data consolidation of fauna records and fauna habitat mapping for the Development Envelopes, including a review and reconciliation of fauna records and fauna habitat mapping across the Development Envelopes to develop one consolidated GIS layer for the Proposal.	Section 7.3 Appendix G.1
30	Demonstrate how surveys are relevant, representative, and consistent with current EPA policy and guidance and this Environmental Scoping Document.	Section 7.3
31	Provide a map of the survey effort applied in relation to the fauna habitats, the study area, Development Envelope, identifying the direct and indirect impact areas.	Section 7.3.1
32	Identify and describe the fauna assemblages present and likely to be present within the Development Envelope that may be impacted by the Proposal.	Section 7.4.2
33	Identify and describe the characteristics of the fauna habitats identified by the desktop study and surveys, including a map their extents in relation to the study area, the Development Envelope, and direct and indirect impact areas. Describe significant habitats, including but is not limited to: refugia, breeding areas, key foraging habitat, movement corridors and linkages.	Section 7.4.1
34	Identify significant fauna and describe in detail their known ecology, likelihood of occurrence, habitats, and known threats. Map the locations of significant fauna records in relation to the fauna habitats, the study area, the Development Envelope, and direct and indirect impact areas.	Section 7.4.3
35	Assess the potential direct and indirect impacts associated with the Proposal on the fauna and fauna habitats within the Development Envelopes. Where appropriate, this will 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 significance as defined in EPA's Factor Guideline, Environmental Factor Guideline: Terrestrial Fauna.	Section 7.6
36	Provide figures of the proposed clearing and predicted direct and indirect impacts to fauna, fauna habitats and significant fauna species including, but not limited to Threatened and / or Priority Ecological Communities, Threatened and Priority fauna and new species of fauna.	Table 7-11 Section 7.6
37	Describe elements of the Proposal which affect the environment (e.g. temporary construction versus operation, impacts/pressures from the Proposal etc.) for use in the fauna habitat risk and impact assessments.	Section 7.5
38	Outline and justify the proposed avoidance and mitigation measures to reduce the potential impacts of the Proposal. Include proposed management and/or monitoring plans that will be implemented pre- and post-construction to demonstrate and ensure residual impacts are not greater than predicted. Management and/or monitoring plans are to be presented in accordance with the EPAs Instructions.	Section 7.5
39	Identify any limitations associated with the terrestrial fauna survey data or existing knowledge and discuss their implications for the impact assessment.	Section 7.3.3
40	Develop environmental management plans and / or proposed monitoring and management where required (i.e. conversation	Appendix C.3

Task No.	Required Work	Section
	significant taxa and / or feral animals) in consultation with State and Commonwealth regulators and Tjamu Tjamu (Aboriginal Corporation) RNTBC, in accordance with EPA Guidance Instructions on how to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans and Environmental Management Plan Guidelines (DoE 2014).	
41	Identify, describe, and quantify the potential residual impacts (direct, indirect, and cumulative) to fauna assemblages, habitats, significant species, that may occur following implementation of the Proposal after considering and applying avoidance and minimisation measures, in a local and regional context. Provide a table of the proportional extents of each habitat within the study area and Development Envelope, and the predicted amount to be directly and indirectly impacted.	Section 7.7
42	Discuss how the proposed action is consistent with the relevant EPBC Act statutory recovery plans and threat abatement plans and has had regard to approved conservation advice.	Section 13
43	Determine and quantify any significant residual impacts to terrestrial fauna in accordance with *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) by applying the Residual Impact Significance Model (page 11) and WA Offset Template, and *Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).	Section 7.7 Section 13
44	If significant residual impacts to terrestrial fauna remain after applying the mitigation hierarchy an appropriate offset strategy will developed, in consultation with the Tjamu Tjamu (Aboriginal Corporation) RNTBC and other relevant stakeholders for the Proposal. The offset strategy will be developed in accordance with the *WA Environmental Offsets Policy* (Government of Western Australia 2011), and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012), including the *Offsets Assessment Guide* for use in determining offsets under the EPBC Act. If required, spatial data defining the area of significant residual impacts will also be provided.	Section 13
45	Where significant residual impacts remain, propose an appropriate offsets package that is consistent with *WA Environmental Offsets Policy* (Government of Western Australia 2011), *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) and, where impacts relate to EPBC Act-listed taxa, *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012). Spatial data defining the area of significant residual impacts should be provided.	Section 13
46	If an offset strategy is required, Agrimin will use its best endeavours to ensure that any offsets are directed towards matters that are relevant to and benefit the Kiwirrkurra People, particularly through support for the Kiwirrkurra Indigenous Protected Area program and its land management activities.	Section 13 Appendix N
47	Prepare a Mine Closure Plan (MCP) consistent with the Department of Mines, and Petroleum (DMIRS) Mine Closure Plan Guidance (DMP and EPA 2015) that addresses the development of completion criteria to protect and conserve significant terrestrial fauna species and their habitat that environmental values are maintained post closure.	Appendix D
48	Within the ERD demonstrate how the Proponent considers the EPA's objectives for this factor have been addressed.	Section 7.7
Subterranean Fauna		
	Provision of relevant Index of Biodiversity Surveys for Assessment (IBSA) data package in accordance with the Instructions and Form: IBSA Data Packages for all subterranean fauna surveys	IBSA data submitted (IBSA Number: IBSA-2021-0387)
49	In accordance with EPA guidance:	

Task No.	Required Work	Section
49a	• conduct a Level 1 (basic) subterranean fauna survey, including a pilot and desktop study that incorporates existing regional subterranean fauna surveys and databases where habitat is not prospective with suitable justification.	Section 8.3
49b	• potentially undertake multi-phased Level 2 (detailed) surveys in prospective areas (calcareous) of impact, to identify and characterise subterranean fauna and subterranean fauna habitat, at a local and regional scale, that may be impacted directly and indirectly by the implementation of the Proposal. This should include sampling inside and outside the impact areas and consider cumulative impacts where possible with suitable justification.	Section 8.3
50	Describe the characteristics of subterranean fauna habitat that may be impacted directly and indirectly by implementation of the Proposal during both construction and operations and describe the significance of these values in a local and regional context. Include relevant geological and hydrological information to determine habitat suitability and connectivity, including inside and outside the impact areas.	Section 8.4
51	Where appropriate, provide figure(s) and maps showing the extent of subterranean fauna habitat in relation to the Proposal and species distributions.	Section 8.4.3.2 Figure 8-9
52	Where appropriate, describe and assess the extent of direct, indirect, and cumulative impacts as a result of implementation of the Proposal during both construction and operations to subterranean fauna, taking into consideration the significance of fauna and fauna habitat.	Section 8.5
53	Where appropriate, quantify the extent of direct, indirect, and cumulative impacts, including percentages, of habitat types to be disturbed or otherwise impacted.	Section 8.5
54	Develop a subterranean fauna risk assessment to assist in predicting inherent and residual impacts from the Proposal's activities (before and after applying the mitigation hierarchy (avoid, minimise, manage, monitor, rehabilitate) in accordance with EPA's Environmental Factor Guideline: Subterranean Fauna, where possible. For species that are likely to be impacted provide information on habitat prospectively and including figures and discussion to demonstrate any habitat connectivity beyond the impacted area.	Section 8.5
55	Outline the proposed management, monitoring and mitigation methods to be implemented to ensure residual impacts (direct and indirect) are not greater than predicted.	Section 8.5
56	Identify any limitations associated with the subterranean fauna survey data or existing knowledge and discuss their implications for the impact assessment.	Section 8.3.1
57	Develop environmental management plans for proposed monitoring and management for subterranean fauna if required, in accordance with EPA Guidance Instructions on how to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans.	Appendix C.4
58	Determine and quantify any significant residual impacts in accordance with *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) by applying the Residual Impact Significance Model (page 11) and WA Offset Template for all direct and indirect impacts, including an explanation of how the information and values within the model have been determined. Determine and quantify any significant residual impacts in accordance with *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012), for all direct and indirect impacts, including an explanation of how the information and values within the model have been determined.	Section 8.6

Task No.	Required Work	Section
59	Where signigicant residual impacts remain, propose an appropriate offsets package with supporting information to demonstrate consistency with the *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) and, where residual impacts relate to EPBC Act-listed threatened and/or migratroy species, the *Environment Protection and Biodiversity Convservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012). Spatial data defining the area of significant residual impacts for each environmental value should also be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat).	Section 8.6
60	If an offset strategy is required, Agrimin will use its best endeavours to ensure that any offsets are directed towards matters that are relevant to and benefit the Kiwirrkurra People, particularly through support for the Kiwirrkurra Indigenous Protected Area program and its land management activities.	Section 13
61	Within the ERD demonstrate how the Proponent considers the EPA's objectives for this factor have been addressed.	Section 8.6
Inland Waters		
62	Undertake a desktop hydrology assessment to:	
62a	• identity and delineate surface water catchment areas and key drainage paths;	Section 9.3
62b	• describe Lake Mackay on-lake flow paths / drainage network;	Section 9.3
62c	• summarise climate data; and	Section 9.3
62d	• develop design rainfall intensity-frequency-duration (IFD) curves in accordance with Australian Rainfall and Runoff (ARR) 2016 to support future hydrologic and hydraulic modelling efforts.	Section 9.3
63	Undertake surface hydrology modelling and flood mitigation assessment to develop an understanding of Lake Mackay hydrology and response to rainfall events under current (pre-development) scenarios. As the Proposal involves both on-lake and land-based operations two different hydrology and hydraulic modelling approaches will be used for the respective land-based and on-lake operations. The focus of the land-based assessment will be on the Proposal area hydrology, surface runoff, potential flooding regimes and characterisation of risk to development and infrastructure. The focus of the on-lake assessment will be to develop an understanding of the baseline (pre-disturbance) surface hydrology of Lake Mackay and the surrounding catchment, lake hydro-period, flooding extents and regimes in relation to environmental values and potential environmental impacts. The Proposal (developed) scenario will include assessment of potential impact of the bunded trench system on the lake surface water flows. Potential climate change impacts will be qualitatively assessed.	Section 9.4.3 Appendix I.11
64	Key modelling tasks include:	-
64a	• develop design rainfall and storm profiles in accordance with ARR (2016);	Appendix I.11
64b	• configure rainfall-runoff models for the external catchment intersecting proposed operational areas using appropriate methods based upon catchment areas (i.e. Rational Method for catchment areas less than 25 km²) or the Rainfall-Runoff Model (RORB) for larger catchments;	Appendix I.11
64c	• for the external catchments simulate design peaks for a range of AEP events, up to the 1% AEP;	Appendix I.11

Task No.	Required Work	Section
64d	• develop a two-dimensional (2D) hydraulic model (TUFLOW) to model the external catchments draining to Lake Mackay and to simulate inflows to Lake Mackay under the 1% AEP design rainfall event, inflows from the external model as source point inputs to the lake-based model;	Section 9.4.3 Appendix I.11
64e	• TUFLOW will be used to assess water levels, flow velocities, and identify potential areas at risk of flooding that may require flood protection / flood mitigation;	Appendix I.11
64f	• the TUFLOW model will be validated using available data from local site rainfall (if available) and historical lake flooding extents. BoM and SILO daily rainfall data will also be considered, along with satellite images of historical inundation extents; and	Appendix I.11
64g	• undertake a surface water salt balance study that will include analysis of sediment, with ionic composition, which can be compared to the composition of waste salts.	Appendix I.18
65	Analyse, discuss, and assess surface water impacts including:	-
65a	• impacts of different flooding scenarios during operations and post-closure on brine abstraction areas, infrastructure, and final landforms, including changes in surface water inundation patterns on fringing areas of Lake Mackay and peripheral wetlands; and	Section 9.5
65b	• the nature, extent and duration of impacts including the relationship between rainfall events and flood inundation; the impact of trenches and bunds on surface water movement on the lake and used to inform potential impact assessment on associated ecosystems; and the influence of lake inundation on sediment generation, turbidity and potential erodibility of these landforms; and	Section 9.5
65c	• impacts on the environmental values of significant receptors.	Section 9.5
66	Demonstrate consideration of design scheduling of the trenching plan to avoid, minimise or manage impacts to inland waters.	Section 9.5
67	Undertake Preliminary Groundwater Modelling Study to provide an assessment of the existing groundwater system and initial predictions of the potential for groundwater extraction.	Section 9.4.2 Appendix I
68	Undertake an assessment of groundwater pumping tests of the trenches to understand actual drawdown extents.	Section 9.4.2 Appendix I.2 Appendix I.4
69	Determine the most acceptable distances of trenches from islands.	Section 9.5
70	Determine if there is connectivity between clay pans and groundwater resources.	Section 9.4.2 Appendix I.13
71	Undertake detailed lake infiltration and recharge testing.	Section 9.4 Appendix I.9
72	Undertake salt-water balance modelling to understand the changes and possible migration of salt back into the lake.	Section 9.4 Appendix I.18
73	Develop a conceptual and numerical hydrogeological model (to meet requirements of H3 level hydrogeological assessment) to predict the development of the drawdown cone, determine the optimum distance between trenches, and impacts associated with a changed regime. The numerical model will be developed using the MODFLOW-SURFACT code within the Groundwater Vistas interface.	Section 9.4.2
74	Groundwater investigation to identify a suitable groundwater resource to establish a groundwater supply borefield options for Proposal's processing requirements. The investigation will include the development of both conceptual and numerical groundwater models (to meet requirements of H3 level hydrogeological assessment). The	Section 9.4.2

Task No.	Required Work	Section
	numerical model will be developed using the FEFLOW software package. The investigation will consider groundwater resource potential, drawdown extends and likely impacts on ecosystems.	
75	Characterise the baseline hydrogeological regimes and water quality, both in a local and regional context, including, but not limited to water levels, quantity, and quality.	Section 9.4
76	Provide a detailed description of the design and location of the Proposal aspects that have the potential to impact hydrogeological processes.	Section 9.5
77	Analyse, discuss, and assess hydrogeological impacts including:	-
77a	• the impacts from groundwater drawdown from trenching activities impacting islands and peripheral habitat;	Section 9.5.4
77b	• the impacts from groundwater drawdown from borefield impacting the ecosystems;	Section 9.5.4
77c	• the nature, extent, and duration of impacts to Lake Mackay, islands, freshwater claypans and subterranean fauna habitat; and	Section 9.5
77d	• impacts on the environmental values of significant receptors.	Section 9.5
78	Undertake an aquatic ecology investigation of Lake Mackay of 20 sites including a range of habitats, comprising up to 14 sites on the playa (across the western and eastern portions of the lake) and six sites on the peripheral wetlands (to provide regional context). The following values will be investigated:	Section 9.4.4 Appendix J
78a	• Habitat Characteristics: Key physical, geological, and hydrological attributes will be recorded, including measurements of salt crust thickness on the lake bed;	Section 9.4.4
78b	• Water and Sediment Quality: Collection of surface water and sediment samples and submission to a NATA-accredited laboratory;	Section 9.4.4.2 Section 9.4.4.3
78c	• Baseline aquatic ecology study including benthic/planktonic algae, diatoms, macrophytes, macroinvertebrates and macroinvertebrates; including sorting and identification to lowest possible level in the laboratory;	Section 9.4.4.4.1 Section 9.4.4.4.2 Section 9.4.4.4.3
78d	• Resting Stages: Scraping of surface sediment to collect dormant propagules of algae and aquatic invertebrates. Processing and identification to genus level in the laboratory;	Section 9.4.4.4.3
78e	• Waterbirds: Migratory waterbird survey of Lake Mackay and periphery wetlands, including an approximation of abundance, with identification to species level; and	Section 9.4.4.4.5
78f	• Riparian Flora and Vegetation Survey: Undertaken in accordance with Technical Guidance: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment. This will include the establishment of transects (length to be determined in the field), comprising 3 m x 3 m quadrats within the riparian zone, and assessment of diversity, abundance, cover, and health. *Tecticornia* specimens will be identified, vouchered, and lodged with the taxonomic expert (K. Shepherd) from the Western Australian Herbarium (WAH).	Section 9.4.4.4.4
79	Identify and characterise the aquatic ecology values and riparian vegetation values (and potential groundwater dependence) and any environmental receptors of Lake Mackay and the peripheral wetlands, both in a local and regional context.	Section 9.4.4.4.6
80	Characterise the ecological values of the island habitats (including freshwater clay pans and riparian vegetation and potential groundwater dependent ecosystems) of Lake Mackay in relation to potential indirect impacts from Proposal activities.	Section 9.4.4.4.6

Task No.	Required Work	Section
81	Discuss how the proposed action is consistent with the relevant EPBC Act statutory recovery plans and threat abatement plans and has had regard to approved conservation advice.	Section 13
82	Undertake additional characterisation of waste salts on the lake from solar evaporation activities and conduct a comparison of waste salt characterisation and baseline lake sediment conditions from the aquatic ecology investigation.	Section 9.4.4.4.6 Section 9.5.3 Appendix I.18
	Provision of relevant IBSA data package in accordance with the Instructions and Form: IBSA Data Packages for all aquatic flora and fauna surveys.	IBSA data submitted (IBSA Number: IBSA-2021-0401)
83	Provision of relevant IBSA data package in accordance with the Instructions and Form: IBSA Data Packages for all flora and vegetation surveys.	IBSA data submitted (IBSA Number: IBSA-2021-0386)
84	Develop an inland waters risk assessment to assist in predicting inherent and residual impacts from the Proposal's activities (before and after applying the mitigation hierarchy.	Section 9.5
85	Identify potential direct, indirect, and cumulative impacts on conservation values of inland waters (e.g. surface water or groundwater flows, islands, wind movement, hydrology, and ecology studies) and consider these within the impact assessment.	Section 9.5
86	Identify any limitations associated with the aquatic ecology investigation data or existing knowledge and discuss their implications for the impact assessment.	Section 9.3.1
87	Discuss the proposed management, monitoring (including on adjacent tenure) and mitigation measures (in terms of the mitigation hierarchy) to prevent impacts to inland waters, and potential flow-on effects on the surrounding environment as a result of implementing the Proposal, at local, catchment and regional scale	Section 9.5
88	If management plans are required to be developed to address specific impacts, they will be prepared in accordance with EPA Guidance Instructions on how to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans and Environmental Management Plan Guidelines.	Section 9.5 Appendix C.4
89	Determine and quantify any significant residual impacts to Inland Waters in accordance with *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) by applying the Residual Impact Significance Model (page 11) and WA Offset Template, and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).	Section 9.6
90	If significant residual impacts to Inland Waters remain after applying the mitigation hierarchy, an appropriate offset strategy will be developed in consultation with the Tjamu (Aboriginal Corporation) RNTBC and other relevant stakeholders for the Proposal in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012). If required, spatial data defining the area of significant residual impacts will also be provided.	Section 13
91	If an offset strategy is required, Agrimin will use its best endeavours to ensure that any offsets required for inland waters are directed towards matters that are relevant to and benefit the Kiwirrkurra People, particularly through support for the Kiwirrkurra Indigenous Protected Area program and its land management activities	Section 13
92	Prepare a Mine Closure Plan (MCP) consistent with the Department of Mines, and Petroleum (DMIRS) Mine Closure Plan Guidance (DMP and EPA 2015), that addresses the development of completion criteria to maintain the quality of surface water and groundwater so that environmental values are maintained post closure.	Appendix D

Task No.	Required Work	Section
93	Within the ERD demonstrate how the Proponent considers the EPA's objectives for this factor has been addressed.	Section 9.6
Social Surroundings		
94	Characterise the cultural heritage values and identity any sites of significance within the Proposals Development Envelopes, their relevance within a wider regional context and any other areas that may be indirectly impacted from Proposal activities.	Section 10.4
95	Conduct Aboriginal heritage surveys of the Development Envelopes, 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 any Aboriginal sites of significance and identify concerns in regard to impacts from proposed Proposal activities.	Section 10.3
96	Provide a description of the heritage values within all Development Envelopes.	Section 10.4
97	Characterise the emission sources, and deposited dust sources from the Proposal in from on-lake, off-lake, and the northern haul road activities to ensure compliance with NEPM standards.	Section 10.4.5
98	Assess the impacts on heritage sites and cultural values in accordance with the Environmental Factor Guideline - Social Surroundings and EPA Guidance Statement No. 41: Assessment of Aboriginal Heritage.	Section 10.6.1
99	Assess the impacts on amenity and predict the residual impacts after considering the mitigation hierarchy.	Section 10.6.2
100	Assess the potential direct and indirect impacts associated with the Proposal from air quality emissions within the Development Envelopes.	Section 10.6.2
101	Predict the residual impacts on social surroundings for direct, indirect, and cumulative impacts after considering mitigation hierarchy.	Section 10.7
102	Identification and discussion of proposed management, monitoring and mitigation measures (in terms of the mitigation hierarchy) to achieve predicted outcomes/objectives for social surroundings.	Section 10.5
103	Identify any limitations associated with the heritage survey data or existing knowledge and discuss their implications for the impact assessment.	Section 10.3.1
104	Develop a Cultural Heritage Management Plan (CHMP) for proposed monitoring and management where required, in accordance with EPA Guidance Instructions on how to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans and the Guidelines for the development of an Aboriginal Cultural Heritage Management Plan for the *Aboriginal Heritage Act 1972* (DIA 2009).	Section 10.5
105	Prepare a Mine Closure Plan (MCP) consistent with the Department of Mines, and Petroleum (DMIRS) Mine Closure Plan Guidance (DMP and EPA 2015). Provide detail on any consultation undertaken with Traditional Owners in undertaking surveys, assessment of significance and in preparing the ACHMP and MCP.	Appendix D
106	Within the ERD demonstrate how the Proponent considers the EPA's objectives for this factor have been addressed.	Section 10.7

Executive Summary

Introduction

The purpose of this Environmental Review Document (ERD) is to support the assessment of the Proposal by Agrimin Limited (Agrimin; the Proponent) to construct and operate the Mackay Sulphate of Potash (SOP) Project (the Proposal).

This ERD has been prepared in accordance with *How to prepare an Environmental Review Document: Instructoins* (EPA 2021b).

Assessment Process

Agrimin referred the Proposal to the Western Australia (WA) Environmental Protection Authority (EPA) on 2 January 2019. On 4 February 2019, the EPA determined the Proposal to be assessed at the level of ERD with a public review period of four weeks, with a Proponent prepared Environmental Scoping Document (ESD).

Since referral, and while under Part IV assessment, Agrimin has submitted two requests to the EPA to undertake minor changes (approved on 12 June 2020 and 11 June 2021) to the Proposal in accordance with section 43A (s.43A) of the *Environmental Protection Act 1986* (EP Act). The key changes were a result of additional information becoming available to inform a number of robust proponent-led avoidance measures to directly reduce clearing of locally important fauna habitats within the Proposal area, and include the following key changes:

- realigning the haulage corridor and the Northern Infrastructure Development Envelope (NIDE) to avoid the local Yagga Yagga Great Desert Skink population;
- reducing the width of the haulage corridor and prohibiting borrow pits in sensitive habitats, where Night Parrot habitats occur;
- refinement of the NIDE to 33,928 ha;
- relinquishment of the proposed western 'dog leg' access route within the Southern Infrastructure Development Envelope (SIDE) and addition of an alternative access track alignment and water pipeline leading from the Off-lake Development Envelope (Off-LDE) to the borefield, allowing for essential infrastructure to be progressively relocated away from areas of elevated heritage significance; and
- decreasing abstraction volumes of groundwater from the SIDE's borefield from 5.0 GL/a to 3.5 GL/a.

These proposed changes demonstrate Agrimin's on-going commitment to protecting the environmental values of the Great Sandy Desert region.

Background and Context

The Proposal is located on Lake Mackay, situated approximately 490 kilometres (km) south of Halls Creek, adjoining the Northern Territory (NT) border (Figure ES-1). Lake Mackay hosts the largest SOP deposit in Australia and covers an area of approximately 3,513 km^2. SOP bearing brine will be extracted from shallow trenches on Lake Mackay's surface before being processed onsite to produce a SOP product. Agrimin's processing plant is proposed to be located in a manner that avoids further disturbance to Lake Mackay, offset to the western shoreline of the lake.

The Proposal requires the construction of a new 346 km sealed haul road to connect the site to the existing public road network (Figure ES-2) to allow for transporting the SOP product to Wyndham Port. For operational purposes a water pipeline from a water supply borefield located 45 km south-east of Lake Mackay is also proposed.

The Proposal lies within three Native Title Determination Areas, as specified under the *Native Title Act 1993* (NT Act). The Proposal's brine reserves, processing plant and non-process infrastructure (including borefields) and a southern portion haul road, are located within the Kiwirrkurra Determination Area, while the haul road crosses into the Ngururrpa and Tjurabalan Determination Areas to the north. The Proposal is also located within Ngaanyatjarra Central, Kearney and Balgo Australia Aboriginal Reserves. The nearest local Indigenous community to the Proposal's operations area is the Kiwirrkurra Community, located 60 km southwest from the borefield. Balgo is located approximately 200 km to the north, 2.6 km west of the proposed haul road.

The Proposal is a valuable strategic asset, both from a domestic and international perspective, as it is expected to:

- provide sustainable economic opportunities and improved social values and connectivity for remote indigenous communities by providing employment and developing improved and safer regional road infrastructure (i.e. upgrade and sealing of the Balgo Track);
- promote the growth and diversify of the local and broader Australian economy; and
- create important SOP supply to support sustainable and high-quality food production globally.

The Proposal will be a significant source of direct and indirect employment over its operational life, providing direct employment for at least 200 staff during construction and operations, as well as create more than 1,500 jobs through the regional supply chain. The Proposal will generate valuable long-term opportunities for the Native Title groups and indigenous communities throughout the Central Desert and the broader Kimberley region.

Furthermore, the Proposal has the potential to provide substantial benefits, including significant royalties to the Kiwirrkurra Native Title holders as well as support for several land projects that are being implemented under the Kiwirrkurra Indigenous Protected Area (IPA) Plan for Country, which manages and protects the biodiversity and cultural resources within the vast Kiwirrkurra region.

Commonwealth Determination

The Proposal was determined to be a 'Controlled Action' by a Delegate of the Commonwealth Minister for the Environment under the EPBC Act on the 5th of August 2019 as it will, or is likely to, have a significant impact on the following Matters of National Environmental Significance (MNES):

- listed threatened species and communities (section 18 and 18A of the EPBC Act).

These listed threatened species have the potential to comprise the:

- Greater Bilby (*Macrotis lagotis*) – Vulnerable;
- Night Parrot (*Pezoporus occidentalis*) – Endangered;
- Princess Parrot (*Polvtelis alexandrae*) – Vulnerable;
- Great Desert Skink (*Liopholis kintorei*) – Vulnerable;
- Australian Painted Snipe (*Rostratula australis*) – Endangered; and
- Dwarf Desert Spike-rush (*Eleocharis papillosa*) – Vulnerable.

On the 5th of August 2019, it was determined that the Proposal was to be assessed by accredited assessment under the Bilateral Agreement between the Commonwealth and WA governments. In accordance with the Bilateral Agreement, the Commonwealth's statutory timeframes prescribed under the EPBC Act for approval of the Proposed Action will commence on receipt of the final WA EPA's assessment report and recommended conditions.

Since submitting the Proposed Action for assessment under the EPBC Act, Agrimin have received approval under section 156A of the EPBC Act for two variations to the Proposed Action (approved on 11 August 2020 and 17 June 2021). The approved variations align with the changes sought under section 43A of the EP Act. As noted previously, the key changes were a result of additional information becoming available to inform a number of robust Proponent-led avoidance measures to directly avoid and reduce clearing of EPBC Act-listed threatened species within the Action's Proposal area.

To inform the impact assessment with regard to MNES, a search of the Protected Matter Search Tool for threatened species was undertaken, followed by on ground survey work, with the results of the desktop study provided in Appendix G.1. Based on this assessment, six threatened fauna species were confirmed to occur. The remaining species were either considered possible (one species), unlikely (three species) or as no longer occurring in the Great Sandy Desert or Tanami bioregions (seven species). No EPBC Act-listed flora species or vegetation communities were recorded, or were considered likely to occur, within the Action's area.

Section 12 provides an assessment of potential impacts on EPBC Act listed threatened species and communities from the Proposed Action, as directed by the EPBC Act determination. Agrimin note that although the controlling provision for 'List Migratory Species' was not part of the Commonwealth's determination, consideration for the Proposed Action's impacts to these species has been provided for information, which again, demonstrates Agrimin's commitment to ensuring all environmental values of Lake Mackay are fully understood and protected.

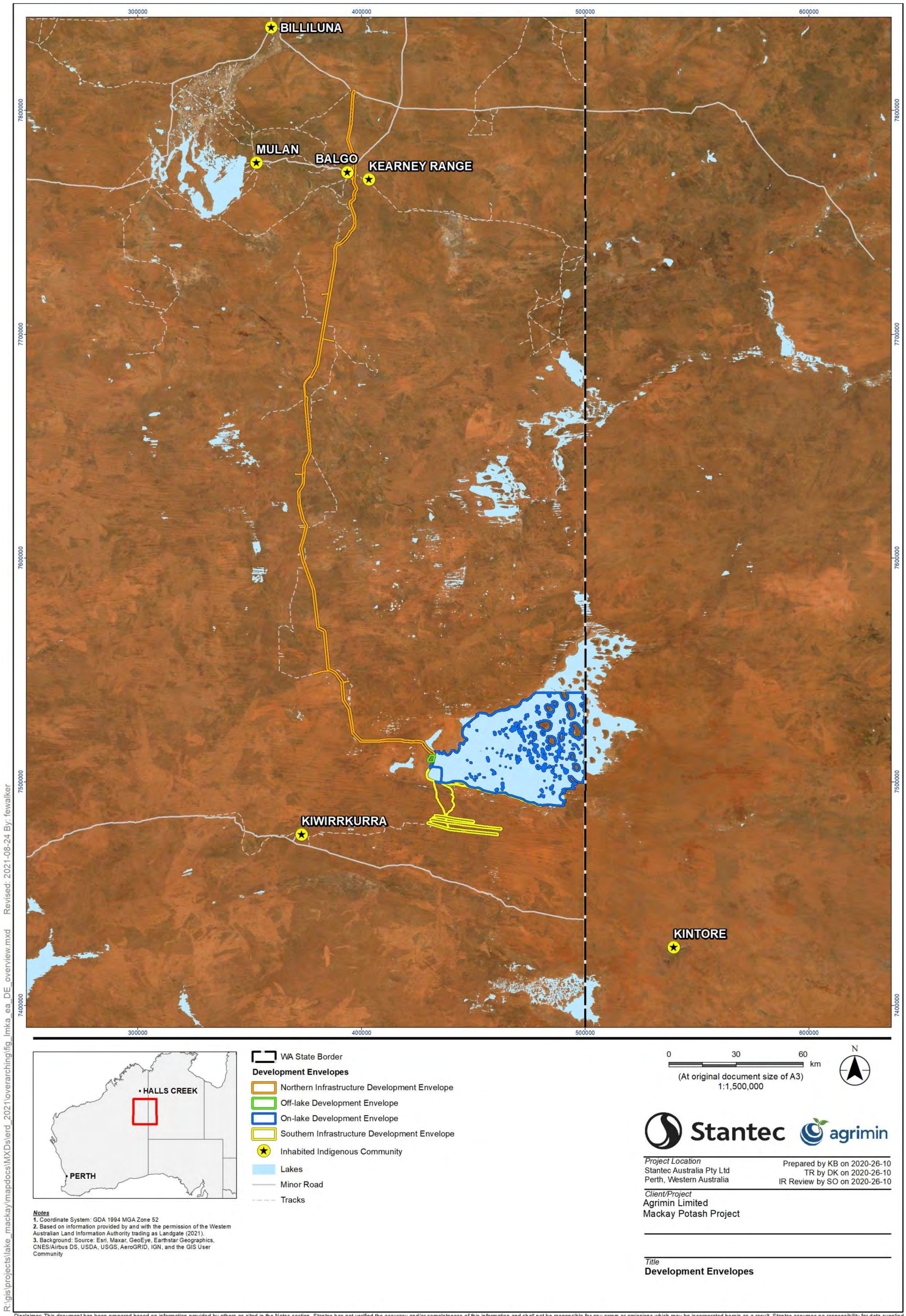
Overview of the Proposal

The Proposal's key physical and operational elements of the Proposal are outlined in Table ES-1, Figure ES-1 to Figure ES-4.

Table ES-1: Key Proposal Characteristics

Proposal title	Mackay Sulphate of Potash Project
Proponent name	Agrimin Limited
Short description	Agrimin Limited proposes to develop a greenfields potash fertiliser operation designed to operate for a 20-year period. The Proposal involves the on-lake development of trenches and solar evaporation ponds for brine extraction and SOP production. The off-lake development includes a processing plant, associated site infrastructure and access roads for trucking SOP product to Wyndham Port. A northern linear access corridor will include the primary site access road, and potentially a water supply pipeline. A southern infrastructure corridor may be used as an alternate water supply option.

Element	Proposed extent
Physical elements	
Proposal area (all Development Envelopes)	Disturbance of up to 15,000 ha on the lake surface and no more than 1,500 ha of clearing of native vegetation within the total development of 263,675 ha.
On-LDE: Brine extraction trenches and evaporation ponds.	Disturbance of no more than 15,000 ha of the lake within the 217,261 ha On-lake Development Envelope (less than 5 % of the lake's surface).
Off-LDE: Processing infrastructure, power supply, access roads, associated infrastructure (camp, airstrip).	Clearing of no more than 200 ha of native vegetation within the 688 ha Off-LDE.
SIDE: Borefield, water pipelines and access tracks.	Clearing of no more than 300 ha of native vegetation within the 11,799 ha SIDE.
NIDE: Haul road.	Clearing of no more than 1,000 ha of native vegetation within the 33,928 ha NIDE.
Operational elements	
Trench Construction	Construction of up to 2,000 km of extraction trenches during the first 17 years of operation.
Brine Abstraction	Abstraction of up to 100 GL/a of hypersaline brine.
Water Abstraction	Abstraction of up to 3.5 GL/a of groundwater for processing.
Water Treatment	Treatment of no more than 0.2 GL/a of water through a reverse osmosis plant.
Waste Salt	Disposal of no more than 18 mtpa of waste salt to be retained on the lake surface.
Wind Turbine	Placement of 5 wind turbines located within the SIDE and NIDE



Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

Figure ES-1: Overview of the Proposal, the Proposal area and Development Envelopes

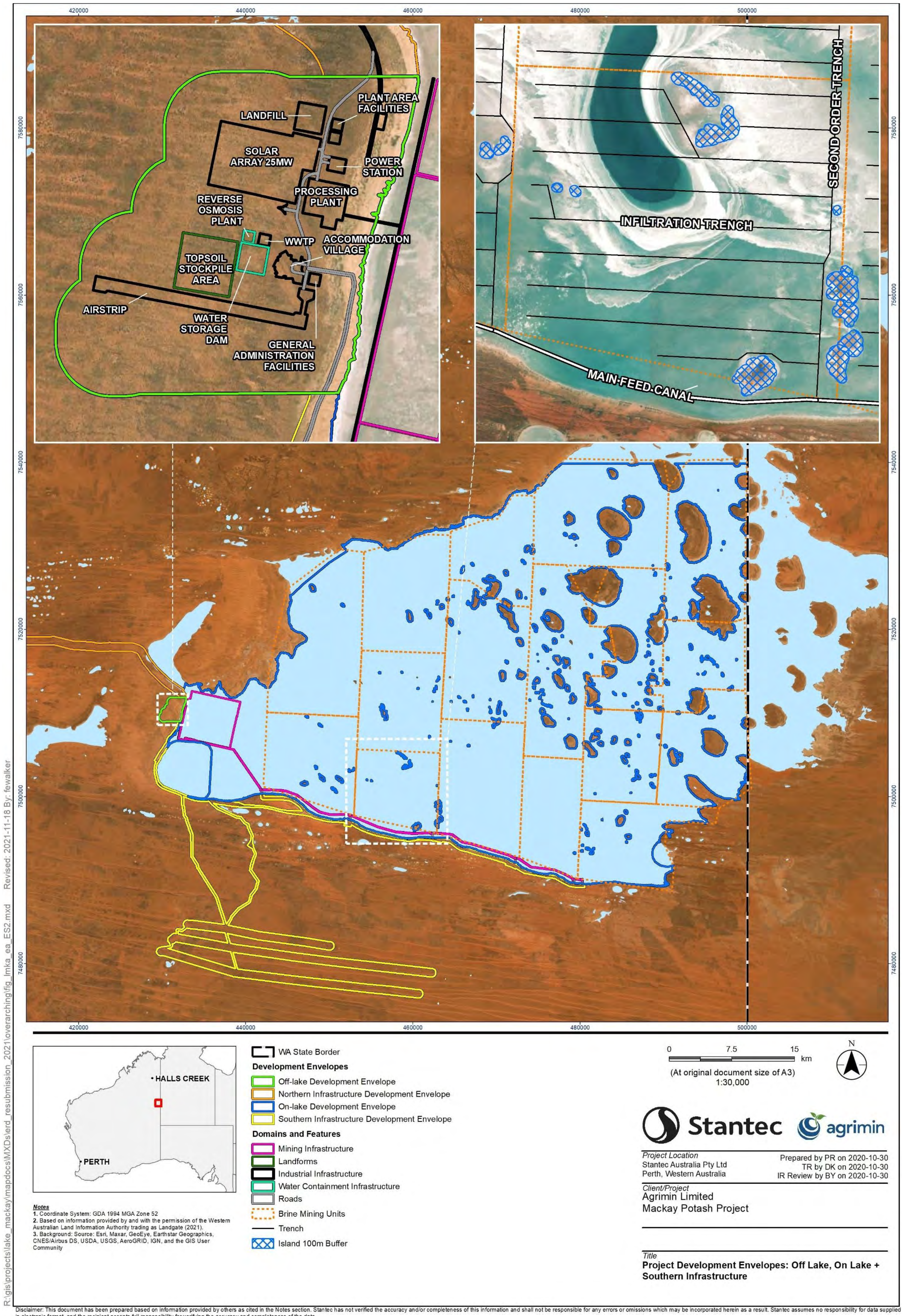


Figure ES-2: The Proposal, the On-LDEs and the Off-LDEs

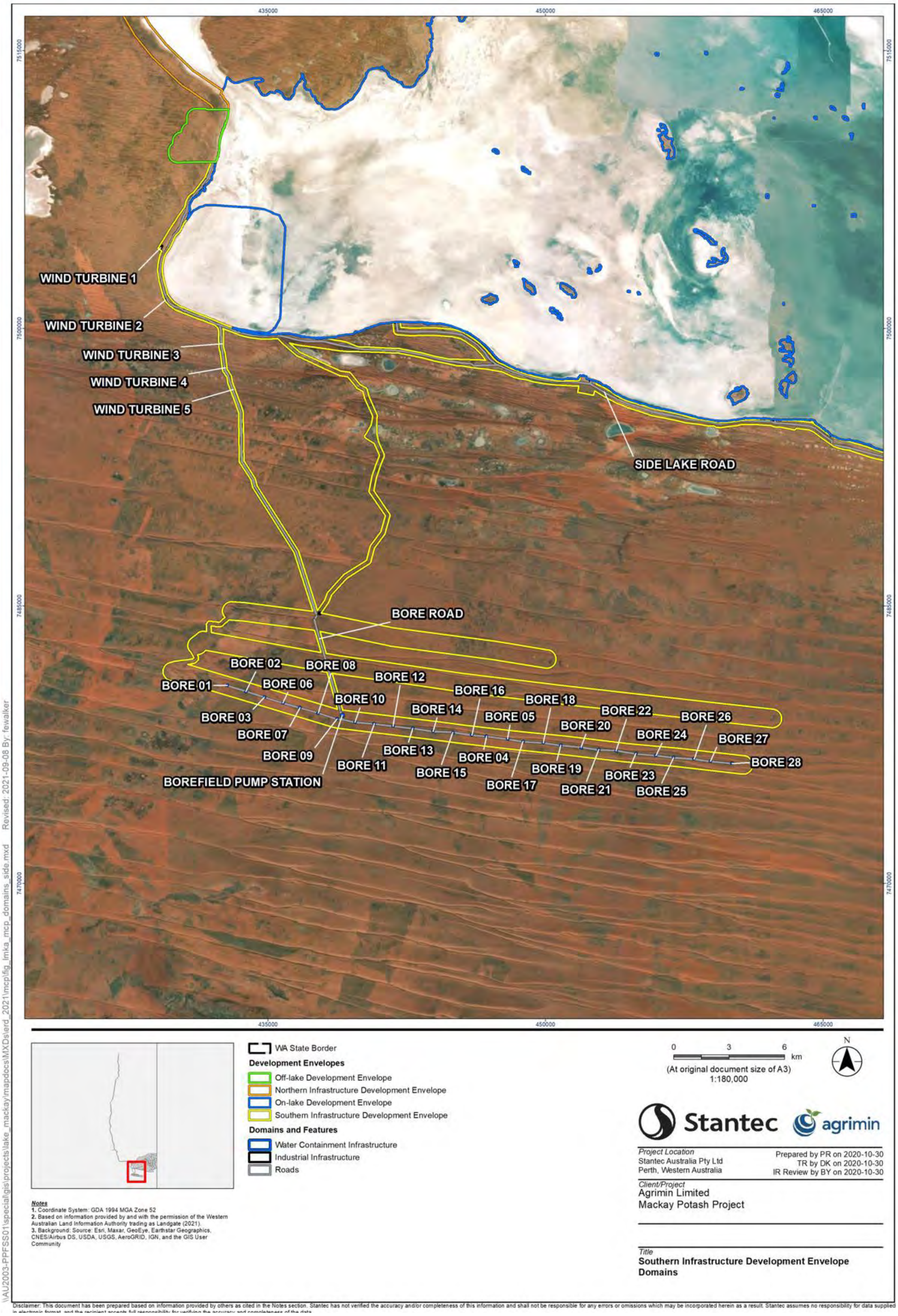


Figure ES-3: The Proposal's SIDE

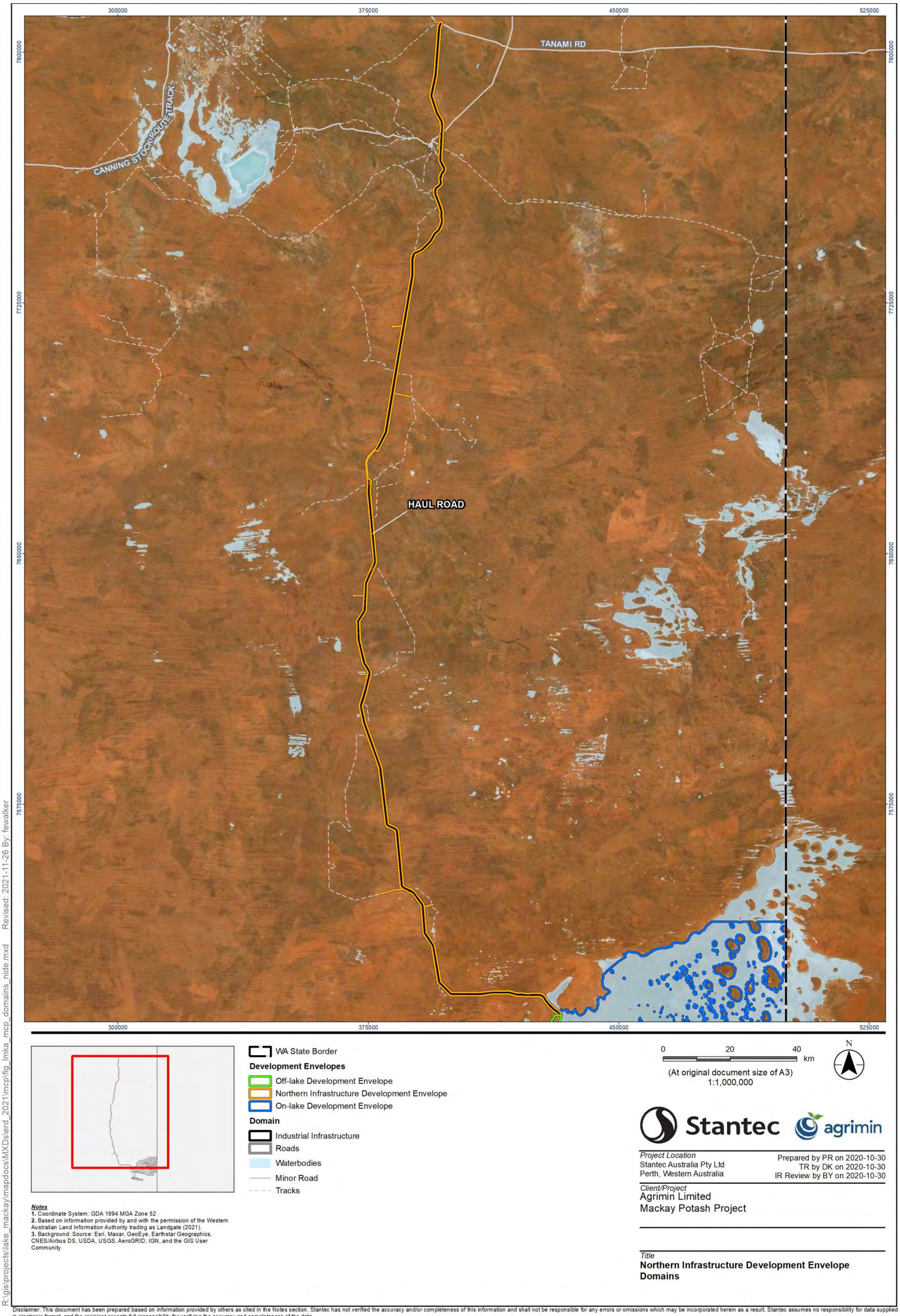


Figure ES-4: The Proposal's NIDE

Summary of EPA's Key Environmental Factors for the Proposal

The Proposal's summary of the environmental review for EPA's key Environmental Factors is provided as follows:

- flora and vegetation (Table ES-2 and Section 5.3);
- terrestrial fauna (Table ES-3 and Section 7);
- subterranean fauna (Table ES-4 and Section 8);
- inland waters (Table ES-5 and Section 9); and
- social surroundings (Table ES-6 and Section 10).

Flora and Vegetation

Table ES-2: Flora and Vegetation

<table>
<tr><th colspan="3">Flora and Vegetation</th></tr>
<tr><td>EPA objectives</td><td colspan="2">To protect flora and vegetation so that biological diversity and ecological integrity are maintained (EPA 2016b).</td></tr>
<tr><td>Policy and guidance</td><td>Legislative instrument
• Biodiversity Conservation Act 2016
• Biosecurity and Agricultural Management Act 2007
• Environment Protection and Biodiversity Conservation Act 1999
• Environmental Protection Act 1986
EPA policy or guidance & considerations
• Environmental Protection Authority. (EPA 2006). Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems: A guideline that references terrestrial habitats and wetlands where cleared land is to be reinstated with natural ecosystem, which helps to establish completion criteria for measuring rehabilitation success.
• Environmental Protection Authority. (EPA 2016b). Environmental Factor Guideline – Flora and Vegetation: The EPA's advice on the flora and vegetation factor was considered for the environmental impact assessment (EIA) of the Proposal's activities and Development Envelopes.
• Environmental Protection Authority. (EPA 2016i). Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment: Vegetation surveys to support the Proposal were undertaken in accordance with this guideline's methodology and reporting requirements.</td><td>Other policy or guidance & considerations
• Government of Western Australia. (Government of Western Australia 2011). WA Environmental Offsets Policy: This document aims to address the protection and conservation of environmental and biodiversity values for present and future generations.
• Department of Environmental Regulation. (DER 2014b). A guide to the assessment of applications to clear native vegetation under the Environmental Protection Act 1986: Used to develop the approach to addressing vegetation clearing for the Proposal, with particular focus on clearing permits.
• Environmental Protection Authority. (EPA 2021c). How to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans: Instructions: A guide for preparing Environmental Management Plans that may be required in conjunction with the Proposal.</td></tr>
<tr><td>Receiving environment</td><td colspan="2">Five flora and vegetation surveys have been undertaken for the Proposal. For the purposes of EIA, the environmental values of both the local and regional context of the Proposal area are considered. Two additional flora and vegetation surveys have been conducted either intersecting with, or entirely within, the Proposal area with applicable findings incorporated within the results of the surveys commissioned for the Proposal. The Study Area of 443,985 ha encapsulates three previous survey areas surveyed for the Proposal (360 Environmental 2017a; ecologia Environment 2017b; Strategen 2018) along with the Stantec 2020 survey area. The consolidation of all previous work (vegetation mapping, survey effort and survey findings) is detailed in Section 5.3 and Appendix F and summarised in the following sections to inform the impact assessment for the Proposal.
Vegetation
• 50 vegetation types have been recorded within the Study Area, none of which represent a Threatened Ecological Community (TEC) or Priority Ecological Community (PEC) or groundwater-dependent vegetation. All 50 of the of the vegetation types described and delineated in the Study Area occur within the Proposal area. Of these 50 vegetation types, 39 occur in the NIDE, 13 in the SIDE, 11 within the On-LDE and five within the Off-LDE.
Riparian vegetation
• Riparian zone vegetation occurs within the Study Area, primarily in association with Lake Mackay and its islands. Chenopod shrublands, dominated by Tecticornia spp. fringe the lake, typically between the playa and hummock grassland communities. A total of 21,636 ha of riparian vegetation occurs within the Study Area. Of this, 1,523 ha (7.04%) occurs within the Proposal area, and 33.13 ha occurs within the Indicative Footprint, which represents only 0.15% of riparian vegetation within the Study Area.
Vegetation supporting significant flora
• 19 vegetation types support Priority flora within the Proposal area and are therefore considered to be locally significant. Of the 19, two support Priority 1 species and both are highly associated with the margins of Lake Mackay and dominated by chenopods including a number of Tecticornia species.
Vegetation condition
• Vegetation condition within the Proposal area ranged from Excellent to Completely Degraded. The majority of the vegetated portions of the Proposal area were considered to be in Excellent condition, with the saline playa disregarded from condition assessment due to being largely devoid of vegetation. Fire has impacted large areas of the region, including within the Study Area and the Proposal area. The extent of fires occurring within the Study Area between 2016 and 2019, was mapped as approximately 19,795 ha (4.46% of the Study Area)
Flora of significance
• There were 541 flora species recorded within the Study Area of which were 14 Priority flora species recorded. Seven Priority flora species were recorded within the Proposal area, none of which are listed under the EPBC Act.
• Six flora records from the surveys are particularly noteworthy, as specimens displayed an affinity ('aff.') to a recognised species; however, also had characteristics that separate it from the known species. In each instance, the species it most closely resembles has been applied with the application of 'aff.'. Further taxonomic work would be required to determine these as distinct taxa and, until resolved, should be considered as flora of other significance.
• Of the 541 species recorded within the Study Area, 135 native flora species and two introduced flora species (approximately 25% of the total species recorded within the Study Area) represent range extensions.
Introduced flora
• Six introduced flora species have been recorded within the Proposal area, all of which occur within the NIDE. One of these weed species, *Tribulus terrestris, has also been recorded on an island, in close proximity to the On-LDE. None of the introduced flora species represent Weeds of National Significance (WoNS) or are listed under the Biosecurity and Agriculture Management Act 2007 as declared pests for either the Tanami or Great Sandy Desert bioregions.</td></tr>
<tr><td>Potential Impacts</td><td colspan="2">The potential exists for direct, indirect, and cumulative impacts from the Proposal to the flora and vegetation values of all four Development Envelopes. The risks of activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of the environmental risk assessment completed by the Proponent. Key or higher risk impacts are discussed in detailed within the ERD (Section 6.6.1 to 6.6.4). Impacts that were considered as having a lower risk level, that can be managed appropriately are summarised in the ERD (Table 6-16).
Potential Direct impacts:
• Clearing and fragmentation of native vegetation of up to 1,500 ha of native vegetation in the Indicative Footprint of the NIDE, SIDE, On-LDE and Off-LDE, including up to 33.13 ha of riparian vegetation.
• Direct disturbance of native vegetation within the Indicative Footprint is typically, less than 5% of a given vegetation type when compared to its extent within the Study Area, an represents only 0.15% of riparian vegetation within the Study Area.</td></tr>
</table>

Flora and Vegetation		
	Potential Indirect impacts: • Clearing and fragmentation of native vegetation – loss of significant flora, significant vegetation, and riparian vegetation). • Weed introduction and proliferation resulting in decline in vegetation health • Drawdown from groundwater abstraction resulting in decline in vegetation health (including riparian vegetation and flora with the ability to use groundwater). • Changes to surface hydrology and water flows during flooding events, causing changes to periods of inundation, resulting in disturbance and decline in flora and vegetation health. • Discharge or seepage of untreated wastewater resulting disturbance and decline in vegetation health; • Chemical, oil or hydrocarbon spill resulting in disturbance and decline in vegetation health; • Altered fire regimes resulting in disturbance and decline in vegetation health; • Increased soil salinity resulting in disturbance and decline in vegetation health; • Erosion causing disturbance and decline in vegetation health; • Disturbance of acid sulphate soils (ASS) causing disturbance and decline in vegetation health; and • Fugitive dust emissions resulting in disturbance and decline in vegetation health. Cumulative impacts • The Proposal is extremely remotely located with no possibility of cumulative impacts from other existing activities or foreseeable proposed development within or surrounding the Proposal area.	
Mitigation	The following mitigation measures are proposed for implementation to avoid, minimise, monitor and rehabilitate impacts to flora and vegetation receptors and reduce environmental risk. Avoid • Processing plant and associated infrastructure to be constructed outside of the riparian vegetation • The location and layout of the On-LDE infrastructure has been designed to minimise impacts to the lake islands and the lake fringe riparian zone, including avoidance buffers ranging from 250 to 500 m and no clearing of native vegetation on lake islands • 30% of the haul road will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas • Trench network will be outside a suitable buffer zone from island formations (buffer dependent on island size) and riparian vegetation to prevent groundwater drawdown impacts • Avoid facilitating the introduction of new weed species or the spread of existing weed species in the Proposal area as a result of the Proposal Minimise • Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing • Large rainfall events (300 millimetres (mm) within one month) will recharge groundwater level and reset to within 0.5 metres (m) of the surface (baseline conditions) • Cohesive salt crust to assist in retention of sediment/soil moisture limiting sediment/soil mobilisation • Borefield pumping is managed to limit groundwater drawdown • Staged development of trenches via Brine Mining Units (BMUs) and engineering design (1 km spacing, install crossovers) to allow natural surface water flows and flooding in natural depressions of the lake • Limit vehicle and personnel movements outside of approved access and disturbance envelopes • Liaising with Traditional Owners about the management of local fire regimes and fire management practices • Fire response equipment maintained at site and in vehicles and machinery and Haul Trucks • Water trucks fitted with high pressure monitors and pumps for fire management • Develop education programs for haul road users (including Traditional Owners) • Spill response equipment (including on all Haul Trucks) and training available	Monitor • Post clearing inspections • Bi-annual inspections of cleared and rehabilitated areas to detect presence of new weed species and to determine success of weed mitigation measures • Routine groundwater monitoring of groundwater drawdown levels and any changes in physio-chemical properties • Monitor vegetation health of riparian vegetation, along drainage features and lake fringes Rehabilitate • Rehabilitation of temporary cleared areas • Seed rehabilitation areas with local native species from reputable supplier (certified seed purity). Seed quality certification from external suppliers and contingency weed spraying during rehabilitation • Trench network and associated bunding will be breached at strategic locations on completion of the life of mine (LoM) operations to allow natural flow paths to return to the lake • Evaporation pond embankment will be breached at closure to allow periodic pulsed flows and natural dissipation of salt piles to the lake over time
Predicted outcome	This Proposal is expected to result in the unavoidable loss of up to 1,500 ha (0.5%) of native vegetation within 263,675 ha Proposal area. There are several activities associated with the Proposal that have the potential to impact flora and vegetation, including clearing and fragmentation of 1,500 ha of native vegetation, including the loss of individuals of significant flora, a small proportions of vegetation types that have the potential to support significant flora or are considered locally significant and a relatively small amount of riparian vegetation. Direct impacts to flora and vegetation when, combined with indirect impacts such as groundwater drawdown, have the potential to result in a decline in vegetation health (including riparian vegetation and flora with the ability to use groundwater), weed introduction and proliferation may result in cumulative impacts from the Proposal. The Proposal is not impacting upon any TECs, PECs, conservation reserves and vegetation types and significant flora are not restricted locally and are distributed widely in the regional context. The vegetation types are not protected under statute and the extent of impacts proposed is not likely to result in the conservation status of them being elevated or increasing the cumulative impact to a critical level. No groundwater-dependent vegetation has been shown to occur in the Proposal 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. The key mitigation measures that will be implemented for Flora and Vegetation for the Proposal largely avoid, mitigate, manage, monitor, and rehabilitate significant impacts to flora and vegetation receptors to reduce the environmental risk. Residual impact to Flora and Vegetation as a result of the Proposal was assessed as unlikely to result in long term, or significant residual environmental impacts requiring an offset, as defined in WA Environmental Offsets Guidelines (Government of Western Australia 2014). Given the above, and the management and mitigation measures proposed, the Proponent's assessment concludes this Proposal can be managed to meet the EPA's objective for Flora and Vegetation. *Based on the implementation of all mitigation measures to limit the impact of the Proposal on the environment, the EPA objective for Flora and Vegetation will be met.*	
Residual impact	No significant residual impact is anticipated for Flora and Vegetation	
Offset	No offsets are proposed for this factor	

Terrestrial Fauna

Table ES-3: Terrestrial Fauna

<table>
<tr><th colspan="3">Terrestrial Fauna</th></tr>
<tr><td>EPA objectives</td><td colspan="2">To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.</td></tr>
<tr><td>Policy and guidance</td><td>Legislative instrument
Biodiversity Conservation Act 2016
Biosecurity and Agricultural Management Act 2007
Environment Protection and Biodiversity Conservation Act 1999
Environmental Protection Act 1986
EPA policy or guidance & considerations
Environmental Protection Authority. (EPA 2016f). Environmental Factor Guideline – Terrestrial Fauna: This guideline is intended to outline the values and significance of terrestrial fauna and the various activities that may impact this factor.
Environmental Protection Authority. (EPA 2020b). Technical Guide: Terrestrial Fauna Surveys: The EPA's advice for conducting desktop studies, survey preparation, habitat assessment, survey techniques, specimen handling, data analysis, mapping and report to ensure a high standard of data available for EIA.
Environmental Protection Authority. (EPA 2016g). Technical Guidance: Sampling of short-range endemic invertebrate fauna: The EPA's advice on minimum requirements of managing and surveying short range endemic invertebrate fauna.
Environmental Protection Authority. (EPA 2020b). Technical Guidance Sampling Methods for Terrestrial Vertebrate Fauna: Technical advice on sampling techniques for different regions of WA for the data analysis, interpretation, and reporting requirements for EIA.</td><td>Other policy or guidance & considerations
Department Biodiversity, Conservation and Attractions. (DBCA 2017a). Interim Guideline for Preliminary Surveys of Night Parrot (Pezoporus occidentalis) in Western Australia: This guideline details the information to determine when and where a night parrot survey should be conducted, as well as the methodology that should be used.
Department of Environment, Water, Heritage, and the Arts. (DEWHA 2010). Survey Guidelines for Australia's Threatened Birds: Helps to provide the necessary information and conduct the appropriate surveys to determine a presence/absence assessment for bird species listed as threatened under the EPBC Act
Department of the Environment. (DotE 2013). Matters of National Environmental Significance: Significant impact guidelines 1.1 – Environment Protection and Biodiversity Conservation Act 1999: Determination of whether any part of the Proposal, pertaining to terrestrial fauna, has a significant impact on a matter protected under the EPBC Act 1999.
Department of Parks and Wildlife (DPaW), The Conservation and Management of the Bilby (Macrotis lagotis) in the Pilbara (DPaW 2017a): Aimed at improving the understanding of Greater Bilby population characteristics in order to provide government and private companies with information to appropriately manage for persistence of the species.
Department of Biodiversity, Conservation and Attractions (DBCA), Guidelines for Surveys to Detect the Presence of Bilbies, and Assess the Importance of Habitat in Western Australia (DBCA 2017b): A guideline for detecting current or recent presence, or absence of Bilbies in a given area, as well as assessing the importance of the habitat proposed to be impacted.
Department of Sustainability, Environment, Water, Population and Communities (DSEWPC), Survey Guidelines for Australia's Threatened Reptiles (DSEWPC 2011c): This document outlines the effort and methods that are appropriate for conducting a presence/absence survey for reptiles listed as threatened under the EPBC Act.
Department of Sustainability, Environment, Water, Population and Communities (DSEWPC), Survey Guidelines for Australia's Threatened Mammals (DSEWPC 2011b): Advice for conducting a presence/absence survey for mammals that are listed as threatened under the EPBC Act, this includes information on the methodologies and effort that should be involved.</td></tr>
<tr><td>Receiving environment</td><td colspan="2">The Proposal area and local surrounds (the Study Area) has been the subject of 11 terrestrial fauna surveys commissioned by Agrimin. The Study Area, which totals 443,985 ha, encompasses the entire Proposal area and is a consolidation of the previous survey areas for the Proposal. This large body of work included level 1 and level 2 terrestrial fauna surveys, as well as targeted Night Parrot, Great Desert Skink and waterbird surveys between 2016 and 2020. In addition, from 2001 to 2018, six regional surveys have been conducted that overlap the Study Area and provide additional local and regional context (Section 7.3). The consolidation of all previous work (habitat mapping, survey effort and survey findings) is detailed in Appendix G.
Fauna habitat
In total, 12 broad fauna habitats have been described and delineated during the consolidation of habitats across the Proposal area. These habitats were delineated on the basis of location, landform, substrate, vegetation type and their importance to different faunal groups, in particular their importance to fauna of significance. All habitats within the Proposal area were relatively untouched and assessed as being in excellent condition. The most extensive habitats in the Study Area were the playa (54.8%), spinifex sandplain (23.3%) and dunefield (9.3%). The remaining nine habitats comprised proportions that were individually less than 5% of the Study Area.
Significant landscape features
Three significant landscape features Lake Mackay, Island Outcropping and Water Sources have been identified within the Study Area and Proposal area, as they provide important sources of shelter, food and water for fauna, including significant fauna.
Lake Mackay and associated wetlands are predominantly dry and subject to irregular and infrequent inundation. The lake fills to a depth of approximately 2 m in the southeast corner of the lake on average once every 10 years. While the lake appears subject to a major flood, under these conditions the persistence of surface water is variable and dependent on preceding conditions. Typically, however, the lake may remain inundated for up several months. During major floods, the lake supports a range of waterbird species including shorebirds, terns and ducks. The larger islands on the lake serve as waterbird breeding habitat while the playa and surrounding claypans/ saline depressions support foraging resource. Two waterbird surveys have been undertaken at Lake Mackay in 2001 and 2017. The survey in 2001 coincided with the deepest and longest inundation event on record (40 years of Landsat data) (Stantec 2021a).
It has been estimated that five of the 271 islands on Lake Mackay comprise gypsiferous sediment, while the remaining islands are predominantly red/orange sands (Stantec 2021a). Outcropping and crevices on these gypsiferous islands were found to support bats belonging to the genus Scotorepens. Two common desert bat species from the genus Scotorepens have been recorded in the broader Study Area, Scotorepens blastoni; and Scotorepens greyii.
Water sources are a limiting factor in arid environments and are an important feature of the arid interior, albeit typically temporarily during and following rainfall events. Specifically, birds and mammals will use these areas for drinking, amphibians will use these areas to breed, and many vertebrate fauna will benefit from increased aquatic invertebrate fauna abundance for food. A total of 13 temporary water sources were identified in the Study Area. Most were pools in exposed bedrock, associated with rocky substrates in rocky ridge and gorge (5), minor drainage line (3), and outcropping and stony rise (2) habitats. Three were identified in claypans and claypan mosaic habitat; these comprised large claypans and a soak. The location of one permanent water source supplied by Tjurabalan representatives is approximately ~250 m west and downstream of the NIDE
Fauna assemblage
In total, across all previous surveys that intersect the Study Area, a total of 245 vertebrate fauna species have been recorded, comprising 22 native mammals, 9 introduced mammals, 129 birds, one introduced bird, 80 reptiles and 6 amphibians. A complete list of all fauna species recorded within the Proposal is presented in Appendix G.1.
Significant fauna species
Based on all previous surveys, 21 significant species, listed under the Biodiversity Conservation Act 2016 (BC Act), the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) or both, have been confirmed in the Study Area (Table 7-8). Three listed mammals were confirmed in the Study Area: Greater Bilby (Macrotis lagotis) (Vu, Vu); Brush-tailed Mulgara (Dasycercus blythi) (P4); Northern Marsupial</td></tr>
</table>

Terrestrial Fauna	
	Mole (*Notoryctes caurinus*) (P4) and Southern Marsupial Mole (*Notoryctes typhlop*) (P4). Five listed birds were confirmed within the Survey area including Night Parrot (*Pezoporus occidentalis*) (E, Cr); Australian Painted Snipe (*Rostratula australis*) (En, En); Princess Parrot (*Polytelis alexandrae*) (Vu, P4); Grey Falcon (*Falco hypoleucos*) (Vu) and Striated Grasswren (*Amytornis striatus striatus*) (P4). Three listed reptiles were confirmed within the Survey area including Great Desert Skink (*Liopholis kintorei*) (Vu,Vu); Broad-eyed Slider (*Lerista aff. Robusta*) (P1) and Spotted Ctenotus (*Ctenotus uber johnstonei*) (P2). • Primary habitats for each significant species have been identified based on survey findings (intersects of recorded locations and habitats) and supplemented with known ecology for each species. It is acknowledged that some species may occasionally be recorded outside their primary habitats, and these have been differentiated as secondary habitats. Each of these habitats have potential to be impacted by the Proposal and are discussed under Section 7.6.1. Migratory species • Migratory species listed under the EPBC Act include birds, mammals or reptiles listed under international agreements. An assessment of likelihood of occurrence was undertaken for the 24 migratory species that was informed by survey work and the results of the desktop study (Appendix G.1). • Based on this assessment, nine migratory species were confirmed to occur including Red-necked Stint (*Calidris ruficollis*) (Mi: migratory shorebird); Sharp-tailed Sandpiper (*Calidris acuminata*) (Mi: migratory shorebird); Oriental Plover (*Charadrius veredus*) (Mi: migratory shorebird); Common Greenshank (*Tringa nebularia*) (Mi: migratory shorebird); Glossy Ibis (*Plegadis falcinellus*) (Mi); Gull-billed Tern (*Sterna nilotica*) (Mi); Marsh Sandpiper (*Tringa stagnatilis*) (Mi: Migratory shorebird); White-winged Black Tern (*Sterna leucopterus*)(Mi: Migratory shorebird); and Fork-tailed Swift (*Apus pacificus*) (Mi). • Four migratory species were considered likely to occur within the Proposal area including Common Sandpiper (*Tringa hypoleucos*) (Mi: migratory shorebird); Pectoral Sandpiper (*Calidris melanotos*) (Mi: migratory shorebird); Oriental Pratincole (*Glareola maldivarum*) (Mi: migratory shorebird); and Wood Sandpiper (*Tringa glareola*) (Mi: migratory shorebird). The remaining species were either considered possible (six species), unlikely (five species) or as not occurring in the Great Sandy Desert or Tanami bioregions (two species). Short-range endemic (SRE) species • Terrestrial short-range endemic (SRE) invertebrate fauna are species defined as having a restricted range and have been broadly defined by Harvey (2002) as species with a maximum range of 10,000 km². The combined surveys of the Study Area yielded a total of 48 taxa from target groups which were represented by 1,490 invertebrate specimens. • Given the high proportion of taxa where SRE status could not be determined, in line with EPA guidance, habitat associations have been used within this document as a surrogate to infer potential distributions of the taxa. The 12 broad habitats described and delineated throughout the Study Area and present in the Proposal area (Section 7.4.1) were assessed based on their potential to support terrestrial SRE taxa (Appendix G.2). Based on this assessment, seven habitats were classified as having potential to support SRE taxa including the playa, lake margin, saline flats and depressions, claypan and claypan mosaic, rocky ridge and gorge, outcropping and stony rise, and drainage line. • Taxa identified as potential SRE species that were collected exclusively from habitats with potential to support SRE species included three wolf spiders (*Hogna* 'FP-11090', *Tetralycosa* sp., and *Venator* 'sp VWF1177'), another araneomorph Spider (Dictynidae 'LM1') a freshwater snail (*Leichhardtia cf. sisurnius*) and four tiger beetles (*Australicapitona* 'LM1', *Pseudotetracha 'blackburni* complex', *Pseudotetracha* 'cf helmsi', and *Rivacindela* sp.). Each of these nine taxa were found to occur in the vicinity of Lake Mackay or in association with peripheral habitats. These comprised combinations of the following habitats including the playa, lake margin, saline flats and depressions, and freshwater claypans and claypan mosaic. These taxa are likely to be distributed in association with these habitats around Lake Mackay. Introduced Fauna • A desktop assessment identified nine species of introduced mammal and one introduced bird that potentially occur in the Study Area. In total, eight species of introduced mammals were recorded within the Study Area and therefore have potential to occur in the Proposal area, including the European Cattle (*Bos taurus*), Camel (*Camelus dromedarius*), Feral Cat (*Felis catus*), Feral Dog (*Canis lupus*), Horse (*Equus caballus*), Red Fox (*Vulpes vulpes*), House Mouse (*Mus musculus*), and the Rabbit (*Oryctolagus cuniculus*).
Potential Impacts	The potential exists for direct, indirect, and cumulative impacts from the Proposal to the terrestrial fauna values of all four Development Envelopes. The risks of activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of the environmental risk assessment completed by the Proponent. Key or higher risk impacts are discussed in detailed within the ERD (Section 7.6.1 to 7.6.16). Impacts that were considered as having a lower risk level, that can be managed appropriately are summarised in the ERD (Table 7-10). Potential Direct impacts • Habitat loss, fragmentation or modification from land disturbance for the Proposal will total 16,500 ha and comprise up to 15,000 ha disturbance on the lake surface within the On-LDE and the disturbance of up to 1,500 ha of native vegetation within the combined remaining Proposal area; • Loss of individuals including significant fauna species; ○ Greater Bilby; ○ Night Parrot; ○ Great Desert Skink; ○ Brush-tailed Mulgara; and ○ Spotted Ctenotus. • Loss of waterbirds foraging and breeding habitat; • Loss of SRE invertebrate fauna species and / or habitat; • Loss of individuals from bird strike (wind turbines) and road strike from construction and haulage activities; • Attraction of waterbirds to artificial water bodies on the playa; and • Loss of fauna individuals from entrapment in ponds and infiltration trenches. Potential Indirect impacts • Altered fire regimes resulting in loss of important habitat for significant fauna; • Feral predators resulting increased predation on significant fauna; • Weed spread resulting in Increased risk of fire, reduced native vegetation cover/ alteration of fauna habitat; • Altered hydrology (excluding lake operations) impacting availability of water and nutrients; • Noise and vibration disrupting fauna behaviour (resting, breeding, foraging); • Light exposure resulting in disruption of fauna behaviour including significant fauna; and • Fugitive dust emissions from clearing of native vegetation and haulage activities, resulting in decline in health of fauna habitats and water sources. Cumulative impacts • The location of the Proposal is extremely remote with no cumulative impacts from other developments within or surrounding the Proposal area currently, or in the foreseeable future. Sensitive receptors (terrestrial fauna) are not expected to be significantly impacted by the Proposal by potential changes to hydrological processes and water quality, or drawdown.
Mitigation	Agrimin has applied the mitigation hierarchy to the Proposal to protect Flora and Vegetation so that biological diversity and ecological integrity are maintained. All identified impacts are mitigated via a robust environmental management approach which has either been developed or is planned to developed and implemented through a series of plans and procedures including, but not limited to, a Terrestrial Fauna

Terrestrial Fauna

Environmental Management Plan (TFEMP), Construction Environmental Management Plan (CEMP), Flora and Vegetation Environmental Management Plan (FVEMP), Mine Closure Plan (MCP), Ground Disturbance Permit System and Procedure, Fire Management Procedure, Feral Predator Control Programs (including on islands), Weed Management Procedure, Traffic Management Plan (TMP), and Incident Investigation and Reporting Procedure.

The following mitigation measures are proposed for implementation to avoid, mitigate, manage, monitor and rehabilitate impacts to terrestrial fauna individuals, habitat and habitat values and reduce environmental risk.

Avoid

- 30% of the haul road will be constructed on the existing cleared track reducing total clearing
- Clearing will only occur in approved ground disturbance areas
- Clearing for Haulage corridor pavement width has been reduced from 7.5 m to 6.5 m, limiting clearing/open areas will minimise open space able to generate dust emissions
- Limit disturbance On-LDE (4.55%; <15,000 ha) and clearing of vegetation on lake islands
- NT portion of the lake will remain undisturbed (56,506 ha)
- Exclusion zone on WA side of the lake that will remain undisturbed (32,261 ha)
- Avoid impacts to Islands (total of 20,119 ha of islands excluded from On-LDE)
- The location and layout of the On-LDE infrastructure has been designed to minimise impacts to the Lake Islands and the lake fringe riparian zone, including avoidance buffers ranging from 250 m to 500 m
- Avoid or limit clearing primary habitat where possible for significant fauna species
- Avoid clearing within drainage features and drainage lines where possible.
- Design of the Proposal avoids impacts to suitable breeding trees for the Grey Falcon (tall trees with raptor nests) and Princess Parrot (large stands of trees with hollows or potential to form hollows (e.g. stands of *Allocasuarina* sp. and *Corymbia* sp).
- Avoid clearing old growth spinifex and primary foraging habitats where possible (as identified by the fine scale mapping)
- The location of the wind turbines has been offset from the lake where possible to avoid migratory bird pathways
- Location of the wind turbines was selected to be on the western edge of the lake, which is away from the deeper eastern parts of the lake which are more likely to flood during inundation events and hence attracting water birds
- Avoid hot works in fire sensitive habitats
- Ban all staff and contractors brining any animals to site
- Avoid facilitating the spread of current weed populations from along Tanami Road to the Haul Road
- Avoid off-road driving and stay on approved access ways
- Restrict haulage on the haul road to daylight hours where possible

Minimise

- Implement strict clearing mitigation that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries.
- Clearing activities are planned to be carried out during daylight hours
- Where possible minimise clearing/disturbance to primary habitats for significant species
- During clearing activities within habitats for potential significant fauna species, have a fauna spotter present to relocate fauna out of the way of machinery.
- Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing
- Where clearing of suitable Greater Bilby habitat is unavoidable, mitigate impacts by clearing outside breeding season where possible.
- Where clearing of burrows (for the Greater Bilby and the Great Desert Skink) is unavoidable, mitigate impacts by relocating individuals to alternative suitable habitat ideally with existing burrows. Initially encourage burrow abandonment by disturbing entrance and monitoring (e.g. burrow sweeps and motion cameras) to confirm individual has left. Close burrow once abandoned. If burrow not abandoned, trap and cage individual at entrance and relocate before collapsing burrow, in the presence of suitably qualified fauna experts.
- Implement and enforce speed limits for all traffic, particularly at dawn/dusk and night-time in habitats and areas of importance to significant species
- Buffer and avoid any Night Parrot confirmed roost sites, if encountered.
- During road construction within drainage features, maintain ecosystem function i.e. surface hydrology (within and outside the DE).
- Restrict road haulage operations to daylight hours

Monitor (cont.)

Minimise (cont.)

- If a Night Parrot roost is detected within the Indicative Footprint, field staff will wait for the bird to leave the roost in the evening (confirmed by visual inspection of roost) before disturbing or removing the roost hummock to discourage the bird from returning. As Night Parrots are likely to use several roosts within their range, and extensive similar roosting habitat is present adjacent to the clearing footprint, it is anticipated that this will not have any long-term negative effects on the individual. If a nest is detected during pre-clearance listening surveys, these methods will not apply, and the nest area will be avoided entirely until any chicks have fledged, or a qualified fauna handler can relocate the nest.
- Staged development of infiltration trenches via BMUs and engineering design (1 km spacing, install crossovers) to allow natural surface water flows and flooding in natural depressions of the lake
- Maintain ecosystem function of SRE habitats that have potential to be impacted by the Proposal i.e. Lake and salt lake margin habitat.
- Implement bird deterrents around artificial water bodies on the lake, if required. To be informed from the monitoring program.
- Natural trench fill-in and breaking of pond bunds at closure to allow flow of water
- Approximately 1.5 m high bunding adjacent to trenches
- Fauna egress will be provided for temporary ponds such as Turkeys nests along the haul road
- Fencing will be installed around the perimeter of permanented freshwater storage dam/s
- Restrict haulage operations to daylight hours.
- Restrict public access to haul road (Agrimin staff, contractors, and Traditional Owners only)
- Implement speed limits for all traffic at dawn/dusk and night-time in habitats and areas of importance to significant species
- Develop education programs for haul road users (including Traditional Owners)
- Liaise with traditional owners to manage feral predators, particularly in habitat important to significant species and/or locations where significant species have been recorded.
- Develop training and awareness packages and inductions

Manage

- Engage and educate other haul road users of the importance in restricting driving to daytime hours and following speed restrictions outside of these hours
- Liaise with Traditional Owners for understanding local fire regimes and fire management practices
- Restricting haulage operations to daylight hours.
- Restrict public access to haul road (Agrimin staff, contractors, and Traditional Owners only)
- Implement speed limits for all traffic at dawn/dusk and night time in habitats and areas of importance to significant species
- Develop education programs for haul road users (including Traditional Owners)
- Liaise with traditional owners to manage feral predators, particularly in habitat important to significant species and/or locations where significant species have been recorded

Monitor

- Conduct a pre-clearance survey (four weeks prior to clearing) within Indicative Footprint
- Monitor any confirmed Night Parrot roost sites (if encountered) to determine success of mitigation
- Monitor foraging activity at known locations to determine success of mitigation
- Monitor vegetation / hydrology along drainage features within suitable Night Parrot habitat to determine success of mitigation
- Monitor Great Desert Skink burrow activity in proximity of disturbance to determine success of avoidance
- Record (and report) mortality events; establish a baseline to determine future mitigation effectiveness and potential 'hot spots' or periods of increased risk (e.g. mating dispersal) requiring particular focus
- Monitor success of fire management, particularly near significant species/habitat
- compared to baseline levels and to determine the effectiveness of control program
- Monitoring for significant species as required
- Record and monitor the presence of feral predators including an assessment of abundance
- Bi-annual inspections of cleared and rehabilitated areas to detect presence of new weed species and to determine success of weed mitigation measures
- Post clearing surveys

Monitor (cont.)

Terrestrial Fauna		
	• If Great Desert Skink burrows are encountered during pre-clearance, where possible avoid active burrows, ideally with a buffer accounting for foraging behaviour (>200 m). If direct impact is unavoidable, relocate individual to similar habitat in the area. • Conduct waterbird surveys after periods of sufficient rainfall to trigger waterbird activity, to better understand importance of the lake and peripheral ephemeral wetlands, and to monitor for potential impacts of the Proposal • Maintain records and report on fauna mortality rates to determine fauna at risk and potential locations of interest. • Implement a waterbird monitoring program from inception of the Proposal with corrective actions to be implemented if required. Given the large scale of the Proposal, monitoring for bird mortality will focus on the evaporation ponds and a representative portion of the trench network (once a week for southern trench and evaporation ponds, once every 6 months for infiltration trenches)	• During major flood events (i.e. one in 10 yr events), conduct waterbird surveys to coincide with peak lake productivity and optimal migratory shorebird occurrence. These surveys will aim to inform the importance of the lake and inform potential impacts of the Proposal Rehabilitate • Rehabilitation of temporary cleared areas • Seed rehabilitation areas with local native species from reputable supplier (certified seed purity). Seed quality certification from external suppliers • Contingency weed spraying during rehabilitation • Trench network and BMUs will be strategically breached on the completion of brine abstraction to allow natural flow paths to return to the lake Revise plan for the artificial waterbodies post closure depending on the findings of the monitoring data

Predicted outcome	The Proposal is expected to result in the unavoidable loss of potential fauna habitat for significant fauna species as a result of clearing activities; however, all habitats are extensive and well represented outside the Indicative Footprint. The salt lake playa comprises the largest proportion of any habitat to be impacted by the Proposal, comprising only 5.49 % of this habitat's extent within the Study Area. Based on the Indicative Footprint, the remaining off-lake disturbance will be largely confined to the spinifex sandplain, dunefield and gravel spinifex plain habitats. Disturbance to these habitats is proposed to be no greater than 2.6% of their individual extents in the Study Area. Disturbance within remaining habitats is proposed to be individually less than 45 ha or less than 1.5% of their individual extent within the Study Area.
	The Proposal is not expected to result in a significant impact to significant fauna. Where species have been identified as having potential for significant impact, specific mitigation measures have been developed and tailored depending upon species occurrence, behaviour and ecology. These species/groups include the following, based on conservation status, relative abundance and/or potential to be impacted by the Proposal:
	• Greater Bilby (Section 7.6.3.1): The species has high mobility, low site fidelity and occupies multiple burrows. Realignment of the Indicative Footprint would be unlikely to mitigate potential impacts as the species will establish new burrows, potentially in the new footprints. Mitigation will involve pre-clearance surveys and encouraged relocations in alignment with DBCA (2018) guidelines.
	• Night Parrot (Section 7.6.3.2): The species has been recorded foraging in two areas with long unburnt spinifex along drainage features that run between 5 km and 10 km perpendicular to the proposed haul road alignment. The species uses multiple roosts in the landscape. The population is estimated to be 2-5 individuals in the north and 2-3 individuals in the south. Given that the proposed width of clearing for the haul road in these areas is only 24 m, it is highly unlikely that clearing will directly impact upon roosting individuals. As a precautionary mitigation measure, pre-clearance listening surveys will be undertaken to identify the potential occurrence of any roost sites within the Indicative Footprint.
	• Great Desert Skink (Section 7.6.3.3): A new population of the species, the Yagga Yagga population, was identified during survey work. Given the sedentary nature of this species, the proposed haul road was realigned to avoid direct impacts and potential secondary impacts from road strike and population fragmentation. There are no other known occurrences of active burrows within the Proposal Area or Indicative Footprint.
	• Migratory or threatened waterbirds (Section 7.6.4): During inundation events, Lake Mackay is an important foraging and breeding ground for waterbirds. On-lake infrastructure has the potential to influence areas of inundation, and drawdown has the potential to influence duration of inundation events. Mitigation has involved the design and modelling of survey infrastructure to reduce potential impacts to areas of inundation, and to buffer all islands from direct impacts. Modelling of inundation events under operational conditions, compared to base conditions, has demonstrated that during large important inundation events, conditions will continue to be suitable for both foraging and breeding of waterbirds.
	Additionally, to minimise the direct, indirect, and cumulative impacts to terrestrial fauna including species of significance, Agrimin has prepared a CEMP and TFEMP to address potential impacts, which include the following key management actions:
	• pre-clearance surveys;
	• speed limits and restrict road haulage operations to daylight hours; and
	• develop a Feral Predator Control Program and Fire Management Procedure and liaise with Traditional Owners to implement these management measures.
	Restricting construction and operation activities to daylight hours along the haul road within the NIDE, also contributes to reducing the potential likelihood of vehicles strikes, and other indirect impacts such as noise, vibration and artificial light, on nocturnal species, such as the Great Desert Skink, Night Parrot and the Greater Bilby.
	Potential impacts on Terrestrial Fauna and proposed mitigation measures are outlined in Table 7-10. All potential direct and indirect impact on terrestrial fauna habitats and populations, are able to be effectively mitigated to meet the EPA objective for Terrestrial Fauna and are unlikely to result in long term, or significant residual environmental impacts.
	Some impacts may require monitoring during the early stages of construction/operation to ensure mitigation measures are sufficient.
	However, Agrimin are aware of the potential for the Proposal to result in significant residual impact to the Night Parrot, Greater Bilby and Great Desert Skink as a result of habitat loss. Currently, Agrimin are proposing to support the conservation of the Night Parrot through the provision of two packages of voluntary indirect offsets. These are summarised in Section 13 and below, and detailed within Appendix N:
	• Research: Funding of research to increase knowledge of the Night Parrot to better inform conservation management of the species; and
	• Social: Funding of ranger programs to manage existing key threats to the Night Parrot (and other threatened fauna that occur in the region) comprising feral predator control and fire management. These programs will have the following benefits:
	  ○ direct engagement of indigenous groups to manage land on respective IPAs; and
	  ○ meaningful conservation outcomes for the Night Parrot and other threatened fauna where feral predation and altered fire regimes are listed as key threatening processes.
	Based on the implementation of all mitigation measures to limit the impact of the Proposal on the environment, the EPA objective for Terrestrial Fauna will be met.	

Residual impact	*The Proposal has the potential to result in significant residual impact to the EPBC Act-listed Night Parrot, Greater Bilby and Great Desert Skink.*	
Offset	*Agrimin will be required to offset any significant residual impact to compensate for the loss of critical and supporting habitat for these species. Agrimin are committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with WA Environmental Offsets Policy* and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*.	

Subterranean Fauna

Table ES-4: Subterranean Fauna

<table>
<tr><th colspan="3">Subterranean Fauna</th></tr>
<tr><td>EPA objectives</td><td colspan="2">To protect subterranean fauna so that biological diversity and ecological integrity are maintained.</td></tr>
<tr><td>Policy and guidance</td><td>Legislative instrument
• Biodiversity Conservation Act 2016
• Biosecurity and Agricultural Management Act 2007
• Environment Protection and Biodiversity Conservation Act 1999
• Environmental Protection Act 1986
EPA policy or guidance & considerations
• Environmental Protection Authority. (EPA 2016d). Environmental Factor Guideline – Subterranean Fauna: Surveys and information provided for the Proposal were carried out in accordance with the requirements as set out in this guideline.</td><td>• Environmental Protection Authority. (EPA 2021e). Technical guidance – Subterranean fauna surveys for environmental impact assessment: The EPA's advice for conducting surveys, particularly focusing on the design and methodology, for subterranean fauna.
Other policy or guidance & considerations
• ANZECC & ARMCANZ. (ANZECC & ARMCANZ 2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy No.4: Used to assess and subsequently manage ambient water quality in natural and semi-natural water resources.
• Water Quality Australia (2018). Australian Water Quality Guidelines for Fresh and Marine Waters: Detailed guidelines for implementing adequate management of water quality in natural and semi-natural water resources.</td></tr>
<tr><td>Receiving environment</td><td colspan="2">Three subterranean fauna studies have been undertaken for the Proposal. Initial work included pilot and Level 1 studies by Invertebrate Solutions in 2017 which primarily targeted stygofauna within the surficial calcareous deposit within the Southern Regional area to the south of the On-LDE and east of the SIDE Borefield, with limited sampling On-LDE (islands and playa). To build on this knowledge, Stantec undertook a study comprising five separate subterranean fauna (stygofauna and troglofauna) field surveys in 2020 and 2021, focusing on sites (bores) located within the On-LDE (islands and playa), SIDE Borefield, and Southern Regional area (south of Lake Mackay).
Stygofauna
Lake
• No stygofauna have been recorded from the hypersaline groundwater associated with the lake bed sediments.
Islands
• A total of 85 stygofauna specimens have been recorded, predominantly from landform islands. These were represented by three copepod (microcrustacean) species. In addition, one individual of a potential stygofauna taxon, the oligochaete (segmented worm) Enchytraeidae sp., was also recorded.
• The three confirmed stygofauna species include the harpacticoid copepod Schizopera 'bradleyi' and cyclopoid copepods Fierscyclops fiersi and Halicyclops kieferi.
SIDE Borefield
• Two specimens of the potential stygofauna Enchytraeidae sp. (Oligochaeta) have been recorded from the proposed SIDE Borefield. Enchytraeids are known to occur in a wide range of habitats including terrestrial, marine and freshwater ecosystems. The extent of comparable geological units (Neogene alluvials) and associated groundwater in the area also implies a wider distribution in the area.
Troglofauna
Lake
• No troglofauna have been recorded from the playa, due to hypersaline groundwater in close proximity to the surface and limited interconnected voids.
Islands
• A single individual of the potential troglofauna Projapygidae-OES3 was recorded at one of the landform islands and may represent an endemic species.
SIDE Borefield
No troglofauna have been recorded from the SIDE.</td></tr>
<tr><td>Potential Impacts</td><td colspan="2">The potential exists for direct and indirect impacts from the Proposal to the subterranean fauna values of the lake islands and SIDE. The risks of activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of the environmental risk assessment completed by the Proponent. Key or higher risk impacts are discussed in detailed within the ERD. However, impacts were considered as having a risk level that can be managed appropriately are presented and addressed via management measures in the CEMP and other relevant management plans.
Potential Direct impacts
• Loss of subterranean fauna and/or prospective habitat due to groundwater drawdown associated with trench brine extraction (On-LDE) and abstraction for process water supply (SIDE Borefield)
• Excavation and destruction of prospective habitat for stygofauna and troglofauna beneath landform islands due the construction and establishment of trenches, ponds and infrastructure (On-LDE)
Potential Indirect impacts
• Groundwater contamination due to hydrocarbon spills and subsequent seepage into the subterranean environment, or increases to groundwater salinity due to the operation of abstraction trenches and evaporation ponds
• Increased runoff, and reduced infiltration and aquifer recharge due to changed surface topography, compaction or creation of hard surfaces resulting in altered groundwater flow paths (SIDE Borefield)
Potential Cumulative impacts
• The location of the Proposal is extremely remote with no cumulative impacts from other developments within or surrounding the Proposal area currently, or in the foreseeable future. Sensitive receptors (subterranean fauna) are not expected to be significantly impacted by the Proposal by potential changes to hydrological processes and water quality, or drawdown.</td></tr>
<tr><td rowspan="2">Mitigation</td><td colspan="2">Agrimin has applied the mitigation hierarchy to the Proposal to protect subterranean fauna so that biological diversity and ecological integrity are maintained. All identified impacts are mitigated via a robust environmental management approach which has either been developed, or is planned to be developed, and implemented through a series of plans and procedures including, but not limited to a CEMP, Inland Waters Environmental Management Plan (IWEMP), Ground Disturbance Permit System and Procedure, Fire Management Procedure, Hazardous Substances Management Plan (HSMP) and Procedure, Groundwater Monitoring Procedure (outlined in the IWEMP), and Incident Investigation and Reporting Procedure.
The following mitigation measures are proposed for implementation to avoid, mitigate, manage, monitor and rehabilitate impacts to subterranean fauna values and reduce environmental risk.</td></tr>
<tr><td>Avoid
• Implementation of suitable buffer zones between islands and abstraction trenches of up to 500 m for landform islands, negating the possibility of habitat disturbance and minimising drawdown
• Several larger islands (approximately 10) occur within the exclusion zone on the NT of the lake and will not be impacted by drawdown</td><td>• Delineate clearing boundary areas, and confirmed cleared areas
• Natural variance during dry conditions is substantial, suggesting stygofauna have a high natural resilience to fluctuating groundwater levels
Manage</td></tr>
</table>

Subterranean Fauna		
	• Drawdown within the SIDE Borefield area at a maximum will be <7% of total aquifer thickness, with limited habitat prospectivity for subterranean fauna • Avoid fuel/chemical storage and transfer from occurring outside of designated area • Clearing will only occur in approved ground disturbance areas and will avoid unnecessary changes to surface topography, compaction and/or creation of hard surfaces Minimise • Progressive implementation of BMUs to limit the rate and magnitude of drawdown • Major rainfall events (>300 mm in one month) will restore groundwater levels to baseline conditions	• Groundwater investigations and modelling will be used to investigate drawdown extent and change in surface flows to minimise impacts to lake, island and associated subterranean fauna habitat Monitor • Environmental monitoring programs with suitable site-specific trigger criterion (abiotic) will be implemented pre- and post-construction as required • Routine monitoring of groundwater levels and quality during operations as required Rehabilitate • Following closure of each BMU, recovery of groundwater levels to within 95% of baseline conditions is expected within two to five years
Predicted outcome	The potential environmental impacts of the Proposal can be effectively managed and are unlikely to result in long-term (or significant), residual impact to subterranean fauna values. The majority of the Proposal area has limited or no habitat prospectivity for stygofauna and troglofauna. The lake bed sediments and hypersaline groundwater associated with the playa are not conducive to subterranean fauna, while the SIDE borefield also has limited habitat within the fine textured alluvials. Low salinity groundwater in calcareous gypsiferous sands on the landform islands (predominantly landform islands) support stygofauna and troglofauna and may be affected by minor drawdown. However, this is expected to be a temporary habitat disturbance, with recovery of groundwater levels following cessation of mining, aided by major rainfall events. Groundwater monitoring and additional hydrogeological characterisation are planned for the larger lake islands, to appropriately manage potential impacts from the Proposal. Potential direct and indirect impacts to subterranean fauna are able to be effectively mitigated to meet the EPA objective for Subterranean Fauna; therefore, there are unlikely to be long term, or significant residual environmental impacts as a result of the Proposal. *Based on the implementation of all mitigation measures to limit the impact of the Proposal on the environment, the EPA objective for Subterranean Fauna will be met.*	
Residual impact	No residual impact is anticipated for Subterranean Fauna	
Offset	No offsets are proposed for this factor	

Inland Waters

Table ES-5: Inland Waters

Inland Waters	
EPA objectives	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected
Policy and guidance	Legislative instrument • *Biodiversity Conservation Act 2016* • *Biosecurity and Agricultural Management Act 2007* • *Environment Protection and Biodiversity Conservation Act 1999* • *Environmental Protection Act 1986* • *Rights in Water and Irrigation Act 1914* EPA policy or guidance & considerations • Environmental Protection Authority. (EPA 2016e). Environmental Factor Guideline – Terrestrial Environmental Quality • This document was written according to EPA (2021d) Statement of environmental principles, factors, objectives and aims of EIA • Environmental Protection Authority. (EPA 2020b). Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment: The EPA's advice for conducting desktop studies, survey preparation, habitat assessment, survey techniques, specimen handling, data analysis, mapping and report to ensure a high standard of data for EIA. Other policy or guidance & considerations • ANZECC & ARMCANZ. (ANZMEC/MCA 2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy No.4: Used to assess and subsequently manage ambient water quality in natural and semi-natural water resources. • Water Quality Australia. Water Quality Australia (2018). Australian Water Quality Guidelines for Fresh and Marine Waters: Detailed guidelines for implementing adequate management of water quality in natural and semi-natural water resources. • Australian Government National Water Commission. (Australian Government National Water Commission 2012). Australian Groundwater Modelling Guidelines: Seeks to provide a consistent and reliable approach to developing groundwater flow and solute transport models. • Environmental Protection Authority. (EPA 2018a). Environmental Factor Guideline – Inland Water Quality: The EPA's advice in relation to consideration of impacts to Inland Waters has been considered in the design of the Proposal to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected • Environmental Protection Authority. (EPA 2018d). Environmental Factor Guideline – Flora and Vegetation: The EPA's advice on the flora and vegetation factor was considered for the EIA of the Proposal's activities and Development Envelopes, with particular focus on riparian vegetation. • EPA Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016): Vegetation surveys to support the Proposal were undertaken in accordance with this guideline's methodologies and reporting requirements. • Department of Environmental Regulation. (DER 2015a). Identification and investigation of ASS and acidic landscapes: Used to address the minimum level of investigation into identifying presence and to define the nature and extent of ASS in a given area. • Department of Water. (DoW 2013). Western Australian water in mining guidelines: Advice on the management of water and the licensing assessment process to be considered in the proposal of mine planning. • Environmental Protection Authority. (EPA 2018e). Instructions on how to prepare Environmental Management Plans: A guide for preparing Environmental Management Plans that may be required in conjunction with the Proposal. • Geoscience Australia. (Geoscience Australia 2016). Australian Rainfall and Runoff Guidelines: Used for estimating flood characteristics, this guideline provides guidelines as well as data and a software suite.
Receiving environment	A substantial body of work has been completed to understand the Inland Waters factor for the Proposal. More than 30 studies have been undertaken across the geology, groundwater, surface hydrology and aquatic ecology disciplines, the results of which have been collated into technical reports and memorandums (Appendix H, Appendix I, Appendix J). These studies span from 2001 to 2021 and have included the lake and islands (On-LDE), claypans and riparian zone (Off-LDE), and the SIDE. Due to infrequent flood events on Lake Mackay, there was limited information on the aquatic biota of Lake Mackay when inundated. Rewetting trials in the laboratory were undertaken to simulate flooding and to document the emergence of aquatic biota. This was followed by opportunistic aquatic biota field surveys, targeted riparian flora (*Tecticornia*) collection and a waterbird survey during flooded conditions in early 2021. Geology • Lake Mackay typically comprises a thin salt (predominantly halite) crust up to 5 mm thick, which is more extensive in the west of the lake, compared to the east, where it becomes patchy and interspersed with increasing proportions of gypsum and windblown quartz sands. • Shallow lake bed sediments is the primary geological unit of interest within the On-LDE, which varies in composition from east to west across the lake due to varying depositional processes. The eastern portion of the lake is characterised by a variably cemented, white-brown, evaporitic crust, largely comprised of halite and gypsum underlain by a sequence of largely unconsolidated and damp gypsum sand. The western portion of the lake is characterised by a distinct white evaporite crust often underlain by a dark grey organic bed or laminations within a red-brown clay matrix and typically interspersed with gypsum crystals of varying grain sizes. • Lake Mackay is host to more than 270 islands within the On-LDE. The islands range from less than 1 m in height to more than 13.5 m. The lake islands are composed of unconsolidated aeolian sand at surface which is underlain by calcrete and gypsiferous sand. • Off-LDE geology is dominated by ephemeral claypans, irregularly spaced between longitudinal dunes around the periphery of Lake Mackay. They comprise poorly sorted interbedded sand and pebbles in a red-brown clay dominated matrix. • SIDE geology varies in composition from east to west. The eastern portion of the SIDE hosts sequence of sandstone, siltstone and shale and is consistent with the Carnegie/Pertatataka Formation. The western portion of the SIDE is dominated by the Angas Hills Formation consists of interbedded pebble and cobble conglomerate, sandstone, pebbly sandstone and siltstone with a matrix of clayey sandstone and minor mudstone. Groundwater • Recharge is predominantly from direct rainfall onto the lake surface. Surface water contributions from the immediate catchment areas surrounding the lake are infrequent and only occur as a result of major rainfall events. As the lake is a terminal drainage point for the surrounding watershed, discharge is solely from evaporation and evapotranspiration. • The relatively flat topography of Lake Mackay results in a very low horizontal groundwater flow gradient in a northwest to southwest direction. • Long-term (5 years) groundwater level monitoring across the lake, plus more recent and detailed (<2 years) monitoring of test trenches and piezometers, shows seasonal fluctuations in groundwater levels ranging from 0.4 to 0.7 mbgl, with an average fluctuation of 0.3 m. Under prolonged dry conditions (below average rainfall), groundwater levels show a decreasing trend over time, up to 0.6 mbgl. Major rainfall events (>300 mm in one month) result in significant recharge, saturating the vadose zone and increasing groundwater levels to within 0.2 m of the surface. • Groundwater infiltration varies from east to west across the lake due the differing geological composition of lake bed sediments. The eastern portion of the lake has high infiltration capacity and high hydraulic conductivity which results in surface water rapidly infiltrating the lake bed sediments following major rainfall events. The western portion of the lake has relatively low infiltration rates and low hydraulic connectivity which results in water remaining on the surface for days to weeks (rarely months) following major rainfall events. • Groundwater monitoring indicates lake bed sediments is characterised by circumneutral pH, elevated nitrate, and hypersaline water typically greater than 200,000 mg/L, up to 340,000 mg/L. The major ionic constituents of the lake bed sediments is consistent, comprising a cation dominance of $Na > K > Mg > Ca$ and an anion sequence of $Cl > SO_4 > HCO_3$. • Groundwater associated with island formations within the On-LDE is typically found to be less than 5 mbgl, which is influenced by a dynamic equilibrium between precipitation, evaporation and evapotranspiration. The largest landform islands in the eastern portion of the lake appear to host a lower salinity 'capillary fringe' within the porous gypsiferous sands that overlay the hypersaline lake bed sediments.

Surface hydrology, water and sediment and water quality

Topography of Lake Mackay is considered subdued and flat, with elevations ranging from approx. 360 mAHD in the east to 364 mAHD in the west. The deepest areas with the longest retention times on the WA portion of the lake occur in the southeast portion although it is likely that the NT side is deeper.

- Surface water assessments determined the total catchment area of Lake Mackay is approximately 87,000 km^2, of which only 20% is considered effective. The lake is a closed system with no outflow or historic evidence of spilling into adjacent lakes. There are small ephemeral creeks and watercourses along the margins of the lake that drain the surrounding landscape and potentially contribute surface water runoff to the lake during major rainfall events.
- Lake Mackay and associated wetlands are predominantly dry and subject to irregular and infrequent inundation. The lake fills to a depth of approximately 2 m in the southeast corner of the lake on average once every five to 10 years, following rainfall events that exceed 250 mm. The lake may remain inundated for several months while subject to major flooding; however, the persistence of surface water is variable and dependent on preceding conditions. The longest inundation of Lake Mackay based on the available records occurred in 2001. This followed well-above average annual rainfall (at Balgo) during the preceding wet season of 2000 (768 mm), and again in 2001 (796 mm), causing flooding of the lake equivalent to a 1:20 or 1:50-year event.
- Analysis of satellite imagery indicates that since 2000, the lake has had increased rainfall, resulting in more frequent, smaller inundation events, likely attributed to climate change, with increased intensity of rainfall during the wet season. However, major flood events such as those that occurred in 2000 and 2001 are rare, with the lake tending to dry rapidly unless subsequent top-up rainfall occurs.
- The peripheral wetlands are typically inundated during the wet season, by direct rainfall and surface water runoff from the immediate catchment area, holding water for short periods (less than one week) following 10 mm or more of rain.
- Lake Mackay surficial sediment was characterised by elevated salinities, ranging from 74,800 mg/kg to 179,000 mg/kg, during dry conditions, with substantially lower concentrations in flood (20,700 mg/kg to 58,100 mg/kg). Similar trends were also observed from the peripheral wetlands during dry and wet conditions (78,200 mg/kg to 302,000 mg/kg, and from 80 mg/kg to 46,000 mg/kg respectively).
- The pH of sediment at Lake Mackay ranged from neutral to alkaline (6.6 to 8.1) during dry conditions, trending to alkaline when in flood (7.4 to 7.9). The pH at peripheral wetlands followed a similar trend during dry conditions, ranging from neutral to alkaline during dry conditions (7.3 to 8.4) although displayed greater variability during flood (5.4 to 8.5). The pH of sediment at the island claypan was neutral at time of sampling (flooded conditions only).
- Nutrient concentrations were typically higher in peripheral wetlands and the island claypan, compared to the lake, which may reflect differences in allochthonous inputs as well as the high productivity of wetlands under flood conditions. All metals in the sediment of Lake Mackay, the island claypan and peripheral wetlands were below the Water Quality Australia (2018) recommended toxicant default guideline values (DGVs) during dry and flooded conditions.
- The pH of the surface water at Lake Mackay ranged from acidic to circumneutral during early flooded conditions (6.5 to 6.7) with circumneutral conditions also recorded for the island claypan (6.6) and peripheral wetlands (6.6 to 6.7). Data from limited, previous sampling and rewetting trials indicate that there is a shift towards the end of the hydroperiod, where the pH becomes acidic to alkaline at the lake and alkaline at the peripheral wetlands.
- Surface water salinity, measured as electrical conductivity (EC)ranged from hyposaline (29,800 µs/cm) to hypersaline (131,000 µs/cm) at Lake Mackay during flood and increases substantially through the hydroperiod, as reflected in rewetting trial and historic (2017) data.
- Nutrient concentrations at the lake were generally low under flooded conditions, as compared to the peripheral wetlands. The higher values at the majority of peripheral wetlands were likely associated with allochthonous inputs, inputs of organic material from riparian vegetation habitats, and the release of nutrients from newly wetted sediment. The island claypan had naturally elevated nitrogen and low phosphorus concentrations.

Aquatic ecology

- There have been several lake-based investigating various ecological components of Lake Mackay and the peripheral wetlands, ranging from lake sediment, aquatic biota, riparian vegetation, and waterbirds. With some exception, much of this previous work was undertaken during prevailing dry conditions. Opportunistic field surveys undertaken in flooded conditions in early 2021, consolidated with the data from the previous surveys, have provided an understanding of the aquatic ecology of Lake Mackay and periphery during the wet and dry periods of hydrocycle.
- A total of 42 algal taxa from three phyla (Bacillariophyta, Cyanophyta and Chlorophyta) have been recorded across Lake Mackay and the peripheral wetlands, including benthic and planktonic algae from rewetting trials and flood sampling. Lake Mackay was more diverse (37) than the peripheral wetlands (25), dominated by Bacillariophyta (diatoms) and Cyanophyta (cyanobacteria) with 20 and 12 taxa respectively. Chlorohytes (green alga) accounted for the remaining taxa (5). The peripheral wetlands had a similar diversity of cyanobacteria and diatoms (11 and nine taxa) and limited green alga taxa (5). In general, the taxa recorded were considered widespread, with a consistent composition to assemblages from inland waters throughout WA.
- While no true aquatic plants were observed, the propagules of the charophyte (large green alga) *Chara* sp. were prevalent in the sediment of the peripheral wetlands, reflecting the low salinity tolerance of the genus and association with freshwater habitats. Propagules of the charophyte *Lamprothamnium* sp., commonly recorded from salt lakes throughout Australia, were also recorded from a limited number of peripheral wetlands.
- In total 25 diatoms from 12 genera were recorded across Lake Mackay, the island claypan and peripheral wetlands (field survey and rewetting trials). The peripheral wetlands had a higher diversity (21) compared to Lake Mackay (14), while five taxa were recorded from the island claypan (sampled in flood only). There was greater variability in diversity between peripheral wetlands, reflecting in substrate composition and water quality, and likely, higher overall biological productivity. *Hantzschia* sp. aff. *baltica*, *Navicula* sp. aff. *incertata* and *Amphora coffeaeformis* were the most common taxa at Lake Mackay (flooding and rewetting trials) and are all well-known from salt lakes in WA. Several genera were recorded from the peripheral wetlands and island claypan only, reflecting the lower salinity or freshwater conditions.
- A total of 53 aquatic invertebrate taxa have been recorded from the lake, and peripheral wetlands, based on a consolidated dataset from the baseline ecology study, rewetting trials and earlier work. These belonged to five higher level taxonomic groups; Insecta, Bivalvia, Branchiopoda, Maxillopoda (Copepoda) and Ostracoda. Diversity at Lake Mackay (13) was lower than the peripheral wetlands (45 taxa) while five taxa were recorded from the island claypan. Diversities between sites were generally comparable for Lake Mackay during flood with greater variability observed between peripheral wetlands, in response to differences in water quality, substrate, and allochthonous inputs.
- The aquatic invertebrate community of Lake Mackay was primarily dominated by halophilic branchiopods and copepods, with a lesser contribution from ostracods and insects. The widespread salt-lake taxa *Parartemia laticaudata* (brine shrimp) and *Meridiecyclops platypus* (cyclopoid copepod) were predominant. *Parartemia* sp. and ostracod eggs were also recorded from the sediment, with *Parartemia laticaudata* and two species of ostracod hatching during rewetting trials. The peripheral wetlands supported a higher proportion of opportunistic (insect) taxa, *Branchinella* as the dominant anostracan and a higher diversity of diplostracans from the orders Cladocera (water fleas) and Spinicaudata (clam shrimp); ostracods also contributed to the peripheral wetlands.
- The south eastern portion of the lake is important in providing relatively deep, stable conditions for aquatic biota and waterbirds during large flood events. However, it is likely the NT side holds water for longer, and may therefore provide higher ecological values, particularly for waterbirds.
- Vegetation within the riparian zone was dominated by chenopod shrublands, characterised by halophytic genera, including *Tecticornia*, *Frankenia* and *Eragrostis*. There have been 96 riparian vegetation taxa from 25 families recorded from Lake Mackay, the islands and peripheral wetlands, 46 of which were recorded during the comprehensive baseline aquatic ecology study. Chenopodiaceae was the most diverse family (21 taxa), with 17 *Tecticornia* taxa (samphires) were identified from the riparian vegetation zone of the lake, islands and peripheral wetlands.

12 waterbird species including four conservation significant (migratory) species were reported during a waterbird survey following flood in 2021. An earlier survey (2017) had recorded 26 species from the peripheral wetlands and seven species from the lake, including one taxon listed as Endangered under the BC Act and EPBC Act.

Inland Waters	
	Summary of Ecological Values and Significant Taxa • Lake Mackay is a predominantly dry, highly episodic saline lake that supports a relatively low number of resilient, halophytic aquatic biota when inundated, comparable to other inland salt lakes throughout Australia. Peripheral wetlands comprise larger saltpans, with comparable characteristics to the playa. The island claypans and freshwater claypans are more diverse, while most of the taxa recorded from the lake and peripheral wetlands are considered widespread, having been documented from regional salt lakes in WA. • The algae and diatoms comprised common, ubiquitous and cosmopolitan genera and species with no significant taxa recorded and a high level of similarity in the community structure of the lake and saltpans. • The aquatic invertebrate communities were more variable, with higher diversity in the freshwater claypans, attributed to a broader range of habitat types, based on the consolidated dataset. Ten new taxa were identified including two spinicaudatans (clam shrimp) and eight ostracods (seed shrimp). Two of these taxa were widespread throughout the playa and likely occur across the border into the NT. The peripheral wetlands to the south of the lake, also support eight new aquatic invertebrate species (two spinicaudatan and six ostracod taxa). • The productivity of algae, diatoms and aquatic invertebrates throughout the lake and peripheral wetlands during flooded conditions provides important foraging conditions, as well as an optimal breeding environment, for waterbirds. One threatened waterbird species (Australian Painted Snipe; En) and up to eight migratory waterbird species have been recorded from Lake Mackay and surrounds during field surveys. Suitable breeding conditions occur for waterbirds, specifically Banded Stilts during inundation events that last for >65 days, with only six of these events recorded since 2000, according to assessment of satellite imagery. The largest of inundation events only occur on average, once every 20 to 50 years. • Increased productivity during the smaller inundation events is associated with areas of the lake on the WA side that hold water for longest, corresponding to small areas associated with the north-western arm and central southern area of the lake adjacent to a small island. The predominant area of the lake with the longest water retention time is the south-eastern portion of the lake, although it is likely the NT side holds water for longer, and may therefore provide higher ecological values, particularly for waterbirds. Regardless, the south-eastern portion on the WA side of Lake Mackay is important in providing deeper, stable conditions for aquatic biota and waterbirds during the largest flood events. • Lower salinities at the beginning of the hydroperiod provide a cue for aquatic biota to emerge, providing a food source for higher order consumers including waterbirds (boom phase). During these initial stages, water quality conditions are relatively homogenous, with salinities increasing as water levels recede, before drying completely (bust phase). During the inundated period, aquatic biota (algae and aquatic invertebrates) matures and reproduces, replenishing the egg bank, contributing to the recovery of the lake and peripheral wetlands during the next flood event. • *Tecticornia* which dominate the riparian zone of the lake islands and peripheral wetlands is likely to be supported by fresh and low salinity water associated with the vadose zone (as opposed to hypersaline groundwater). One taxon of significance was identified from a landform island on Lake Mackay; *Tecticornia globulifera* (P1), which was also a range extension. In addition, several *Tecticornia* taxa were of other significance, comprising another three range extensions and two affinity species. These taxa were widespread within the riparian zone of the lake and islands and were not considered to be restricted. • Lake Mackay is subject to a boom phase during flooding, in line with all inland wetlands in the arid zone of WA. During the largest of these events (equivalent to 1:20 or 1:50 year events), the ecological values of the lake are considered highest, due to reduced salinities. The lake, islands and peripheral wetlands support a diverse and abundant array of aquatic biota and waterbirds, while samphires in the riparian zone also flower prolifically. However, in the last 20 years, rainfall and smaller inundation events at the lake have also become more frequent, likely attributed to climate change, with more intensive rainfall occurring during the wet season. These tends to lead to partial filling of the lake, with resulting elevated salinities limiting ecological values, as they often exceed the tolerance limits required for the emergence of aquatic biota.
Potential impacts	The potential exists for direct and indirect impacts from the Proposal to the inland water values of all four Development Envelopes. The risks of activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of the environmental risk assessment completed by the Proponent. Key or higher risk impacts are discussed in detailed within the ERD. However, impacts were considered as having a risk level that can be managed appropriately and presented will are addressed via management measures in the CEMP, IWEMP, and other relevant management plans and procedures. Potential Direct impacts • Aquatic and riparian habitat loss, increased habitat fragmentation or modification, and loss of aquatic biota of scientific interest or other significance due to clearing and construction of infrastructure (access roads, trench network, bunding and evaporation ponds). • A total of 21,636 ha of riparian vegetation occurs within the Study Area. Of this, 1,523 ha (7.04%) occurs within the Proposal area, and 33.13 ha occurs within the collective Indicative Footprint of proposed disturbance, which represents only 0.15% of riparian vegetation within the Study Area. Potential Indirect impacts • Altered surface hydrology associated with development (including under future predicted climate change scenarios), influencing surface water flows and inundation during major flooding, which may adversely affect aquatic biota and waterbirds. • Increased salinity due to runoff from evaporation ponds and salt piles, which may adversely affect aquatic biota and riparian vegetation. • Groundwater drawdown causing changes to hydraulic connectivity and/or reduction in moisture content of sediment, adversely impacting aquatic biota and riparian vegetation. • Abstraction of groundwater from lake bed sediments changing salinity and/or ionic composition of groundwater, adversely impacting aquatic biota and riparian vegetation. • Potential disturbance and exposure of ASS during trench excavation, adversely impacting aquatic and riparian habitat. • Potential for contamination of surface water and/or groundwater as a result of hydrocarbon and/or chemical spills, and landfill / wastewater treatment plant operations. • Changes in hydraulic connectivity and groundwater quality from abstraction of up to 3.5 GL/a of groundwater for operational use (processing) from borefield. • Fugitive dust emissions that may negatively affect aquatic and riparian habitats or riparian vegetation. Potential Cumulative impacts • The location of the Proposal is extremely remote with no cumulative impacts from other developments within or surrounding the Proposal area currently, or in the foreseeable future. Sensitive receptors (aquatic biota, riparian vegetation and waterbirds) are not expected to be significantly impacted by the Proposal by potential changes to hydrological processes and water quality, or drawdown.
Mitigation	Agrimin has applied the mitigation hierarchy to the Proposal so that biological diversity and ecological integrity are maintained. All identified impacts are mitigated via a robust environmental management approach which has either been developed, or is planned to be developed, and implemented through a series of plans and procedures including, but not limited to, a CEMP, IMEMP, FVEMP, MCP, Ground Disturbance Permit System and Procedure, Fire Management Procedure, HSMP and Procedure, Groundwater and Surface Water Monitoring Procedures (both outlined in the IWEMP) and Incident Investigation and Reporting Procedure. The following mitigation measures are proposed for implementation to avoid, mitigate, manage, monitor and rehabilitate impacts to inland waters and reduce environmental risk. Avoid • Limit disturbance On-LDE (4.55%; <15,000 ha) • Avoid impacts to NT section of the lake (16.6%; 56,506 ha) • Exclusion heritage zones on WA side of the lake will remain undisturbed (9.5%; 32,261 ha) • Implement buffer zones around islands (up to 500 m) **Avoid (cont'd)** • Limit disturbance of riparian vegetation (33.13 ha) • Avoid impacts to peripheral wetlands • Avoid impacts to island including riparian vegetation (5.9%; 20,119 ha) • Avoid impacts to peripheral wetlands • Limit disturbance on the lake from evaporation ponds and salt piles (2.7%, <9000 ha) • Avoid islands with infrastructure located in western portion of the lake • Implement a buffer zone to the riparian vegetation of up to 250 m • Engineering design; 1 km distance between trenches to limit drawdown • Avoid use of diesel for power generation by using LNG, solar and wind operation alternatives for the Proposal • Salt harvesters will be powered using reticulated power sources limiting diesel usage on the lake surface

Inland Waters		
	Avoid (cont'd) • Avoid fuel/chemical storage and transfer from occurring outside of designated areas • Prevent chemical/hydrocarbon spills from spreading • Avoid off-road driving and stay on approved access ways • Avoid peripheral wetlands (claypans) with the implementation of suitable buffer zones • Implement suitable buffer zone between evaporation ponds and salt piles and riparian vegetation Minimise • Detailed hydrological modelling of surface water flows, simulation 1:100-year events to determine impacts • Staged development of trenches via implementation of BMUs • Engineering design; 1 km distance between trenches, installation of crossovers to maintain hydrological processes • Detailed long-term time series water balance modelling to determine baseline and operational scenarios and predicted climate change • At closure, breaching of southern feeder canal, trenches to infill naturally within ~10 years, aided by flooding • Natural attenuation of salts via dilution and dispersal during major flood events and some infiltration into the lake bed sediments • Staged development of evaporation ponds and salt piles • Evaporation ponds have been designed for a 1% AEP flood event, with minimum embankment height of 1.5 m, providing sufficient freeboard to limit saline runoff into the lake during major rainfall events • Evaporation ponds will be breached at closure, with salts gradually dissipating and returning to the playa over time • Large rainfall events (300 mm within one month) will recharge groundwater levels to within 0.4-0.8 m of the surface (baseline conditions • Large rainfall events (300 mm within one month) will recharge groundwater levels dissolving salts within the lake bed sediments and restoring the ionic equilibrium • Development of ASS Management Plan (ASSMP) to enable identification and management of ASS • ASS neutralising material kept on site to respond to acid generating materials encountered during construction • Signage and bunding on all unstable landforms • Spill response equipment available (including on all Haul Trucks) • Spill response training for all personnel and contractors • Maintain high standard of housekeeping around processing plant	**Minimise (cont'd)** • Salts from evaporation ponds/salt piles have cohesive properties that will prevent movement • Groundwater investigations and modelling will be used to investigate drawdown extent and change in surface flows to minimise impacts to SIDE aquifers and associated subterranean fauna habitat, and demonstrate residual impact are not greater than predicted Manage • Comply with CEMP, MCP, IWEMP, FVEMP and ASSMP • Develop a Ground Disturbance Permit System and Procedure • Develop an Incident Reporting & Investigation Procedure • Develop an Emergency Response Plan • Develop a Groundwater Monitoring Procedure (outlined in the IWEMP) • Develop a HSMP and Procedure • Develop a Refuelling Procedures of on-lake vehicles, plant and equipment • Develop a Spill Response Plan • Management of sites as per the Contaminated Site Act 2003 • Develop a Contaminated Sites Register Monitor • Routine monitoring of aquatic biota resting stages during dry conditions through rewetting trials • Opportunistic monitoring of surface water extent, depth, quality and aquatic biota during flood conditions • Monitoring of riparian vegetation health • Routine monitoring of groundwater levels and quality during operations • If required, sampling of soils to ensure all contaminated material has been removed and in situ soils sediment have been remediated • If required, monitoring riparian vegetation in affected areas and adjacent areas Rehabilitate • Trench network and associated bunding will be breached as BMUs are progressively closed over LoM to allow natural flow paths to return to the lake • Evaporation pond embankment will be breached at closure to allow periodic pulsed flows and natural dissipation of salt piles to the lake over time • Trench network and associated bunding will be strategically breached to allow natural flow paths to return to the lake • If required, undertaken contaminated site rehabilitation
Predicted outcome	Potential impacts on the Inland Water factor and proposed mitigation measures are outlined in Table 9-20, and impact predictions detail in Section 9-6. Agrimin is of the view that the potential environmental impacts of the Proposal can be managed effectively and is considered unlikely to result in long-term (or significant), residual impact to hydrological regimes, groundwater and surface water quality, and associated sensitive environmental receptors. Therefore, no offset as defined in WA Environmental Offsets Guidelines (Government of Western Australia 2014) are required for the Inland Waters factor. There are no Ramsar wetlands or wetlands of national importance the vicinity of the Proposal area. The On-LDE was not found to support a highly diverse aquatic biota community, although is likely to be productive during major flood events, supporting waterbirds, which occur on average, once every 10 years. There are two aquatic invertebrate species of scientific interest known (a brine shrimp and ostracod), which are distributed well beyond the Proposal area. *Tecticornia* species were also not considered to be true GDEs and are more likely reliant on the capillary fringe, with a root system that is not reliant on saline groundwater. Preliminary hydrological modelling indicates engineered crossovers for the trench network will assist with maintaining hydrological processes and ecological function. Crossovers will also prevent significant flooding of the riparian zone, while evaporation pond infrastructure will provide an adequate distance to allow flow and movement during major flooding. In addition, progressive breaching of bunds following cessation of BMU mining will return flows to the lake. Suitable buffer zones established for the islands will maintain habitat and reduce drawdown. The Proposal will not impede productivity of the lake during major flood events and large rainfall events will naturally mitigate drawdown. It is expected that during major flood events, the entire surface of the lake will continue to be inundated at depth, allowing for emergence of aquatic biota that is likely to support, albeit it rarely, waterbirds on the lake. At closure, it is expected that groundwater levels will recover within six years, and that salts from the evaporation ponds and salt piles will gradually dissipate and return to the playa (within 400 years), without affecting the overall salt balance. Agrimin understand that the EPA's Guidelines for Inland Waters identify a number of key concerns of particular interest to the EPA relating to potash proposals on salt lake systems, including: • disturbance of the lake surface that may change the flooding regimes leading to inundation of areas outside the lake surface with saline water that are not normally inundated; • the impacts of the disposal of large amounts of excess salt from evaporation basins, which may be on the lake surface; and • how this impacts on water quality and surface water flows on the lake in the long-term following closure of the proposal. These are in addition to the normal issues of finding freshwater sources in the arid regions of WA and the management of these water sources to prevent environmental impacts. Flood simulations undertaken by Agrimin (Section 9.5.2) show negligible and temporary effect will occur along the southern shoreline only, and no expected changes to the majority of the lake periphery and associated riparian zone. The breaches and trench network will also allow for direct rainfall and runoff to enter the lake and fill the deepest parts of the basin. In addition, relative to the natural inflows resulting from rainfall events, the brine from the waste salt ponds is substantially more saline; however, relative to the existing natural salt content of the lake, the proposed additional salt load is not significant. The proposed addition of salts over a temporary period is not expected to alter the salt balance of Lake Mackay significantly. However, residual salt loads may remain in the lake over time in localised areas behind bunds until mobilised by infrequent flood events (Section 9.5.3). *Given the above, and t**he management and mitigation measures proposed, Agrimin is of the view that this Proposal can be managed to meet the EPA's ob**jective for Terrestrial Fauna the Proposal will meet the EPA objectives for Inland Waters.*	
Residual impact	No residual impact is anticipated for Inland Waters	
Offset	No offsets are proposed for this factor	

Social Surroundings

Table ES-6: Social Surroundings

<table>
<tr><th colspan="3">Social Surroundings</th></tr>
<tr><td>EPA Objectives</td><td colspan="2">To protect social surroundings from significant harm.</td></tr>
<tr><td>Policy and guidance</td><td>Legislative instrument
• Aboriginal Cultural Heritage Act 2021
• Environment Protection and Biodiversity Conservation Act 1999
• Environmental Protection Act 1986
EPA policy or guidance & considerations
• Environmental Protection Authority. (EPA 2004a). Guidance Statement No. 41: Assessment of Aboriginal Heritage: EPA's advice in relation to consideration of impacts to social surroundings has been considered in the design of the Proposal to minimise impacts to Indigenous heritage values, cultural sites, and amenity.</td><td>• Environmental Protection Authority. (EPA 2016c). Environmental Factor Guideline – Social Surrounding: EPA's advice in relation to consideration of impacts to social surroundings has been considered in the design of the Proposal to minimise impacts to heritage values and amenity.
• Environmental Protection Authority. (EPA 2016a). Environmental Factor Guideline – Air Quality: EPA's advice in relation to consideration of impacts to social surroundings has been considered in the design of the Proposal to minimise any adverse impacts to the chemical, physical, biological and aesthetic characteristics of air.</td></tr>
<tr><td>Receiving environment</td><td colspan="2">Social surroundings include the aesthetic, cultural, economic, and social values of the environment, which affect or are affected by physical and biological surroundings. They also include Aboriginal heritage and culture, natural and historic heritage, and amenity (EPA 2016c). Agrimin has worked closely with Traditional Owners during the development of the Proposal to understand the heritage and cultural values of the Proposal area and surrounding environment. Numerous Aboriginal heritage surveys of the Proposal area have been undertaken. Agrimin have a strong working relationship with the relevant Traditional Owner groups and have undertaken numerous surveys within these determination areas to inform their impact assessment.
Aboriginal Heritage
• The Proposal area lies within three Native Title Determination Areas established under the Commonwealth NT Act including the Kiwirrkurra Determination Area (Determination Number: WCD2001/002), Ngururrpa Determination Area (Determination Number: WCD2007/004) and Tjurabalan Determination Area (Determination Number: WCD2001/001).
• Three Aboriginal Land Titles under the Aboriginal Land Rights Act 1976 are located within the Proposal area, including the Kearney Reserve (26399), Ngaanyatjarra Central Australia Reserve (24923) and the Balgo Reserve (46573).
Proposal Infrastructure
• A desktop review of the Aboriginal Heritage Inquiry System for the On-LDE, Off-LDE and SIDE identified one registered Aboriginal heritage site (Site ID 2033) was located 6.8 km south-west of the SIDE, while no sites were found to intersect with the On-LDE or the Off-LDE.
• Pre-clearance Aboriginal heritage surveys On-LDE, Off-LDE and SIDE, identified two areas that may be of cultural significance and as such, were excluded from the Development Envelopes to ensure there is no impact on these areas from Proposal activities.
Haul Road
• The NIDE traverses all three Native Title Determination Areas, with the longest stretch of road corridor (approximately 220 km) located within the Ngururrpa Native Title Determination Area.
• A desktop review of the Aboriginal Heritage Inquiry System for the NIDE identified 13 Aboriginal heritage sites that directly intersected with the NIDE, four sites that were within a 500 m buffer area and 11 sites that were located within a 1 km buffer. Results identified that the highest occurrence of registered Aboriginal heritages sites is within the NIDE, in the Ngururrpa Native Title Determination Area, warranting further cultural survey work to inform the impact assessment, which was undertaken in February and April of 2021.
• Agrimin's archaeological consultants undertook a cultural heritage assessment of the proposed NIDE located within the Ngururrpa Native Title Determination Area, in consultation with the Ngururrpa Native Title holders. The assessment focused on the haulage corridor to understand the potential for the proposed infrastructure to disturb any (previously known or otherwise) areas of cultural significance and assist with informing the re-alignment of the infrastructure corridor, if required. The Proposal area, had been subjected to historical disturbance from exploration and settlement activities, including extensive road networks, drill and seismic line construction. The cultural heritage assessment of the proposed NIDE concluded that the alignment of the NIDE passes through country that has elevated significance for mythological and ethnographic values. However, it was determined that NIDE's current alignment has reasonably attempted to avoid focal locations (sites of significance) within that broader mythological landscape.
Other Heritage Places
• No State Registered Places or Heritage Places were identified within the Proposal area. The region has however, historically been subjected to high impact exploration activities historically, since the 1930s, particularly in the northern areas. To minimise clearing and ground disturbance impacts relating to the Proposal, Agrimin will utilise, where possible, previously disturbed areas including tracks, drill lines, and seismic lines
Infrastructure, Services and Roads
• There is limited public access to the Proposal area, as the whole area lies within Aboriginal Determination Areas, and entry permits from respective Traditional Owner groups are required to gain lawful access into this area. The proposed development of the haul road within the NIDE will connect to the Tanami Road to the north which may encourage interest from external parties to visit the area for tourism or recreational purposes, including post closure of the Proposal.
Amenity / Land Use
• The Kiwirrkurra Aboriginal community is located 60 km southwest of the SIDE and Balgo is located 2.6 km west of the NIDE are the two nearest sensitive receptors to the Proposal area.
• Local land uses are predominantly conservation and natural environment for traditional Indigenous uses. Bililuna and Lake Gregory pastoral stations are located 6.3 km west and northwest of the NIDE, respectively.
Air Quality Emissions
• Air quality modelling or monitoring has not been undertaken at the Proposal as there are no sensitive receptors or other industries located within close in proximity to the Proposal.
Recreation and Tourism
• Due to remoteness of the Proposal, tourists and visitors in the area are limited.
Socioeconomic
• The entire Proposal area is established under Aboriginal Determination Areas therefore all socio-economic factors are associated with Traditional Owner community purposes or mining exploration. Agrimin hopes to provide a series of financial and non-financial benefits for the Traditional Owners and communities impacted by the Proposal, including employment, education/training, improved infrastructure and community development opportunities.</td></tr>
</table>

Social Surroundings	
Potential impacts	The potential exists for direct and indirect impacts from the Proposal to the social surroundings values of all four Development Envelopes. The risks of activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of the environmental risk assessment completed by the Proponent. Key or higher risk impacts are discussed in detail within the ERD. Impacts that were considered as having a risk level that can be managed appropriately are presented and addressed via management measures in the CEMP and CHMP. Potential Direct impacts: • Unauthorised vegetation clearing and earthworks resulting in disturbance of Aboriginal heritage sites and / or mythological landscapes Potential Indirect impacts • Disturbance to amenity values from wind turbines, salt stockpiles and fugitive dust emissions from construction, operations and product haulage • Disruptive noise emissions, from aircraft or machinery • Altered fire regime • Non-compliance with post closure commitments
Mitigation	Agrimin has applied the mitigation hierarchy to the Proposal to protect the social surroundings so that potential impacts to the aesthetic, cultural, economic and social values within and surrounding the Proposal area can be avoided or minimised. All identified impacts are mitigated via a robust environmental management approach which has either been developed, or is planned to be developed, and implemented through a series of plans and procedures including, but not limited to, a CHMP for the Kiwirrkurra Determination Area, Ground Disturbance Permit System and Procedure, Fire Management Procedure, and Incident Investigation and Reporting Procedure. The following mitigation measures are proposed for implementation to avoid, mitigate, manage, monitor and rehabilitate impacts to social surroundings and reduce environmental risk. Avoid • Roads and access tracks to be engineered to avoid registered Aboriginal Sites, listed heritage places and areas of significant cultural values • Culturally sensitive areas will be avoided through the use of exclusion zones (demarcated) within the Off-LDE, On-LDE, NIDE and SIDE • Demarcation of heritage sites and exclusion zones created to avoid destruction of heritage values of landforms • Buffer zones established around heritage areas to be protected • Avoid off-road driving and stay on approved access ways. • Flights only operated during daylight hours to reduce nuisance impacts to local communities • Wind turbines will be located on the edge of Lake Mackay, with the nearest sensitive receptor over 60 km away • 30% of the haul road will be constructed on the existing cleared track reducing total clearing • Haul Road will be sealed in the early stages of the Proposal, limiting dust emissions that would otherwise be likely from an unsealed Haul Road Minimise • Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing • Establish and maintain a geospatial Aboriginal Heritage Management Database to ensure any areas of concern, exclusion areas, sensitive areas and cleared areas in the Development Envelopes are readily identified, and effectively managed with fencing and/or signage of exclusions areas in accordance CHMP and CEMP • Haul road constructed to avoid impediments to surface water flows/sheet drainage during flooding events • Engagement and consultation with Traditional Owners regarding the hazards associated with construction and operations • If Aboriginal heritage artefacts or unregistered sites are identified during post-clearance surveys, Agrimin will first consult the relevant Traditional Owners, and where appropriate, seek relevant approvals in alignment with the *Aboriginal Cultural Heritage Act 2021* • Engagement of Traditional Owners for understanding local fire regimes and fire management practices • Develop education programs for haul road users (including Traditional Owners) • The haul road will initially be unsealed; however, Agrimin plan to bituminise the haul road and this will subsequently reduce noise and vibration. • Use of dust suppression (water carts) during clearing activities and operations, with a focus on areas in close proximity to Priority flora, significant vegetation, and riparian vegetation • Vehicle speeds on construction roads will be reduced where necessary to minimise dust emissions • Salt stockpiles will be maximum height of 7 m (excess salt stockpiles) and 20 m (process salt management area only) and will be located in areas considered low impact regarding visual impact to community/tourism. • Removal of all equipment from site. • Agreement with landholder for any retained infrastructure. Manage • Development of CHMP's in consultation with Traditional Owners and Native Title Groups • Restrict public access to haul road (Agrimin staff, contractors, and Traditional Owners only) • Implement speed limits for all traffic at dawn/dusk and night-time in habitats and areas of importance to significant species • Develop an Agreement with Traditional Owners regarding remaining stockpiles • Scrap metal/metal to be buried in situ. • Triennial updates of MCP. Monitor • Post-clearance heritage surveys • Annual inspections of any exclusion areas within the Kiwirrkurra Native Title determination area with native holder • Internal incident reporting and investigation process • Complaints Procedure and Register • Mine Rehabilitation Fund reporting and contributions Rehabilitate • Progressive rehabilitation is to be undertaken which will assist in reducing wind erosion • Salt stockpiles will remain at closure, unrehabilitated and passively assimilate into the surrounding landscape over the long-term. • Rehabilitation cost estimation and provisioning to IFRS Standard. • Rehabilitate bores, access tracks and borrow pits post haul road construction
Predicted Outcome	The Proposal has been designed to avoid recorded Aboriginal heritage sites wherever practicable and will utilise previously disturbed areas wherever possible within the Proposal area, and in particular the NIDE. Agrimin have undertaken extensive consultation with relevant Traditional Owners for the Proposal area, all of whom are supportive of the development of the Proposal and will benefit from improved infrastructure, increased connectiveness of communities and the generation of valuable long-term opportunities, including employment, for the Native Title groups and Indigenous communities throughout the Central Desert and the broader Kimberley region via employment and regional supply chain. Agrimin has prepared a CHMP with the Kiwirrkurra Native Title holders that incorporates the findings of the surveys within the Kiwirrkurra Determination Area and includes the designation, management and annual monitoring of the exclusion areas. The Ngururrpa and Tjurabalan Native Title holders have provided letters of support for the Proposal (Appendix K) to ensure ongoing consultation and discussions regarding for the Proposal, while Native Title negotiations are being finalised with Agrimin. Agrimin is committed to undertaking further consultation with the relevant Traditional Owners to manage interactions and engagements and ensure the safety, protection, and sustainable cultural management of the landscape and environment within the Proposal area. Due to the remoteness of the Proposal area, changes to aesthetic value from native vegetation clearing are minimal as remote area with no sensitive receptors and restricted public access, vegetation types well represented through the region. *Based on the implementation of mitigation measures to limit the impact of the Proposal on social surroundings, the EPA objective for Social Surroundings will be met.*
Residual impact	No residual impact is anticipated for Social Surroundings
Offset	No offsets are proposed for this factor

Other Environmental Factors

The following other environmental factors or matters relevant to the Proposal have been identified:

- Landforms (Table 11-1);
- Terrestrial Environmental Quality (Table 11-2);
- Air Quality (Table 11-3); and
- Greenhouse Gas Emissions (Table 11-4).

Due to the predicted low level of impact, application of industry standard mitigatoin and other regulatory mechanisms, these factors are not expected to be required to be assessed in detail by the EPA.

Offsets

Agrimin understands its obligation to offset any significant residual impact that result from implementing the Proposal. After applying the mitigation hierarchy, no key environmental factors or MNES were assessed as being subject to significant residual impact. However, Agrimin are aware of the potential for the Proposal to result in significant residual impact to the Night Parrot, Greater Bilby and Great Desert Skink as a result of habitat loss, which may require compensatory offsets. Any offsets that are required for the Proposal will be developed with State and Commonwealth agencies in accordance with *WA Environmental Offsets Policy* and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. While offsets have not yet been finalised, Agrimin are committed to supporting the conservation of the Night Parrot. As a result, Agrimin have provisioned two packages of voluntary indirect offsets. These are summarised in Section 13 and below, and detailed within Appendix N:

- Research: Funding of research to increase knowledge of the Night Parrot to better inform conservation management of the species; and
- Social: Funding of ranger programs to manage existing key threats to the Night Parrot (and other threatened fauna that occur in the region) comprising feral predator control and fire management.

These programs will have the following benefits:

- direct engagement of Indigenous groups to manage land on respective IPAs; and
- meaningful conservation outcomes for the Night Parrot and other threatened fauna where feral predation and altered fire regimes are listed as key threatening processes.

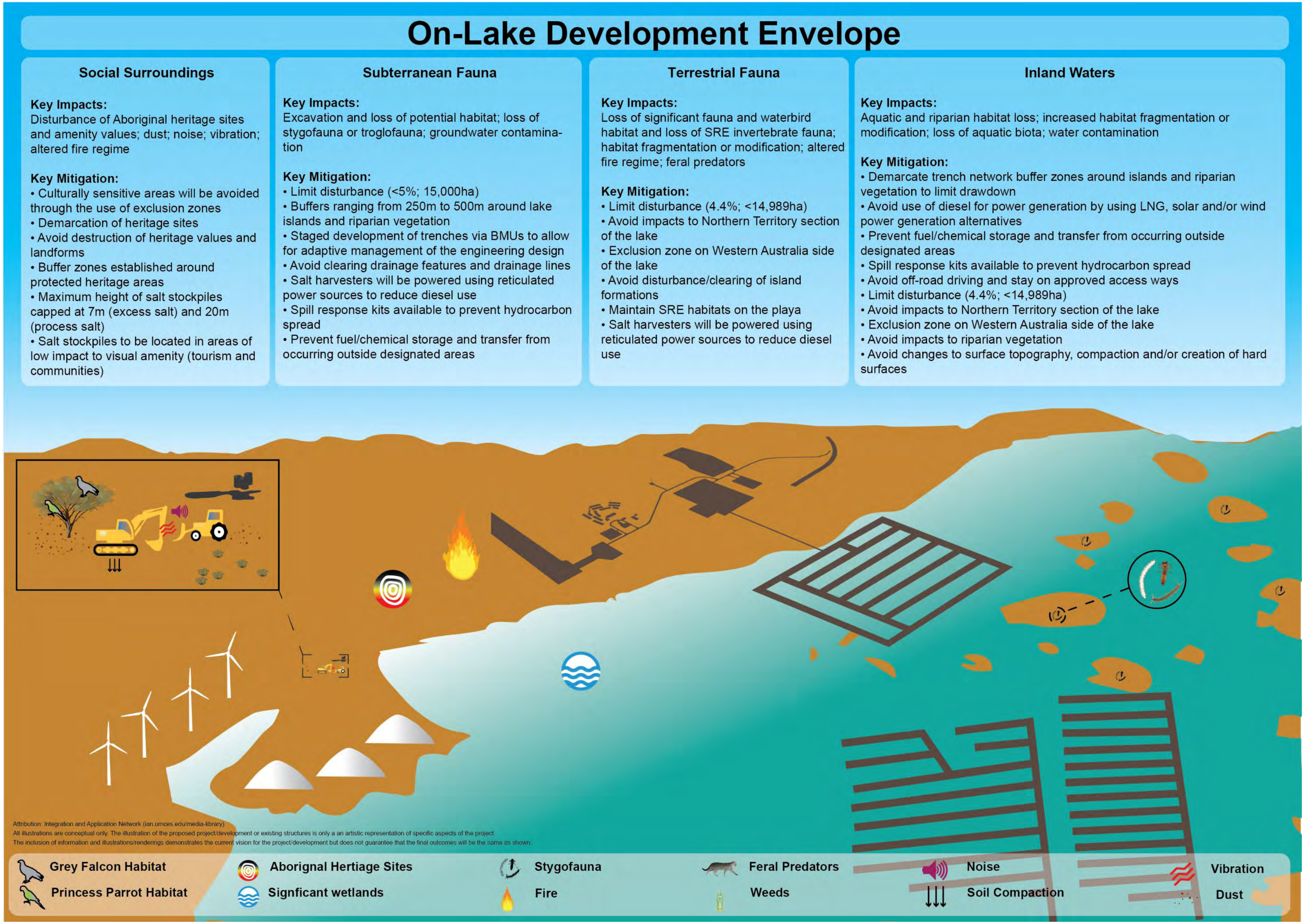


Figure ES-5: Conceptual model of the construction and operation of the On-LDE for the Proposal and the interacting impacts on the key environmental factors

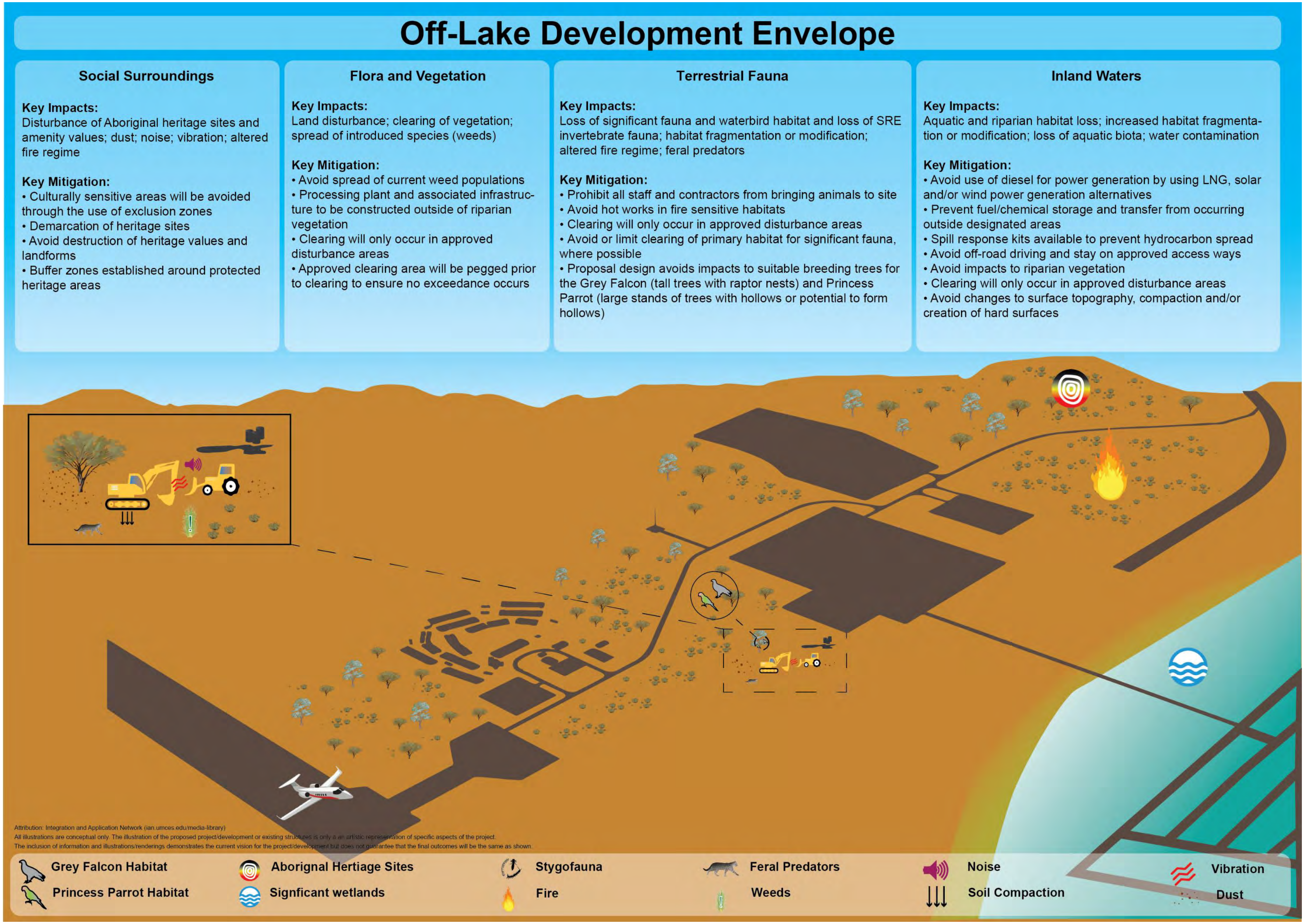


Figure ES-6: Conceptual model of the construction and operation of the Off-LDE for the Proposal and the interacting impacts on the key environmental factors

Southern Infrastructure Development Envelope

Social Surroundings

Key Impacts:
Disturbance of Aboriginal heritage sites and amenity values

Key Mitigation:
- Culturally sensitive areas will be avoided through the use of exclusion zones
- Demarcation of heritage sites
- Avoid destruction of heritage values and landforms
- Buffer zones established around protected heritage areas

Subterranean Fauna

Key Impacts:
Excavation and loss of potential habitat; loss of stygofauna or troglofauna; ground-water contamination

Key Mititgation:
- Comply with 5C Licence
- Prevent fuel/chemical storage and transfer from occurring outside designated areas
- Spill response kits available to prevent hydrocarbon spread
- Spill response training for on-site employees
- Clearing in approved disturbance areas only
- Avoid changes to surface topography, compaction and/or creation of hard surfaces

Flora and Vegetation

Key Impacts:
Land disturbance; clearing of vegetation; spread of introduced species (weeds)

Key Mitigation:
- Clearing in approved ground disturbance areas only
- Approved clearing area will be pegged prior to clearing to ensure no exceedance occurs
- Avoid spread of current weed populations

Terrestrial Fauna

Key Impacts:
Loss of significant fauna and waterbird habitat and loss of SRE invertebrate fauna; habitat fragmentation or modification; ; altered fire regime; feral predators

Key Mitigation:
- Clearing will only occur in approved ground disturbance areas
- Avoid or limit clearing of primary habitat for significant fauna, where possible
- Pre-clearance surveys
- Proposal design avoids impacts to suitable breeding trees for the Grey Falcon (tall trees with raptor nests) and Princess Parrot (large stands of trees with hollows or potential to form hollows)
- Avoid hot works in fire sensitive habitats
- Prohibit all staff and contractors from bringing any animals to site
- Avoid off-road driving and stay on approved access ways

Inland Waters

Key Impacts:
Aquatic and riparian habitat loss; increased habitat fragmentation or modification; loss of aquatic biota

Key Mitigation:
- Avoid use of diesel for power generation by using LNG, solar and/or wind power generation alternatives
- Salt harvesters will be powered using reticulat-ed power sources to reduce diesel use
- Prevent fuel/chemical storage and transfer from occurring outside designated areas
- Prevent chemical/hydrocarbon spill from spreading to native vegetation
- Avoid off-road driving and stay on approved access ways

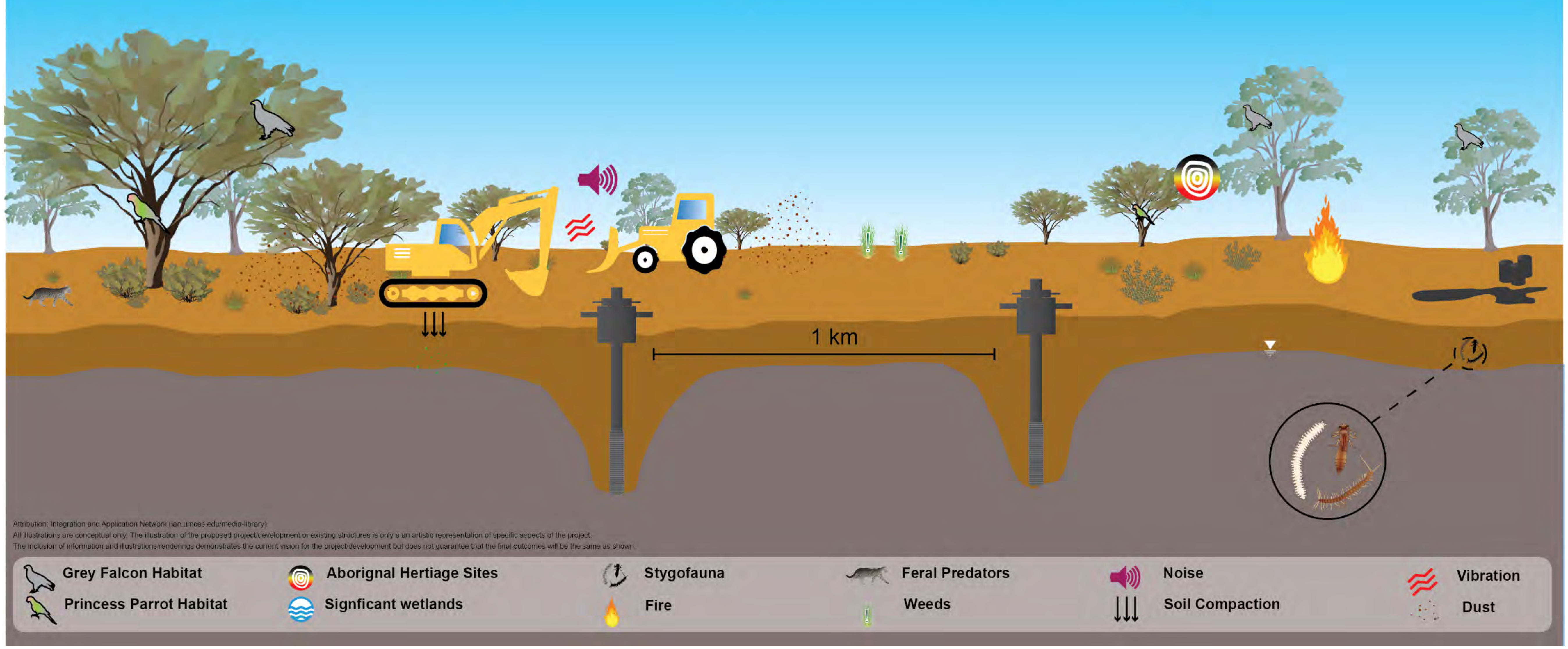


Figure ES-7: Conceptual model of the construction and operation of the SIDE interactions for the Proposal and the interacting impacts on the key environmental factors

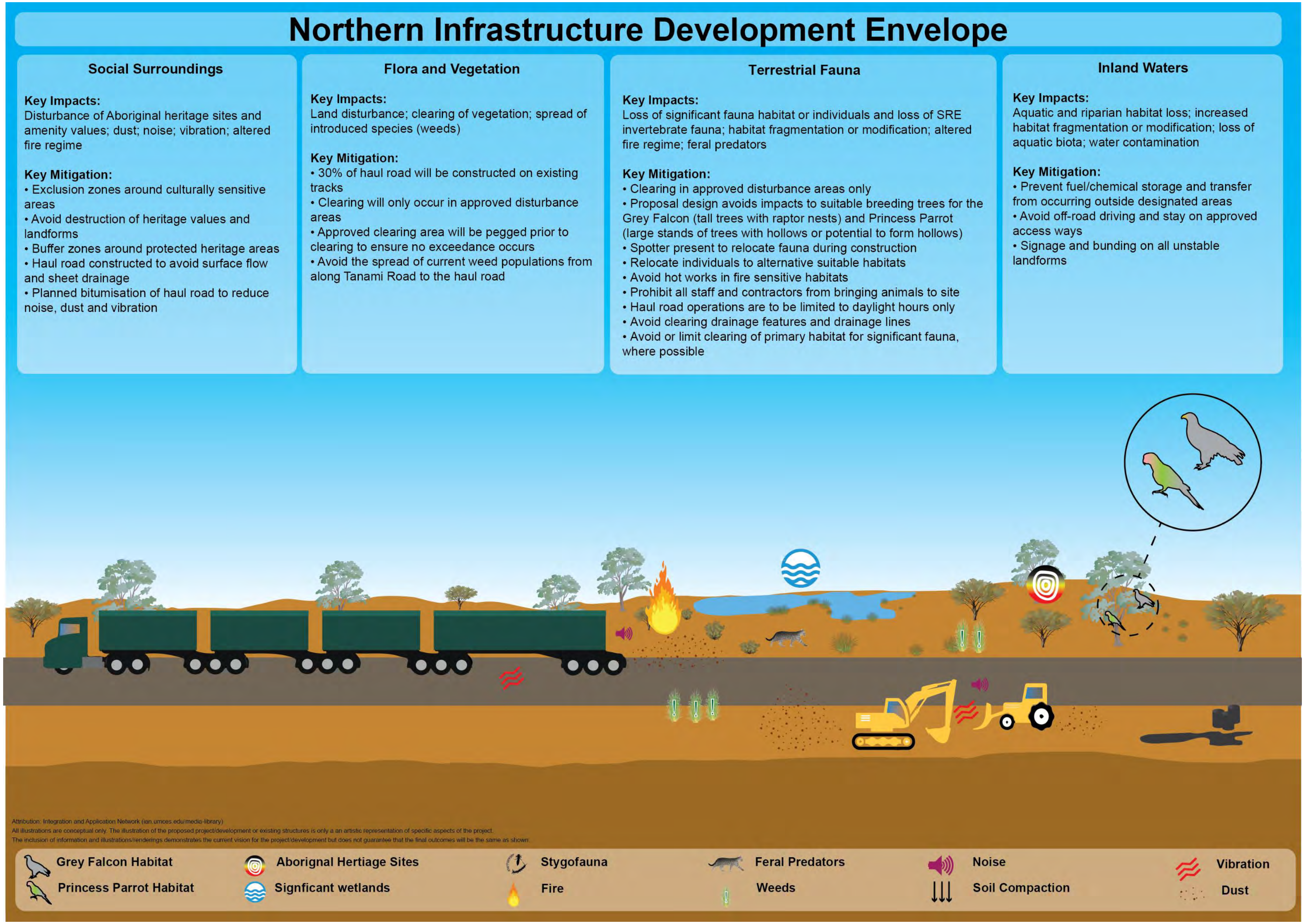


Figure ES-8: Conceptual model of the construction and operation of the NIDE for the Proposal and the interacting impacts on the key environmental factors

Holistic Impact Assessment

As part of the EIA process, Agrimin have commissioned numerous studies to understand the local environment, and potential impacts as a result of implementing the Proposal. The outcomes of these studies have assisted with the refinement of the Proposal, allowing for the application of the mitigation hierarchy (avoid, minimise, manage, monitor, rehabilitate, offset). Agrimin has sought to understand the environmental processes and environmental values of the Lake Mackay ecosystem as a whole, including the potential to impact the environmental values of the NT side of the lake (a jurisdictional component of ~25% of the lake). Agrimin has recognised the inextricable links between flora and vegetation, terrestrial fauna, inland waters and social surroundings and connections and interactions between parts of the environment to inform a holistic view of impacts to the lake.

Agrimin recognises that Lake Mackay is an integral part of the landscape and to the way of life of the Traditional Owners. Consequently, the need to manage the impacts on environmental factors that integrate with ongoing use of the area for the sense of place for these communities is a vital component of the Proposal. There has been, and remains, ongoing consultation with the Traditional Owners. In addition to this, consultation has been undertaken with the relevant NT government departments and NT EPA as part of the assessment process, to inform them of the Proposal's potential to impact Lake Mackay. Agrimin propose further consultation as part of the WA EPA's assessment process.

The holistic view of potential impacts to the lake's ecosystem and implementation of the proposed management measures and environmental management plans will avoid and minimise environmental impacts. This has provided Agrimin with confidence that any changes in the surface hydrological or groundwater regimes will not significantly impact the aquatic ecology of the lake, including migratory birds, or the riparian zone, with no known groundwater dependent vegetation in the area (including the WA and NT jurisdictions). In addition, drawdown is expected to be managed to minimise impacts to subterranean fauna inhabiting low salinity groundwater occurring above the lake sediments and driven by recharge from rainfall.

A conceptual model has been developed to demonstrate the interaction between the key environmental factors, predicted impacts and mitigation measures implemented during the construction and operation phases of the Proposal, for the On-LDE, Off-LDE, SIDE and NIDE (Figure 14 1). This figure highlights the scale, connections and interactions of the various components of the Proposal, while delineating where impacts will occur spatially and temporally.

Therefore, a holistic impact assessment of the Proposal demonstrates that the environmental risk is acceptable and aligns with the WA and NT EPA's principles and objectives. The Proposal impacts are able to be avoided, mitigated or managed, following application of the mitigation hierarchy. The holistic impacts assessment is further detailed in Section 14.

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Abbreviations

Abbreviation	Term
Agrimin	Agrimin Limited
ANC	Acid neutralising capacity
ASS	Acid sulphate soils
BC Act	*Biodiversity Conservation Act 2016* (State)
BESS	Battery Energy Storage System
BMU	Brine Mining Unit
CEMP	Construction Environmental Management Plan
CHMP	Cultural Heritage Management Plan
CO_2-e emissions	Carbon dioxide equivalent emissions
MCP	Mine Closure Plan
cm	Centimetre
DBCA	Department of Biodiversity, Conservation and Attractions
DEPWS	Department of Environment, Parks and Water Security (Northern Territory)
DFS	Definitive feasibility study
DGV	Default guideline value
DIWA	Directory of Important Wetlands in Australia
DMAs	Decision making authority
DAWE	Department of Agriculture, Water and the Environment (Commonwealth)
DPIRD	Department of Primary Industries and Regional Development
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
EIA	Environmental impact assessment
EIL	Ecological investigation level
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPAS	Department of Water and Environmental Regulation – EPA Services
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERD	Environmental Review Document
ERT	Emergency Response Team
ESD	Environmental Scoping Document
FID	Final Investment Decision
FVEMP	Flora and Vegetation Environmental Management Plan
GDE	Groundwater-dependent Ecosystem
GHG	Greenhouse Gas
GIS	Geographical information Systems
GJ/a	Gigajoule per annum
GL	Gigalitre

Abbreviation	Term
GL/a	Gigalitre per annuum
GSD	Great Sandy Desert
ha	Hectare
HIL	Health Investigation Levels
IBSA	Index of Biodiversity Surveys for Assessment
IPA	Indigenous Protected Area
L	Litre
LNG	Liquefied natural gas
km	Kilometre
LiDAR	Light Detection and Ranging
L/s	Litres per second
mAHD	Metres Australian Height Datum
mbgl	Metres Below Ground Level
m	Meters
m/s	Metres per second
mg/L	Milligrams per litre
mg/kg	Milligrams per kilogram
mm	Millimetres
mm/h	Millimetres per hour
MNES	Matter of National Environmental Significance
Mt	Million tonnes
mtpa	Million tonnes per annum
MW	Megawatt
NASS	Not Acid Sulphate Soils
NGO	Non-Government Organisation
NIDE	Northern Infrastructure Development Envelope
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NP	Night Parrot
NT	Northern Territory
NT Act	*Native Title Act 1993*
On-LDE	On-lake Development Envelope
Off-LDE	Off-lake Development Envelope
PASS	Potentially Acid Sulphate Soils
PEC	Priority Ecological Community
PFCs	Perfluorocarbons
ppm	Parts per millions
PV	Photo voltaic
RO	Reverse Osmosis
RIWI Act	*Rights in Water and Irrigation Act 1914*

Abbreviation	Term
s.43A	Section 43A
SIDE	Southern Infrastructure Development Envelope
SOP	Sulphate of Potash
SRE	Short Range Endemic
TDS	Total dissolved solids
TEC	Threated Ecological Community
TFEMP	Terrestrial Fauna Environmental
tpa	Tonnes per annum
TPFL	Threatened and Priority Flora Database
µm	Micrometre
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compounds
WA	Western Australian
WAH	Western Australian Herbarium
WHO	World Health Organisation
WoNS	Weed of National Significance
WWTP	Waste Water Treatment Plant

1. Introduction

Agrimin Limited (Agrimin; the Proponent) propose to construct and operate the Mackay Sulphate of Potash Project (the Proposal), the subject of this assessment. Development of this greenfield operation will involve the extraction of brine from a network of shallow trenches established on the surface of Lake Mackay (Figure 1-1). The brine will be transferred into on-lake evaporation ponds for the precipitation of salt, which will be harvested and then processed to produce a potash fertiliser product. The Proposal includes an off-lake processing plant and other associated site infrastructure, a haul road for transporting potash to Wyndham Port, as well as a fresh water borefield located to the south of Lake Mackay.

1.1 Purpose and Scope

The purpose of this Environmental Review Document (ERD) is to present an environmental impact assessment (EIA) of the Proposal for public review and assessment by the Western Australian (WA) Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act). It also allows for assessment by the Commonwealth Department of Agriculture, Water and the Environment (DAWE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The ERD includes a detailed impact assessment and description of proposed mitigation and management measures for the environmental factors identified in the EPA approved Environmental Scoping Document (ESD) (Appendix A).

The ERD includes a detailed description of the Proposal's key components, identification of the preliminary key environmental factors, and potential impacts to those factors. Specific technical studies and investigations have been conducted by Agrimin since 2014 across all environmental factors to:

- ensure that the full environmental impacts of the Proposal are properly understood;
- provide information for management measures to mitigate the Proposal's impacts; and
- enable a reliable and knowledge-based EIA to be conducted.

This document has been prepared in accordance with the EPA's *Environmental Impact Assessment Administrative Procedures* (EPA 2021a), *How to Prepare an Environmental Review Document: Instructions* (EPA 2021b) and EPBC Act requirements to provide sufficient information for the EPA to assess the Proposal. An overview of the scope of this document is included in Table 1-1.

Copies of investigations and technical studies undertaken to inform the EIA referred to in this ERD are provided in the appendices to this document.

Table 1-1: Document overview

Section	Purpose
Executive Summary	Overview of the Proposal, summary of the existing environment, impact assessment, mitigation measures, residual impact, and offsets.
Section 1: Introduction	Provides the purpose and scope of the ERD, proponent detail and key legislative requirements for the impact assessment and approvals.
Section 2: The Proposal	A description of the Proposal, including the key characteristics of the Proposal that have the potential to cause an impact on the environment.
Section 3: Local and Regional Context	A discussion on how the Proposal fits within the local and regional areas in relation to other developments, the existing environment, and environmental assets.
Section 4: Stakeholder Engagement	A summary of stakeholder consultation undertaken in support of the Proposal.
Section 5: Environmental Principles and Factors	The Proponent's consideration of the *Environmental Protection Act 1986* environmental protection principles for the Proposal.
Section 6 Flora and Vegetation	Assessments of the potential environmental impacts of the Proposal for each of the EPA's Key Environmental Factors.
Section 7: Terrestrial Fauna	
Section 8: Subterranean Fauna	
Section 9: Inland Waters	

Section	Purpose
Section 10: Social Surroundings	
Section 11: Other Environmental Factors	An assessment of potential environmental impacts of the Proposal on Other Environmental Factors.
Section 12: Matters of National Environmental Significance	An assessment of potential impacts of the Proposal on Matters of National Environmental Significance.
Section 13: Offsets	Identification of any significant residual impact and offsets proposed for the Proposal.
Section 14: Holistic Impact Assessment	A holistic impact assessment summarising the potential impacts of the Proposal.
Section 15: References	A list of technical reports, policy, and guidance references.

The Proposal area is remote, extensive and difficult to access. Agrimin have faced similar access and survey constraints/limitations as experienced by other recent large-scale approved projects (i.e. Asian Energy Renewable Hub and Mardie Salts), were the EPA noted that the surveys were not undertaken in a manner that fully met relevant guidance due to the large geographic extent of the Development Envelope. As in the case of these large scale and remote projects, Agrimin considers the survey work conducted provide sufficient context and information for the assessment of the proposal (including compliance with the ESD's work requirements) and allows for public review and scrutiny to be undertaken in an adequately manner.

The Proposal area is remote and extensive (263,675 ha) and therefore four Development Envelopes have been defined (Figure 1-2). The following terms are used ERD:

- Study Area – refers to the boundary within which all investigations and field surveys were undertaken.
- Proposal area - The combined area in which the four Development Envelopes are contained, define d below.
- Development Envelopes – the boundary within which the elements of the Proposal are situated. The Development Envelopes occur entirely within the Study Area and comprise four components that make up the Proposal. The Proposal includes disturbance of up to 15,000 ha of the lake's surface and clearing of approximately 1,500 ha of native vegetation. The proposed extent of the physical and operational elements includes four Development Envelopes (Figure 1-2):
    - On-lake Development Envelope (On-LDE): On-lake development of trenches, extraction of up to 100 GL/a of brine, and solar evaporation and harvesting ponds for potash salts, including ground disturbance of approximately 15,000 ha contained within the 217,261 ha On-LDE.
    - Off-lake Development Envelope (Off-LDE): Off-lake development of a processing plant and associated site infrastructure, including access roads, accommodation camp, airstrip and solar farm, including clearing of approximately 200 ha of native vegetation within the 688 ha Off-LDE.
    - Southern Infrastructure Development Envelope (SIDE): Development of borefield, water pipeline and access tracks for abstracting up to 3.5 GL/a of processing water and off-lake access to Lake Mackay, including clearing of approximately 300 ha of native vegetation within the 11,799 ha SIDE.
    - Northern Infrastructure Development Envelope (NIDE): Haul road for trucking potash production to Wyndham Port, including clearing of approximately 1,000 ha of native vegetation within the 33,928 ha NIDE.
- Indicative Footprint – The proposed Indicative Footprint occurs entirely within the Proposal area and refers to the area that is proposed to be directly disturbed by the Proposal (e.g. clearing of native vegetation). The layout of the Indicative Footprint may be subject to change; however, total disturbance will not exceed the maximum extent of disturbance for each Development Envelope as presented in the ERD. Proponent-led avoidance and minimisation measures have been implemented where possible to reduce and minimise potential impacts on areas of high ecological or heritage value through the detailed design of the Indicative Footprint.

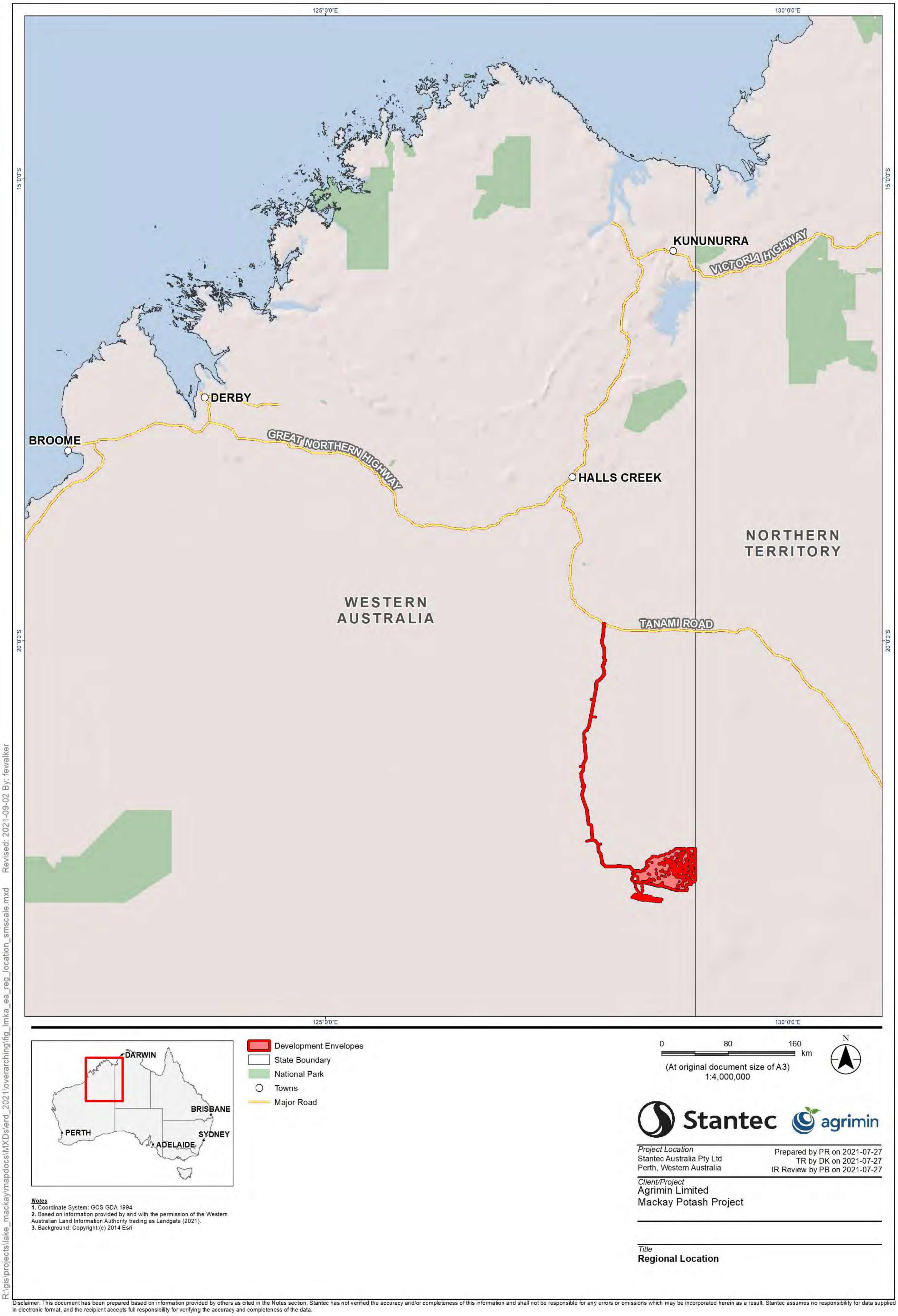

Figure 1-1: Location of the Proposal

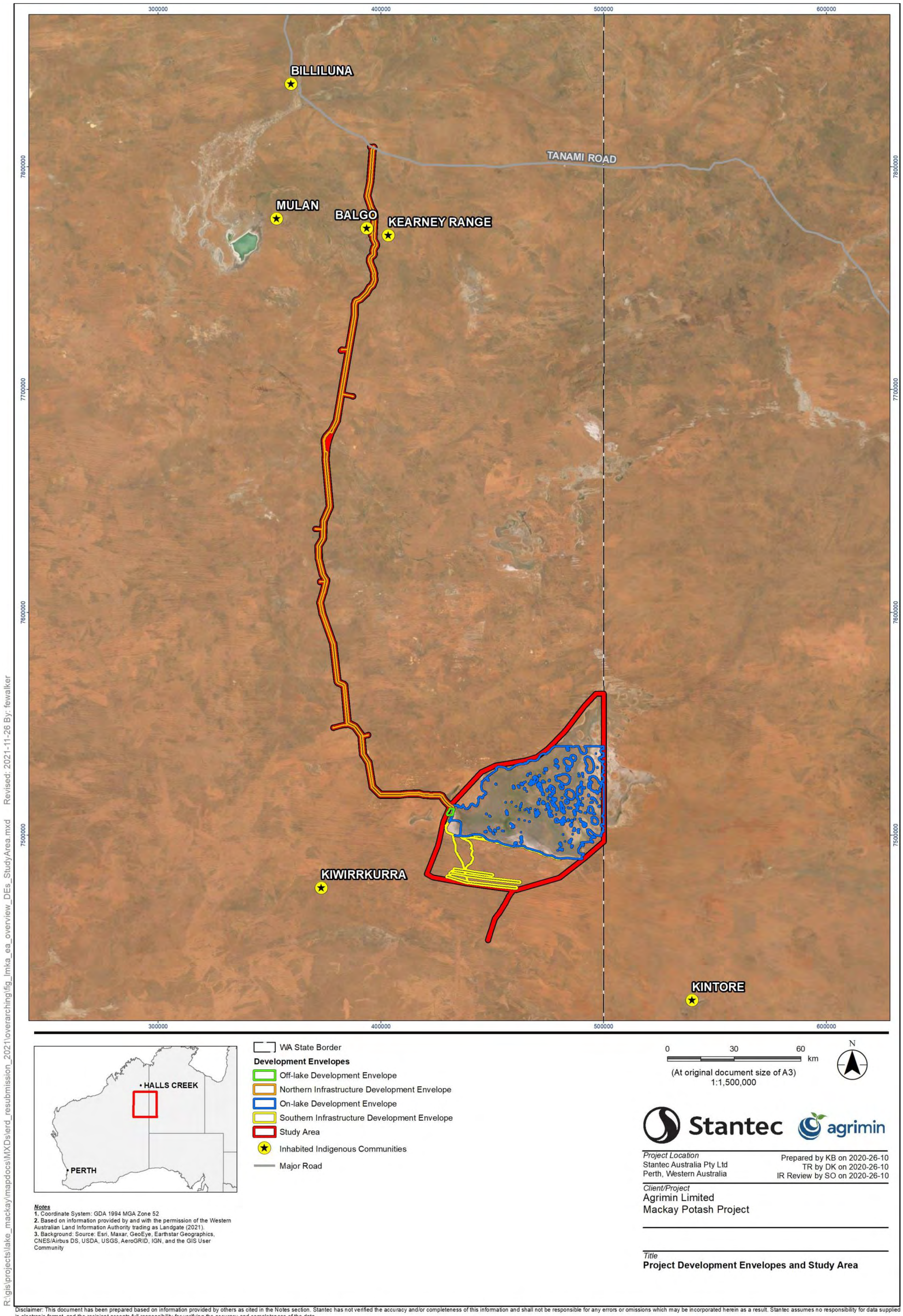

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Figure 1-2: The Proposal's Development Envelopes and Study Area

1.2 Proponent

Agrimin is a WA minerals company that has 100% ownership of the Mackay Sulphate of Potash Project and is the proponent for the Proposal (Table 1-2).

Table 1-2: Proponent details

Company	Agrimin Limited
ABC/ACN	ACN: 122 162 396
Address	2C Loch Street, Nedlands, Western Australia 6009
Proponent key contact	Mark Savich – Chief Executive Officer Telephone: (08) 9389 5363 Email: msavich@agrimin.com.au
Consultant key contact	Fiona Taukulis – Group Manager - Environment Telephone: (08) 9388 8799 Email: fiona.taukulis@stantec.com

1.3 Environmental Impact Assessment Process

WA and Commonwealth legislation of relevance to environmental approvals includes the:

- *Environmental Protection Act 1986* (EP Act) (WA);
- *Biodiversity Conservation Act 2016* (BC Act) (WA); and
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cth).

Implementation of the Proposal will require compliance with Australian legislation and regulations that are discussed throughout the ERD, specific to environmental factors where relevant.

1.3.1 WA Environmental Impact Assessment Process

Agrimin referred the Proposal (Assessment No.2193) to the WA EPA under section 38 (s.38 Referral) of the EP Act on 2 January 2019. The EPA determined on 4 February 2019 that the Proposal requires formal assessment under Part IV of the EP Act and set the level of assessment at "*Environmental Review Document*" with a 4-week public review period.

As detailed previously, Agrimin have submitted two requests to the EPA to allow for minor changes to the Proposal under section 43A (s.43A) of the EP Act. The EPA consented to Agrimin's proposed changes to the Proposal during assessment without the requirement to refer a revised Proposal as the proposed changes were considered unlikely to significantly increase any impact the Proposal may have on the environment.

Agrimin prepared an ESD (Appendix A) to define the form, content, timing, and procedure of the environmental review, which was endorsed on by the EPA 10 September 2020. Since the endorsement of the ESD, minor refinements have been made to the proposed Development Envelopes. These revised developments envelopes are presented and discussed in detail in Section 2. The final revised Proposal area has been reduced from 265,395 ha to 263,675.2 ha (a reduction of 1,720 ha) since the approval of the Section 43a and ESD by EPA.

The EPA's *Statement of environmental principles, factors, objectives and aims of EIA (EPA 2021d)* lists a number of environmental factors that need to be considered in the EIA process. The ESD for the Proposal identified the following five Key Environmental factors:

- flora and vegetation;
- terrestrial fauna;
- subterranean fauna;
- inland waters; and
- social surroundings.

Consultation with Decision Making Authorities (DMAs) regarding the Proposal has commenced (Section 1.4.2). Table 1-3 sets out the timeline for the assessment of the Proposal agreed between the EPA and the proponent.

Table 1-3: Assessment timeline

Key Assessment Milestones	Completion Date
EPA Approves ESD	10 September 2020
Proponent submits first draft ERD	27 November 2020
EPA provides comment on first draft ERD (6 weeks from receipt of ERD)	23 March 2021
Proponent submits revised draft ERD	11 April 2022
EPA authorises release of ERD for public review (2 weeks from EPA approval of ERD)	....
Proponent releases ERD for public review for 4 weeks	....
Close of public review period	....
EPA provides summary of ERD Submission (3 weeks from close of public review period)	....
Proponent provides Response to ERD Submissions	....
EPA reviews the Response to ERD Submissions (4 weeks from receipt of Response to Submissions)	....
EPA prepares draft Assessment Report and completes assessment (6 weeks from acceptance of ERD)	....
EPA finalises assessment report (including two weeks consultation on draft conditions) and gives report to the Minister (6 weeks from completion of assessment)	....

1.3.2 Commonwealth Environmental Impact Assessment Process

Agrimin referred the Proposal to the Commonwealth Department of Environment and Energy (now DAWE) under the EPBC Act on 21 December 2018. The Proposal was determined to be a 'Controlled Action' by a Delegate of the Commonwealth Minister for the Environment on the 5th of August 2019 as it will, or is likely to, have a significant impact on the following Matters of National Environmental Significance (MNES):

- listed threatened species and communities (s 18 and s 18A; EPBC Act).

On the 5th of August 2019, it was determined that the Proposal was to be assessed by accredited assessment under the Bilateral Agreement between the Commonwealth and WA governments.

1.4 Other Approvals and Regulation

1.4.1 Tenure and Land Access

Agrimin currently hold Exploration Licences and Miscellaneous Licences associated with the Proposal including in the On-LDE, Off-LDE, SIDE and the southern portion of the NIDE within E80/4889, E80/5172, L80/96 (Figure 1-3). Agrimin is currently in the process of applying for a Miscellaneous Licence for development of the haul road over the NIDE. The relevant mining tenure will be obtained under the *Mining Act 1978* to support mining and processing activities. Tenure details are provided in Table 1-4.

The Proposal area lies within three Native Title Determination Areas proclaimed under the *Native Title Act 1993* (NT Act); Kiwirrkurra, Ngururrpa and Tjurabalan Determination Areas. Agrimin has signed a Native Title Agreement (WAD6019/1998) with Tjamu Tjamu Aboriginal Corporation (RNTBC), the registered Native Title body corporate for the Kiwirrkurra Native Title holders. Agrimin has also prepared Cultural Heritage Management Plan (CHMP) with the Kiwirrkurra Native Title holders to manage interactions and dealings with Traditional Owners. Agrimin is in the process of negotiating Native Title Agreements with the Parna Ngururrpa and Tjurabalan Native Title holders for the haul road.

The Proposal is also located within Ngaanyatjarra Central, Kearney and Balgo Australia Aboriginal Reserves, created under the *Aboriginal Affairs Planning Authority Act 1972*. Under this Act the Native Title holders have exclusive rights to occupy, use and benefit from the Reserve. Land within the within Aboriginal Reserves is non-transferable freehold title under the *Aboriginal Land Rights Act 1976.* Agrimin has been issued with mining entry permits by the Minister for Aboriginal Affairs, authorising it to access the Aboriginal Reserves. The Minister for Mines and Petroleum has issued the corresponding Consent to Mine notices.

Table 1-4: Proposal tenure and ownership details

Tenure	Tenement Type	Tenement Holder	Issue Date	Expiry Date	Tenement Area (ha)	Development Envelope
E80/4887 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	22/01/2015	21/01/2025	61,681	On-LDE
E80/4888 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	28/04/2015	27/04/2025	63,360	On-LDE
E80/4889 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	22/01/2015	21/01/2025	27,196	NIDE, On-LDE, Off-LDE and SIDE
E80/4890 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	22/01/2015	21/01/2025	63,270	On-LDE
E80/4893 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	22/01/2015	21/01/2025	11,372	SIDE and On-LDE
E80/4995 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	18/07/2017	17/07/2022	4,740	SIDE and On-LDE
E80/5055 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	27/07/2017	26/07/2022	52,912	SIDE and On-LDE
E80/5124 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	11/07/2018	10/07/2023	21,805	On-LDE
E80/5172 (WA)	Exploration Licence	Agrimin Potash Pty Ltd	11/02/2010	10/02/2024	29,127	NIDE, On-LDE, Off-LDE and SIDE
L80/87 (WA)	Miscellaneous Licence	Agrimin Potash Pty Ltd	10/02/2017	09/02/2038	14,379	SIDE
L80/88 (WA)	Miscellaneous Licence	Agrimin Potash Pty Ltd	06/09/2017	05/09/2038	153	SIDE
EL30651 (NT) (application)	Exploration Licence	Agrimin Limited	N/A	N/A	18,010	Excluded from Proposal area
EL31870 (NT) (application)	Exploration Licence	Agrimin Limited	N/A	N/A	52,817	Excluded from Proposal area
EL31871 NT) (application)	Exploration Licence	Agrimin Limited	N/A	N/A	53,122	Excluded from Proposal area

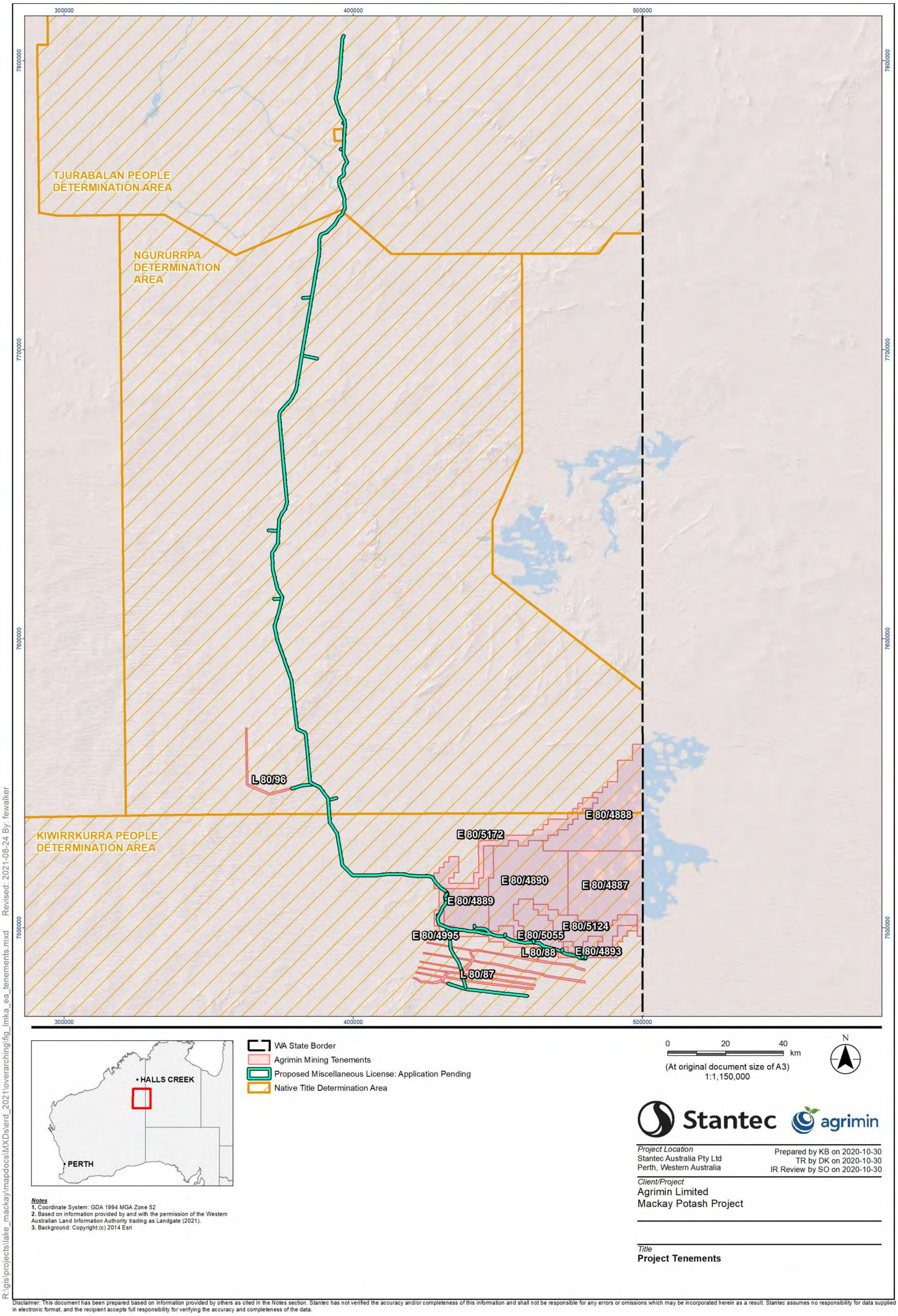

Figure 1-3: Proposal tenure and Native Title Determination Areas

1.4.2 Decision Making Authorities

Key DMAs relevant to the Proposal are shown in Table 1-5. Additional DMAs may be identified by the EPA throughout the referral and assessment process.

Table 1-5: Decision Making Authorities for the Proposal

Decision Making Authorities	Relevant legislation
WA	
Minister for Environment – Western Australia	*Environmental Protection 1986 (Part IV)* *Biodiversity Conservation Act 2016*
Chief Executive Officer, Department of Water and Environmental Regulation (DWER)	*Environmental Protection 1986 (Part V)* *Rights in Water and Irrigation Act 1914*
Minister for Water – Western Australia	*Rights in Water and Irrigation Act 1914*
Minister for Aboriginal Affairs	*Aboriginal Cultural Heritage Act 2021*
Minister for Mines and Petroleum – Western Australia	*Mining Act 1978* *Dangerous Goods and Safety Act 2004* *Mines Safety and Inspection Act 1994*
State Mining Engineer – Department of Mines, Industry Regulation and Safety	*Mining Act 1978* *Mines Safety and Inspection Act 1994*
A/Executive Director – Resource and Environmental Compliance Division, Department of Mines, Industry Regulation and Safety	*Mining Act 1978* *Mines Safety and Inspection Act 1994*
Chief Dangerous Goods Officer – Department of Mines, Industry Regulation and Safety	*Dangerous Goods and Safety Act 2004*
Chief Executive Officer – Department of Biodiversity, Conservation and Attractions	*Biodiversity Conservation Act 2016*
Chief Health Officer – Department of Health	*Health Act 2016*
Chief Executive Officer – Shire of East Pilbara	*Local Government Act 1995* *Planning and Development Act 2005*
Emergency Services Commissioner, Department of Fires and Emergency Services	*Bush Fires Act 1954*
Commonwealth	
Department of Agriculture Water and the Environment	*Environment Protection and Biodiversity Conservation Act 1999*

1.5 Exclusions

Table 1-6 below provides context on geographical and operational areas that are not included as part of the ERD submission as these areas fall out of the proposed Development Envelopes provided within the ERD submission.

Table 1-6: Proposal ERD exclusion areas

Description	Reason
Wyndham Port Facility	Currently proposing to construct a storage shed and small barge loading facility on freehold land and is proposed to be referred to the EPA at a later stage.
Communication towers	Currently proposing to utilise existing Telstra towers; however, new towers may need to be constructed if the appropriate consents cannot be gained from Telstra in a timely manner (the section of the location/alignment of the infrastructure will be undertaken in consultation with relevant TO groups, appropriately acknowledging the Native Title Determination areas for the region).
Hard-rock aggregate sources for sealing haul Road	Currently investigating options of hard rock sources for sealing the haul road, including existing quarries/mines and potential new sources.
Existing roads & tracks for construction access	Proposing to utilise the Gary Junction Road and the Kiwirrkurra-Balgo Track for the Proposal's construction access (as currently utilised).

2. The Proposal

2.1 Background

Lake Mackay was formally discovered by Donald George Mackay in 1930. The first mining exploration into iron oxide-copper-gold was carried out on the lake between 1996-1997 by BHP Billiton. In 2009 Reward Minerals Limited (Reward) undertook exploration of the lake bed for uranium, precious and base metal deposits. Reward held tenements covering the majority of the lake from 2007 to 2014, conducting some initial exploration programs prior to surrendering the tenement holdings in 2014.

Lake Mackay's hydrogeological setting and favourable brine chemistry provide important attributes that support the development of a globally significant sulphate of potash (SOP) operation. Lake Mackay hosts the largest SOP deposit in Australia and covers an area of approximately 3,513 km^2. Lake Mackay is comparable in size to the two major sources of primary SOP production in the world, being the 4,400 km^2 Great Salt Lake in the USA and the 5,500 km^2 Lop Nur (Luobupo operation) in China.

Agrimin entered into the Australian SOP sector in 2014 and acquired exploration licences covering a total area of 4,370 km^2 including Lake Mackay and surrounding areas required for supporting infrastructure. In 2017 Agrimin signed a Native Title Agreement for the Proposal with the Kiwirrkurra Native Title holders. The local Indigenous people and Traditional Owners have strongly supported the Proposal since 2014. Agrimin has completed extensive pilot testing since 2017 which has produced premium quality SOP product. The Proposal's SOP will be high-grade, water-soluble, and suitable for organic food production. In addition, the Proposal will have the lowest production cost for SOP worldwide.

The Proposal has the following technical attributes that will allow for large scale and low-cost SOP production:

- a shallow and continuous brine resource suitable for trench extraction;
- a large on-lake area suitable for unlined evaporation ponds. Unlined ponds have a low capital construction cost, require no vegetation clearing and the lake surface is the most favourable geotechnical location for the ponds;
- wet harvesting of targeted potassium bearing salts provides a reduced disturbance footprint, requires no diesel consumption, and has a low operating cost;
- a targeted high penetration of renewable energy from wind and solar farms;
- dedicated haulage and ship-loading infrastructure to minimise the impact and costs of transportation; and
- favourable brine chemistry at Lake Mackay is suitable for conventional processing techniques to produce premium quality SOP.

The Proposal's development encompasses a strategic mine-to-ship logistics chain to ensure it remains scalable and successful over its multi-decade life. The Proposal has a life of mine (LoM) of at least 20 years with targeted construction commencement in Q4 2022 with the first SOP production expected approximately 2.5 years after the commencement of construction.

A maiden ore reserve of 20 million tonnes of SOP was reported in July 2020. The resource is based on the Measured and Indicated Mineral Resource of 161 million tonnes. A Definitive Feasibility Study (DFS) was also completed in July 2020 confirming that the Proposal is of a globally significant scale and once in operation, will be the world's lowest cost producer of SOP.

2.2 Justification

SOP is an essential fertiliser that can increase yields for high value crops such as fruits, vegetables, and tree nuts. Strong forecasted demand growth for SOP is linked to an increasing Asian middle-class population driving the demand for better quality food, along with increasing demand for environmentally friendly fertilisers. The Proposal will play a critical role towards improving crop yields and achieving food security in South and Southeast Asia by providing a reliable, affordable, and environmentally friendly seaborne supply of SOP from WA. Agrimin is also of the view that the Proposal will offer a strategic benefit by providing domestically sourced and environmentally friendly SOP for Australian farmers.

Agrimin has completed extensive pilot testing which has established the Proposal can produce premium quality SOP that is certified for use in organic food production systems. Agrimin's SOP will also have the lowest production cost worldwide. A review of the SOP market was conducted by Agrimin based on market engagement and analysis undertaken by CRU Group, a leading industry researcher identified that the SOP market has a positive long-term demand outlook, and that the production of SOP via non-chemical processes remains in short supply globally. Current SOP prices range from US$400 to US$500 per tonne globally.

The Proposal is expected to deliver important economic development into remote Indigenous communities, as well as grow and diversify the Australian economy, and was awarded Major Project Status by the Australian Commonwealth Government in May 2020. The Proposal will be a significant source of direct and indirect employment over its operational LoM of at least 20 years. The Proposal will involve jobs for an estimated 200 direct full-time equivalent personnel and create more than 600 jobs through the regional supply chain, generating valuable long-term opportunities for the Native Title groups and Indigenous communities throughout the Central Desert and the broader Kimberley region.

The Proposal will also provide a significant revenue stream to the WA government through the payment of royalties and taxes. The Proposal has the potential to provide substantial benefits, including royalties as well as support for several land projects that are being implemented under the Kiwirrkurra Indigenous Protected Area (IPA) Plan for Country which manages and protects the biodiversity and cultural resources within the vast Kiwirrkurra region.

2.3 Proposal Alternatives

Agrimin has considered a range of alternatives to avoid and minimise any potential environmental impacts that could be associated with the Proposal. These include:

- Trenches for Brine Extraction - trenching is a low-cost method to extract brines from shallow deposits. Compared to bores, trenching is less than half the capital costs and nearly a tenth of the operating cost, for an equivalent volume of brine. Trenching, as opposed to the use of bores, is the optimal method to extract brines on a large-scale and, brine extraction via trenching networks of this scale is a technique employed by brine potash operations elsewhere in the world.
- Processing Infrastructure Locations - all processing infrastructure and supporting facilities have been placed off the lake and outside of the lake margins, therefore avoiding impacts to riparian vegetation and species of Tecticornia. Any development on peripheral claypans has been avoided. During the Proposal's development, three potential processing plant locations were investigated. Two locations were to the south of Lake Mackay and one was to the west. The selected location was based on the information gathered during environmental and heritage studies, along with the considerations of engineering aspects and proximity to the evaporation ponds.
- Evaporation Pond and salt Piles Locations - the location of evaporation ponds and salt piles on the surface of Lake Mackay was considered to be favourable to an off-lake location as this minimises the required clearing of native vegetation and avoids impacts such as salt dispersion into terrestrial environments.
- Infrastructure Locations and Heritage - the location of all infrastructure has been done in consideration of culturally sensitive areas, with avoidance of any areas of significance the primary consideration in deciding infrastructure locations.
- Power Generation - power will be supplied via a hybrid gas, solar, wind and battery solution which has a modelled 84% renewable energy penetration.
- Borefield Location - three process water supply options were evaluated over the development of the Proposal. The Canning Basin, Kintore palaeovalley and Angas Hills Formation were all identified as prospective groundwater resources within a 100 km radius of the processing plant location. Following a review of available historic drilling data and targeted hydrogeological investigations, the Angas Hills Formation of the Amadeus Basin was identified as a suitable supply source of water for the Proposal. The proximity of the aquifer units to the processing plant site and the required construction depth of the extraction bores made this a viable water supply option for the Proposal.
- Haulage Corridor - Wyndham Port has been selected as the Agrimin's preferred port option due to its relative proximity to the Proposal area and the availability of suitable waterfront property for SOP storage and barge loading infrastructure. Numerous haulage corridors have been investigated (refer to Figure 2-1), with a range of heritage, environmental and engineering studies being completed since 2018. The haulage corridor has been aligned to best meet heritage and environmental constraints, minimise the total area required for native vegetation clearing, and provide most efficient route from mine to port. Southern haulage corridors were considered to have a similar environmental impact; however, were less viable from a financial perspective. Approximately 30% of the preferred haulage corridor is on an existing cleared track. Note that operations at Wyndham Port are not part of this proposal and will be regulated through the existing regulatory framework at the port.

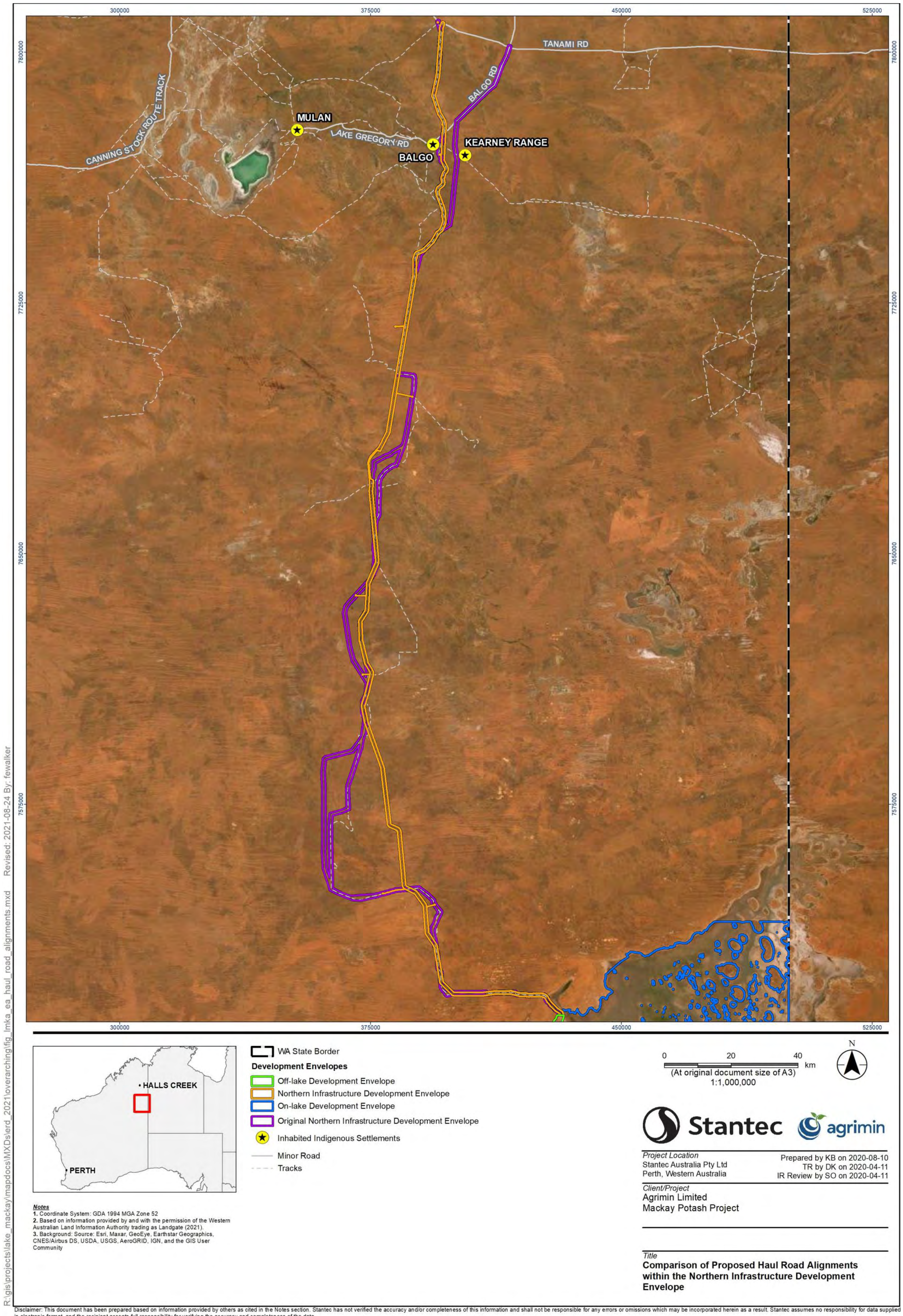

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Figure 2-1: Proposal haulage corridor within the NIDE

2.4 Proposal Description

Agrimin propose to extract brine from a network of shallow infiltration trenches established on the surface of Lake Mackay. The mine plan has been based solely on shallow trench extraction of brine from the near-surface zones. The mine plan proposes an average brine extraction volume of 82 GL/a with an average potassium grade of 2,976 milligrams per litre (mg/L). Throughout the LoM, extraction and recharge processes are expected to gradually dilute the potassium grade from approximately 3,280 to 2,784 mg/L. This grade dilution will be offset by increasing the annual brine extraction rate from 74 to 87 GL/a in order to maintain a constant feed rate of brine to the evaporation ponds. The proposed mine plan is shown in Figure 2-6.

To meet this production, the following infrastructure will be developed:

- network of brine extraction trenches (allocated to Brine Mining Units (BMUs));
- evaporation ponds with wet (floating) harvesters;
- waste salt stockpiles;
- supporting construction and maintenance infrastructure such as mobile equipment, pumps, and pipelines;
- processing plant and associated infrastructure, power supply (gas-fired and renewables), airstrip, access roads, accommodation village and associated facilities. Infrastructure will be set-back from the lake fringe riparian zone, with the exception of some piping and lake access points;
- borefield and associated infrastructure; and
- haulage corridor for the proposed haul road including area required during construction such as borrow pits and temporary water containment for road construction water supply.

The Proposal area is remote and extensive (263,675 ha) and therefore four Development Envelopes have been defined. The following terms are used ERD:

- Study Area – refers to the boundary within which all investigations and field surveys were undertaken.
- Proposal area - The combined area in which the four Development Envelopes are contained, define d below.
- Development Envelopes – the boundary within which the elements of the Proposal are situated. The Development Envelopes occur entirely within the Study Area and comprise four components that make up the Proposal. The Proposal includes disturbance of up to 15,000 ha of the lake's surface and clearing of approximately 1,500 ha of native vegetation. The proposed extent of the physical and operational elements includes four Development Envelopes (Figure 1-2):
    - On-lake Development Envelope (On-LDE): On-lake development of trenches, extraction of up to 100 GL/a of brine, and solar evaporation and harvesting ponds for potash salts, including ground disturbance of approximately 15,000 ha contained within the 217,261 ha On-LDE.
    - Off-lake Development Envelope (Off-LDE): Off-lake development of a processing plant and associated site infrastructure, including access roads, accommodation camp, airstrip and solar farm, including clearing of approximately 200 ha of native vegetation within the 688 ha Off-LDE.
    - Southern Infrastructure Development Envelope (SIDE): Development of borefield, water pipeline and access tracks for abstracting up to 3.5 GL/a of processing water and off-lake access to Lake Mackay, including clearing of approximately 300 ha of native vegetation within the 11,799 ha SIDE.
    - Northern Infrastructure Development Envelope (NIDE): Haul road for trucking potash production to Wyndham Port, including clearing of approximately 1,000 ha of native vegetation within the 33,928 ha NIDE.
- Indicative Footprint – The proposed Indicative Footprint occurs entirely within the Proposal area and refers to the area that is proposed to be directly disturbed by the Proposal (e.g. clearing of native vegetation). The layout of the Indicative Footprint may be subject to change; however, total disturbance will not exceed the maximum extent of disturbance for each Development Envelope as presented in the ERD. Proponent-led avoidance and minimisation measures have been implemented where possible to reduce and minimise potential impacts on areas of high ecological or heritage value through the detailed design of the Indicative Footprint.

The Proposal's detailed design is currently being finalised and the current layout is conceptual at this stage; however, the optimisation of the final design will not extend outside of the four proposed Development Envelopes (Figure 2-2). A summary of the Proposal is provided in Table 2-1 and Figure 2-2, while each Development Envelope is shown in detail in Figure 1-2).

Table 2-1: Key Proposal Characteristics

Proposal title	Mackay Sulphate of Potash Project
Proponent name	Agrimin Limited
Short description	Agrimin Limited proposes to develop a greenfields potash fertiliser operation designed to operate for a 20-year period. The Proposal involves the on-lake development of trenches and solar evaporation ponds for brine extraction and SOP production. The off-lake development includes a processing plant, associated site infrastructure and access roads for trucking SOP product to Wyndham Port. A northern linear access corridor will include the primary site access road, and potentially a water supply pipeline. A southern infrastructure corridor may be used as an alternate water supply option.
Element	**Proposed extent**
Physical elements	
Proposal area (all Development Envelopes)	Disturbance of up to 15,000 ha on the lake surface and no more than 1,500 ha of clearing of native vegetation within the total development of 263,675 ha.
On-LDE: Brine extraction trenches and evaporation ponds.	Disturbance of no more than 15,000 ha of the lake within the 217,261 ha On-LDE (less than 5 % of the lake's surface).
Off-LDE: Processing infrastructure, power supply, access roads, associated infrastructure (camp, airstrip).	Clearing of no more than 200 ha of native vegetation within the 688 ha Off-LDE.
SIDE: Borefield, water pipelines and access tracks.	Clearing of no more than 300 ha of native vegetation within the 11,799 ha SIDE.
NIDE: Haul road.	Clearing of no more than 1,000 ha of native vegetation within the 33,928 ha NIDE.
Operational elements	
Trench Construction	Construction of up to 2,000 km of extraction trenches during the first 17 years of operation.
Brine Abstraction	Abstraction of up to 100 GL/a of hypersaline brine.
Water Abstraction	Abstraction of up to 3.5 GL/a of groundwater for processing.
Water Treatment	Treatment of no more than 0.2 GL/a of water through a reverse osmosis plant.
Waste Salt	Disposal of no more than 18 mtpa of waste salt to be retained on the lake surface.
Wind Turbines	Placement of 5 wind turbines located within the SIDE and NIDE.

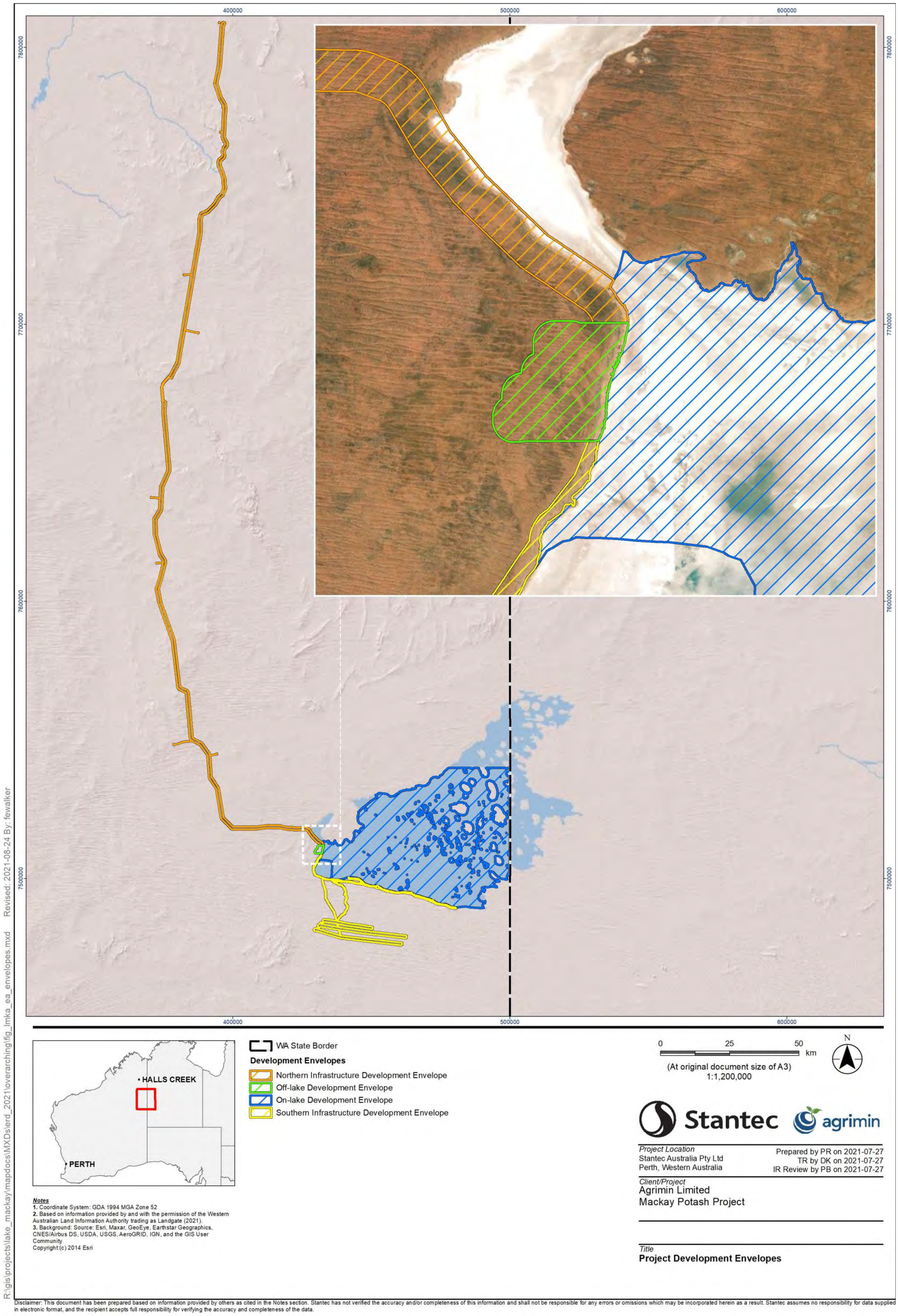

Figure 2-2: Proposal Development Envelopes

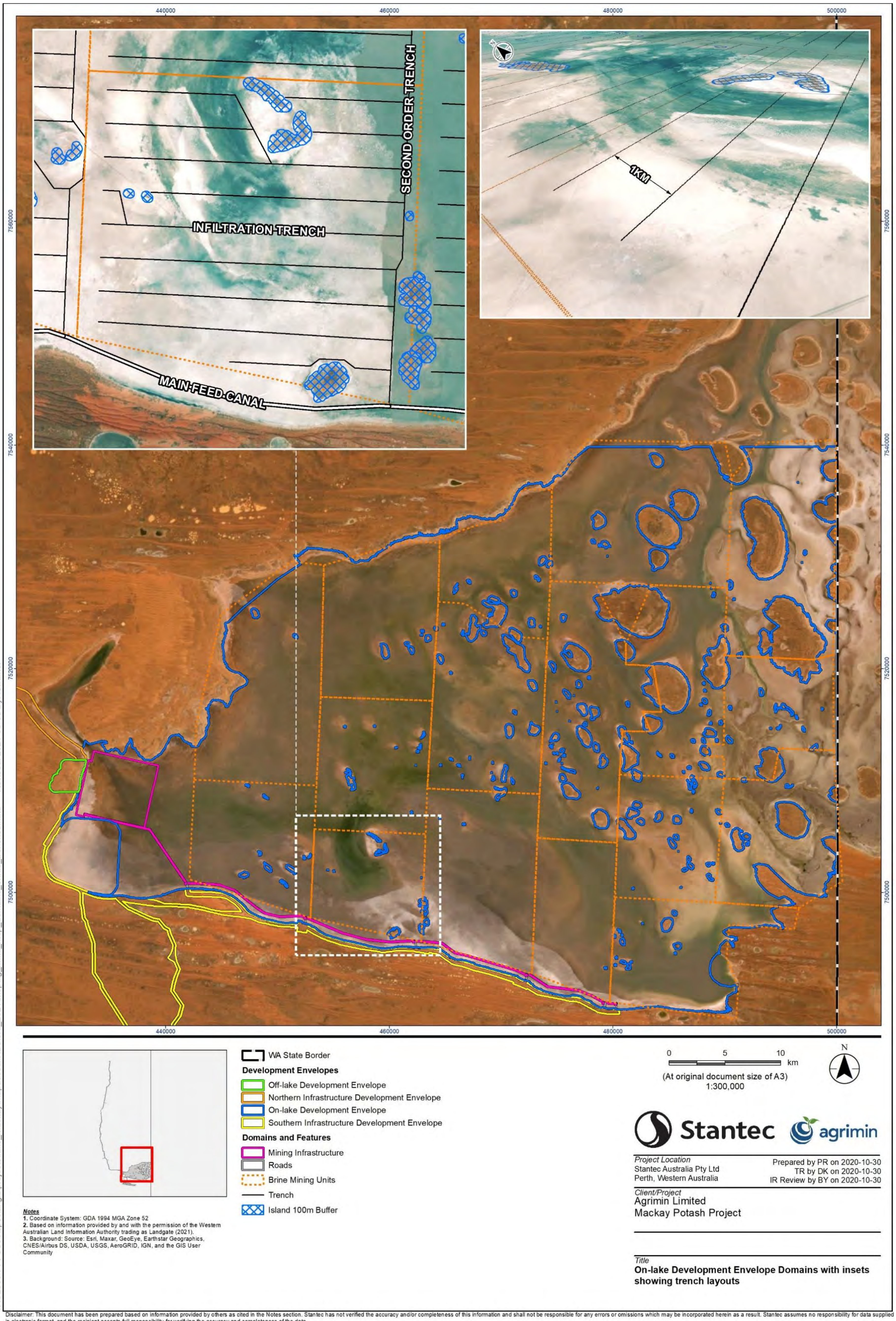

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Figure 2-3: Proposal On-LDE (indicative trench design)

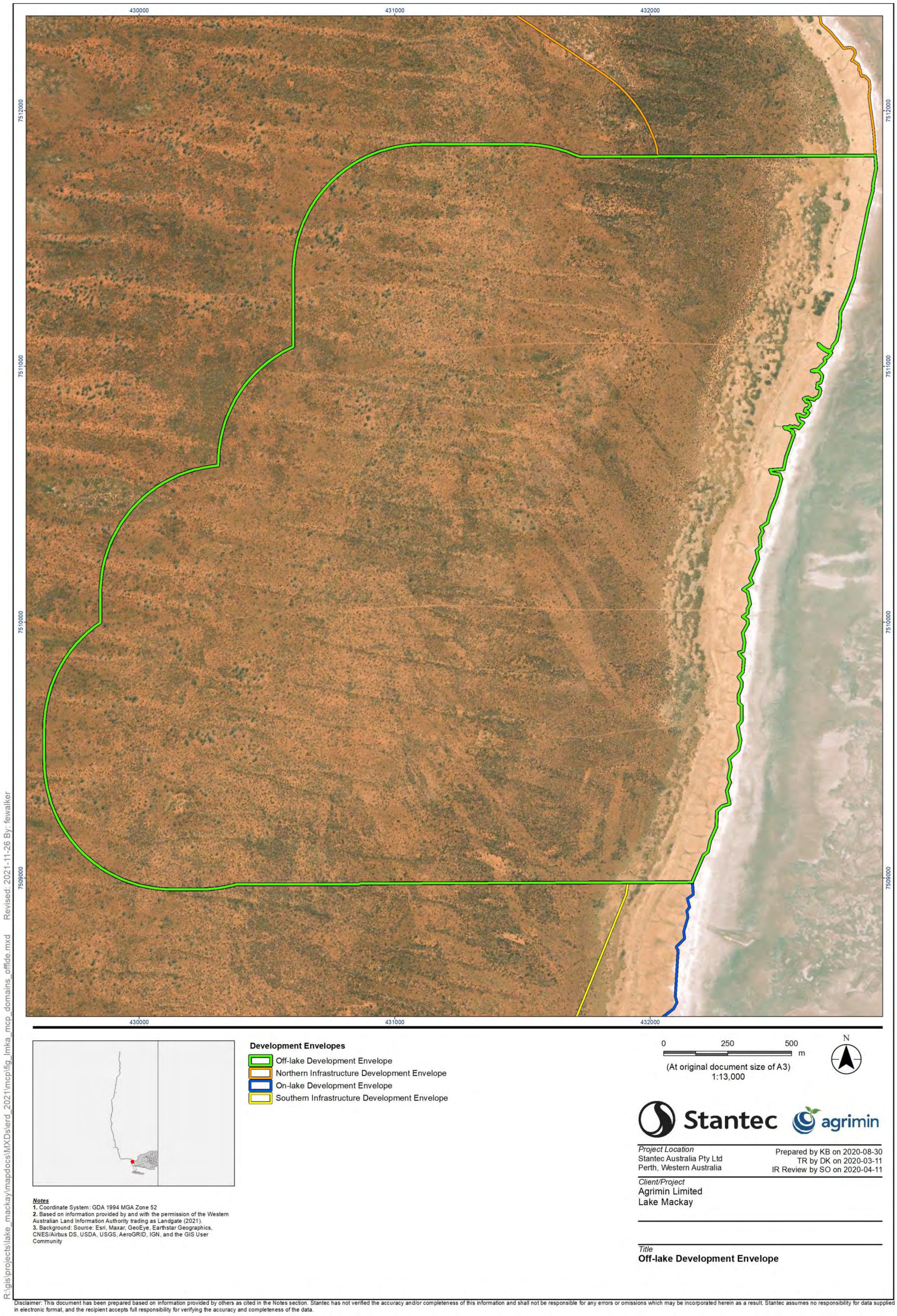

Figure 2-4: Proposal Off-LDE

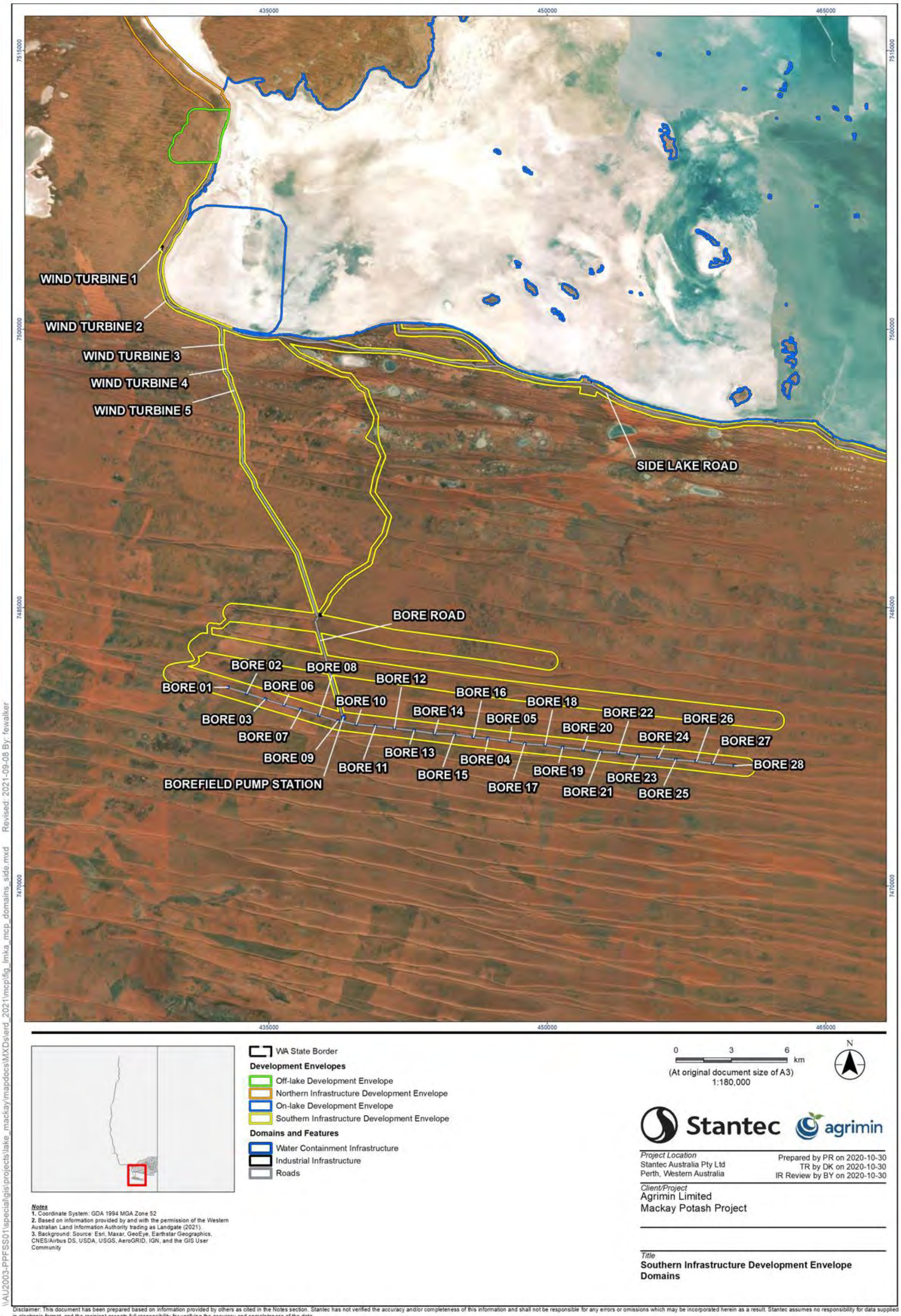

Figure 2-5: Proposed Proposal borefield within the SIDE

2.5 On-Lake Development

On-lake infrastructure includes the construction and use of a brine supply trench network, main feed canal and evaporation ponds resulting in ground disturbance of approximately 15,000 ha within the 217,261 ha On-LDE. The on-lake trench network will extract of up to 87 GL/a of brine for solar evaporation in ponds and harvesting of potash salts for off-lake processing.

2.5.1 Trench Construction

The construction of the trench network is to access potassium bearing brine which is present below the surface across the lake. The trench network consists of a series of parallel west-east running infiltration trenches that are spaced 1 km apart to access the brine aquifer. Brine will seep into the infiltration trenches and then flow into north-south running second order trenches that bring the brine to the south of the lake by gravity flow. A 52 km long main feed canal will be constructed 400 m away from, and parallel to, the southern lake shore to transfer the brine by gravity flow to the pond system to be constructed on the south-western part of the lake. Lift pumps will transfer brine from the north-south second order trenches up and into the main feed canal. This will allow the brine draw from various parts of the lake to be controlled.

The arrangement, depth and shape of the trenches has been optimised to minimise disturbance to the lake, whilst also enabling the valuable potash resource to be extracted. Infiltration trenches will typically be 4 m deep with second order trenches varying in depth from 4 m to 5 m to facilitate gravity flow. The main feed canal will vary in depth from 3 m to 4 m and be up to 14 m wide.

The trench network will be constructed using low ground pressure excavators and using a centreline retreat methodology to minimise disturbance to the lake surface. The lake material excavated from the trenches will be placed on either side of each trench to form a bund around the network. This is to prevent any surface water from draining into the trenches.

The trench network has been partitioned into 17 Brine Mining Units (BMUs) which represent areas of the lake that have similar physical and chemical characteristics (Figure 2-6). Initially the southernmost BMUs will be developed with additional BMUs constructed and brought online over a 17-year period to offset grade decline.

Brine extraction parameters have been estimated from data derived from 22 trial trenches excavated during resource estimation field trials conducted between 2017 and 2019. The trench network is designed to deliver brine at an average rate of 2,500 L/s. Approximately 1,973 km of trenches will ultimately be required to be constructed to produce 9 Mt of SOP over the 20-year LoM (Figure 2-6).

2.5.2 Evaporation Pond Construction

The Proposal will target potassium bearing salts contained in the lake brine through an initial process of solar evaporation ponds. A series of evaporation ponds will be constructed on the south-western side of the lake for this purpose. The process will see brine pumped into the evaporation ponds from the main feed canal, with waste salts including halite (NaCl), thenardite (Na_2SO_4) and epsomite ($MgSO_4{\cdot}7H_2O$) precipitating out as the brine progresses through the series of ponds. The final ponds will accumulate the targeted potassium salts including kainite ($KCl{\cdot}MgSO_4{\cdot}2.75H_2O$) and carnallite ($KCl{\cdot}MgCl_2{\cdot}6H_2O$).

The evaporation ponds will be constructed on the lake surface using lake bed material to form earth embankments. These will vary in height between 1.7m and 3.1m, with typically 5 m crest width. Initial pond development will involve constructing 58km of lineal embankments to create 3260 ha of total pond area (P0 to P7, H1 and H2). The initial pond development will be completed during mine year (-1) in order to allow for pond filling and evaporation to commence in mine year 1.

Geotechnical investigation has determined that the natural lake bed surface has a very low vertical permeability; low seepage losses are therefore expected making it suitable for the construction of un-lined pond floors. Only the pond embankments will be lined with HDPE to prevent horizontal seepage.

As the operation progresses waste salt will accumulate in some of the ponds (P2 to P5) requiring their embankments to be progressively raised. By mine year 10 ponds P3, P4 and P5 will reach 9m in height. Once this height has been reached, further berm raising is no longer cost effective and new pre-concentration ponds will need to be constructed. The new pre-concentration ponds will be constructed and brought into operation in mine year 10, taking the total constructed pond area to 4790ha. The new ponds will also be progressively raised until mine year 20.

Ponds P6 and P7 are expected to produce approximately 6Mt/a of waste salt. These waste salts will be removed from the ponds as a slurry using wet harvesters. A series of waste salt deposition cells, 200 m square, will be constructed adjacent and to the north of P6 and P7. Each deposition cell will consist of a perimeter cut-off trench, nominally 2 m deep, with the trench spoil deposited to form a berm on the outside of the cell; refer to pond layout. The waste salt will be discharged in the cell, with the brine draining into the cut-off trench and then flowing back to a sump pump to be pumped back into the pond system.

The waste salt slurry pipe discharge point will be managed to prevent salt discharging beyond the cut-off trench bund area to recover the valuable brine and prevent brine spilling out onto the lake. Dozers will be used to heap and profile the waste salt piles, as integral to the tails pile management and brine recovery operation. The salt piles for P6 and P7 will accumulate over the LoM and will reach nominally 20 m height and occupy an area of approximately 500 ha after 20 years of operation.

The precipitated salts in ponds H1 and H2 are recovered using wet harvesters and are pumped to the processing plant via slurry pipelines for extraction of the final K_2SO_4. The brine exiting H2 constitutes the bitterns brine, with the majority of this brine recycled back to P7 and a small amount of excess bitterns retained in the bitterns canal.

2.6 BMU Staging

The on-lake trench network will be progressively developed in 5 stages over the 20-year life of mine (Table 2-2), including:

- Stage 1: mine year -1: this stage involves development that occurs prior to commencement of brine pumping;
- Stage 2: mine year 1: this is the first year of brine pumping from the trench network;
- Stage 3: mine years 2-5: the process is ramped up and full production is achieved during this stage;
- Stage 4: mine years 5-10: the trench network is extended to offset grade decline;
- Stage 5: mine years 10-20: the trench network reaches its maximum extent in mine year 17.

The construction and brine extraction timeline for the BMU network is shown in Table 2-2 below. The pumping (or gravity drainage) of individual BMUs commences at different stages after the trench network has been completed for that specific BMU.

The most intense phase of trench construction (Stage 3) occurs in the first 2.5 years after mobilisation, when approximately 917 km of trenching will be excavated. This is necessary to deliver the required brine grade and volume to fill the ponds and commence production. The pond filling and initial evaporation will take 18 months to complete before harvesting of potassium salts can commence.

The development of the trenching network begins along the southern shore of the lake and spans approximately 60 km east to west. The first 2.5 years of trench construction will be undertaken by using a fleet of 14 excavators operating over a full-time schedule (24 hours per day). Thereafter trench construction will be undertaken during daytime only and on a campaign basis to meet the mine plan schedule.

A total of 368 km of trench excavation is required to be completed in mine year 1 prior to commencement of brine pumping. At the start of mine year 1 pumping to the ponds is commenced, drawing from BMUs 6, 7, 9 and 15. During mine year 1 BMUs 12, 17 and 3 will be excavated and brought online. At the start of Mine year 2, BMU 2 comes online and one month later BMU 14 is required at which stage approximately 917km of trenching will be completed.

Table 2-2: BMU buildout schedule

Stage	Mine Year	BMUs Starting Operation	Trench Excavation Required (km)	Number Of Operating BMUs In That Year	Produced Brine (GL)
1	-1	6,7,9,15	367.8	4	73.8
	1	12,17,3	345.6	7	
2	2	2,14	204.2	9	75.1
3	3-5	5	98.7	10	77.4
4	5-10	8	149.3	11	79.1
		11	144.1	12	80.6
5	10	1	106.3	13	81.8
	12	4	174.7	14	83.2
	13	10	90.6	15	83.7
	15	13	127	16	84.7
	17	16	165.1	17	85.7
	18			17	86
	19			17	86.5
	20			17	87
Total			1973.4		

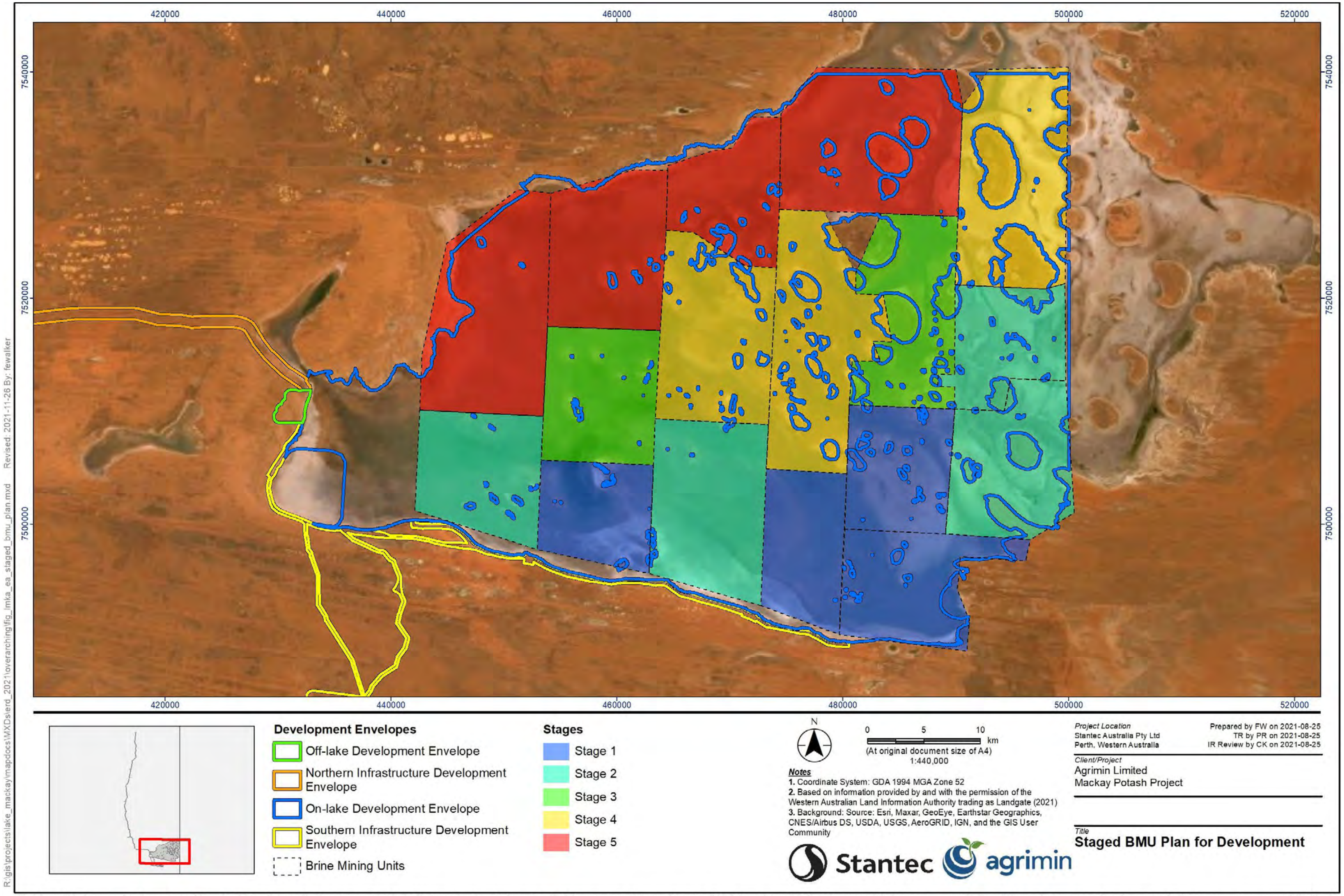

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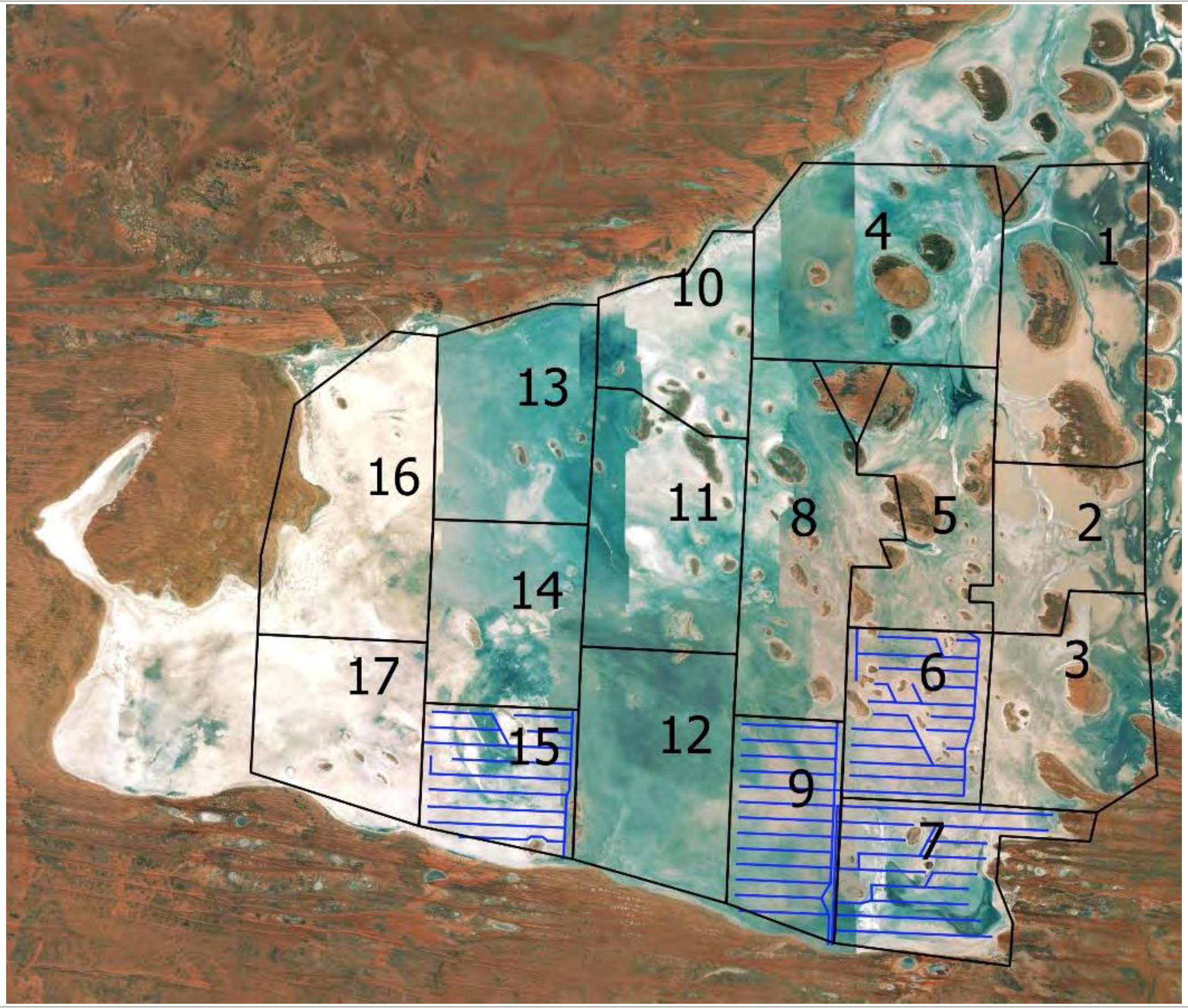
Figure 2-6: Proposal indicative trench network at start-up and BMU layout on the On-LDE

2.6.1 Stage 1 (Mine Year 1)

In mine year minus one (-1) a total 368 km of trench excavation is required prior to commencement of brine pumping operations.

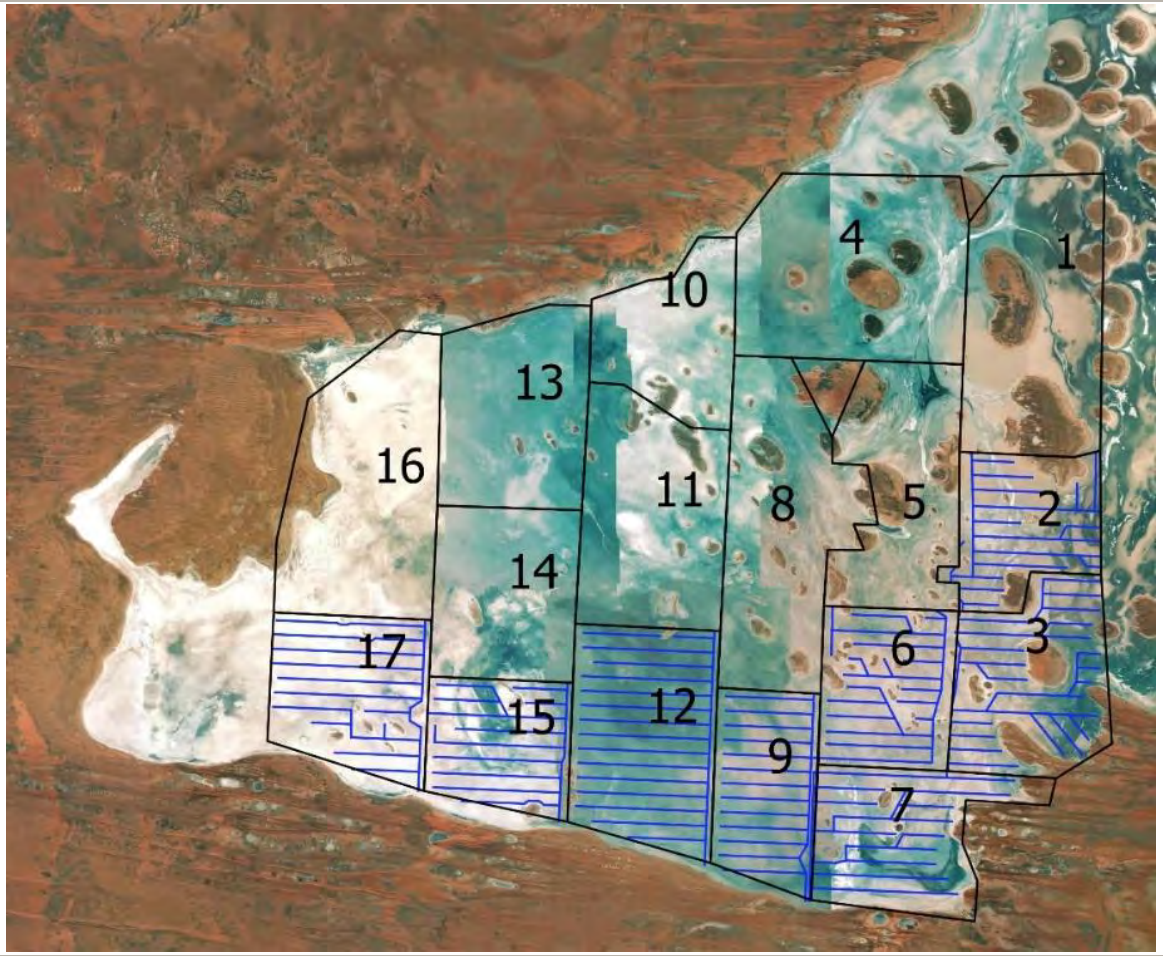
Activity	Schedule (Mine Year)			Phase Intensity		Scale of Development	Impact within DE	
	Start	Finish	Duration (Years)	Construction	Operation	Cumulative Extent and Percent Complete	Development Envelope	Percent of Disturbance On-lake
Stage 1								
BMUs (excavated) 6, 7, 9, 15	1	1	1	24/7	N/A	368 km infiltration trench	On Lake	1.6%



2.6.2 Stage 2 (Mine Years 1 to 2)

At the start of mine year 1 brine is drawn from BMUs 6, 7, 9 and 15 pump to the ponds. During mine year 1, four more BMUs will be constructed, these are 12,17, 3 and 2.

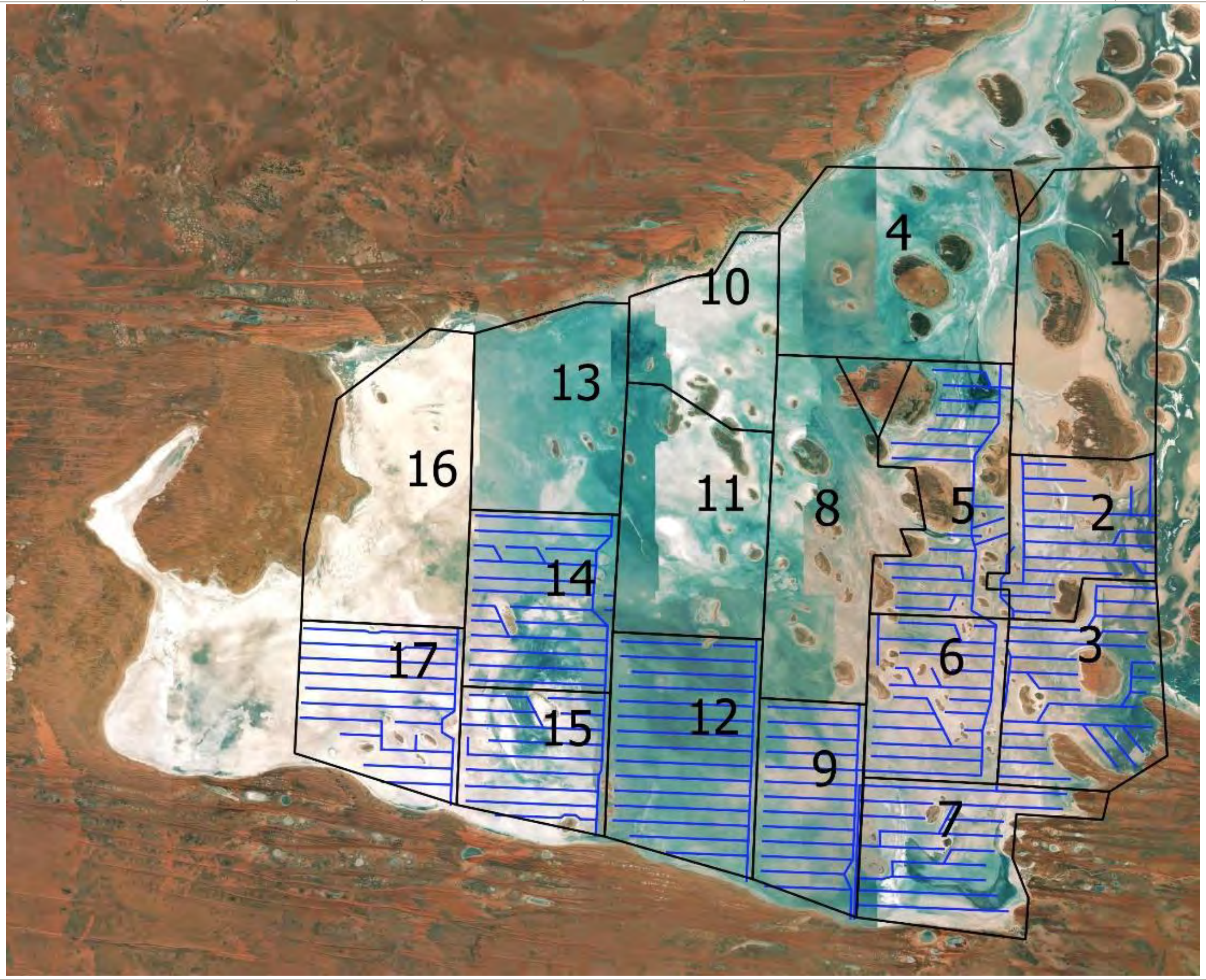
Activity	Schedule (Mine Year)			Phase Intensity		Scale of Development	Impact within DE	
	Start	Finish	Duration (Years)	Construction	Operation	Cumulative Extent and Percent Complete	Development Envelope	Percent of Disturbance On-lake
Stage 2								
BMUs (excavated) 12, 17, 3, 2	1	2	1	24/7		798 km of infiltration trench (41%)	On Lake	2.1%
BMUs (pumped) 6, 7, 9, 15, 12, 17, 3, 2		2	1		24/7 75.1 GL	9 active BMUs (53%)	On Lake	



2.6.3 Stage 3 (Mine Years 2 to 5)

Ramp up stage at the start of year 2- construction of trenches then slows to 12 hours a day.

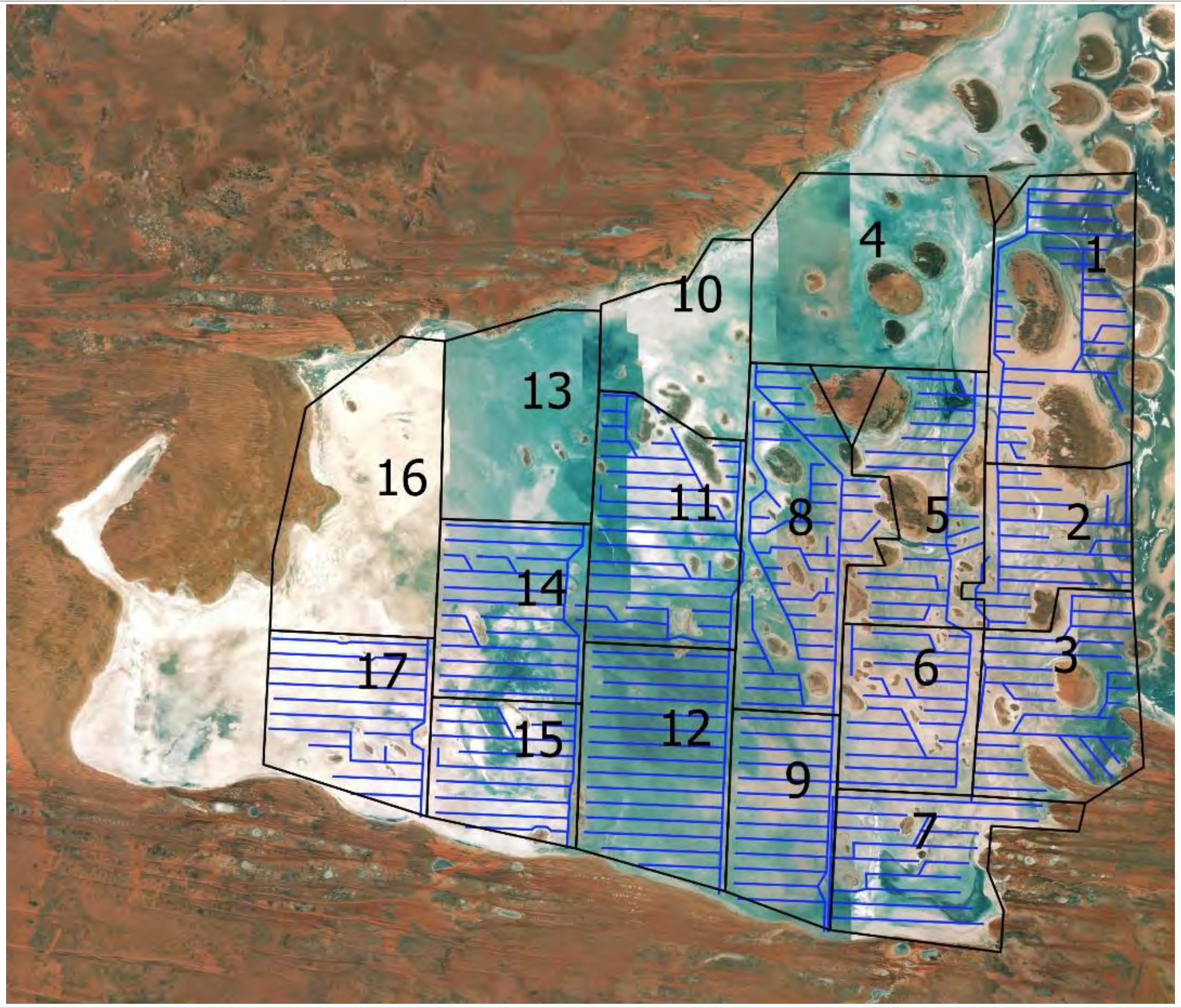
Activity	Schedule (Mine Year)			Phase Intensity		Scale of Development	Impact within DE	
	Start	Finish	Duration (Years)	Construction	Operation	Cumulative Extent and Percent Complete	Development Envelope	Percent of Disturbance On-lake
Stage 3								
BMUs (excavated) 14, 5	2	5	3	12/7		1017 km of infiltration trench (52%)	On Lake	2.3%
BMUs (pumped) 6, 7, 9, 15, 12, 17, 3, 2, 14, 15	1	5	3		24/7 78.3 GL	10 active BMUs (59%)	On Lake	



2.6.4 Stage 4: (Mine Years 5 to 10)

Trench network is extended to offset grade decline.

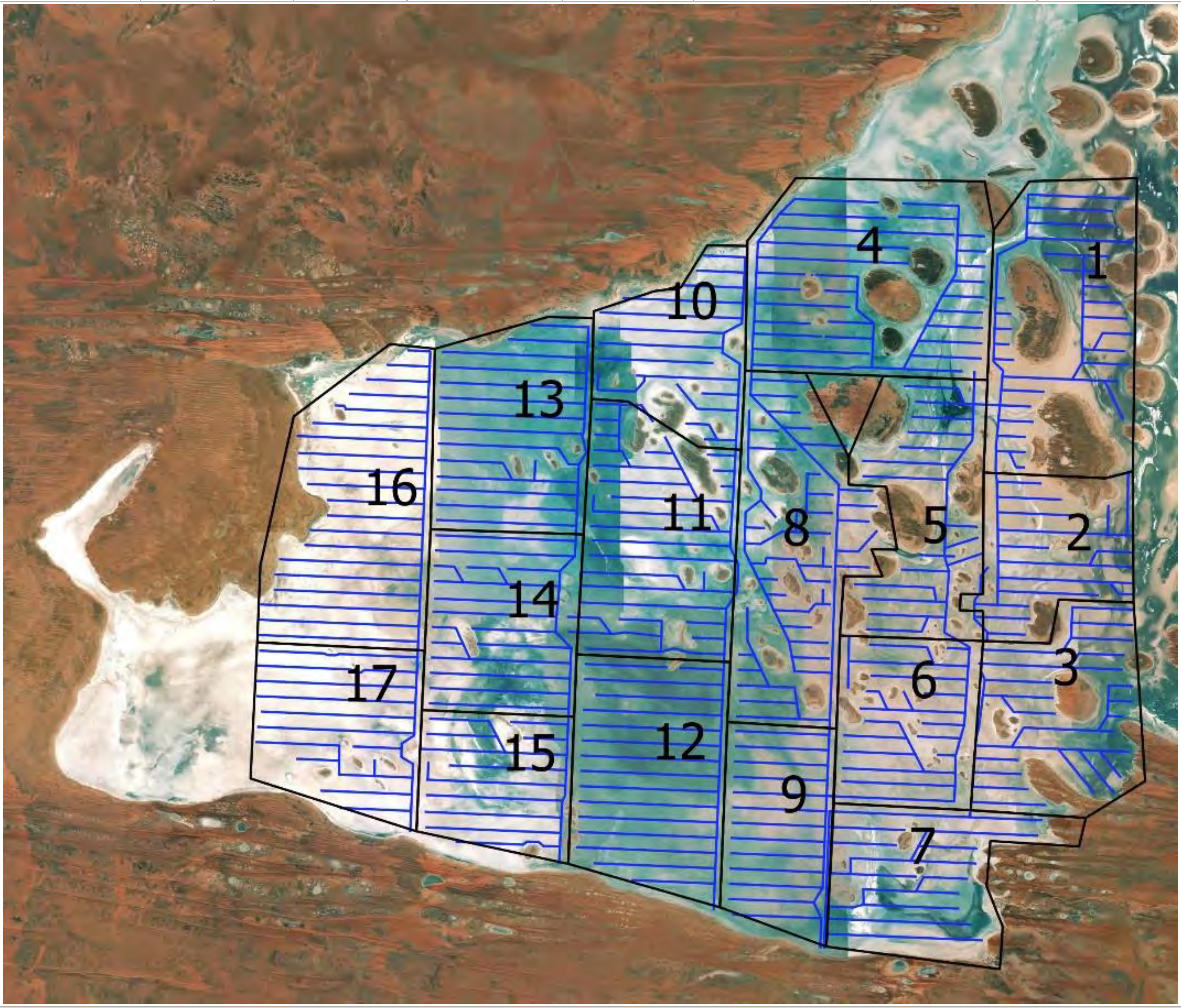
Activity	Schedule (Mine Year)			Phase Intensity		Scale of Development	Impact within DE	
	Start	Finish	Duration (Years)	Construction	Operation	Cumulative Extent and Percent Complete	Development Envelope	Percent of Disturbance On-lake
Stage 4								
BMUs (excavated) 8, 11, 1	5	10	5	12/7		1417 km of infiltration trench (72%)	On Lake	3.05%
BMUs (pumped) 6, 7, 9, 15, 12, 17, 3, 2, 14, 15, 8, 11, 1	1	10	9		24/7 81.8 GL	13 active BMUs (76%)	On Lake	



2.6.5 Stage 5 (10-20)

Trench network reaches full capacity at mine year 17, all BMU's active at this stage.

Activity	Schedule (Mine Year)			Phase Intensity		Scale of Development	Impact within DE	
	Start	Finish	Duration (Years)	Construction	Operation	Cumulative Extent and Percent Complete	Development Envelope	Percent of Disturbance On-lake
Stage 5								
BMUs (excavated) 4, 10, 13, 16	10	17	7	12/7		1,973 km of infiltration trench (100%)	On Lake	4.55%
BMUs (pumped) 6, 7, 9, 15, 12, 17, 3, 2, 14, 15, 8, 11, 1, 4, 10, 13, 16	0	20	20		24/7 87 GL	17 active BMUs (100%)	On Lake	



2.7 Adaptive Management Approach

As the Proposal progresses across the lake's surface, the staged approach allows for a systematic approach to improving the knowledge of the lake's response to the implementation of the Proposal and provide a mechanism for improving the environmental results and management practices as new BMUs are brought online. As the monitoring conducted through the staging progresses, and the understanding of the ecosystem's functions increases, Agrimin will be able to apply learnings and outcomes to adaptions to the trench system accordingly. This review and refinement of the Proposal's management actions will be included in revisions of the suite of management plans.

Further informing revisions of the EMPs will be the collection of baseline data during construction and operations, providing a robust dataset and understanding of the ecosystem's ability to adapt to the progressive construction of the trench network northward across the lake. This monitoring will enable the current objective-based provisions proposed in the management plans to transition towards outcomes-based trigger/threshold management practices. The ability for Agrimin to transition into adjusting the monitoring and management (if required) will allow for a robust set of early response indicators to be implemented into the revision of the management plans, further providing certainty that the progression of the next BMUs is implemented in a manner that identify any precursors to an environmental impact prior to the issue becoming problematic.

Agrimin is committed to reviewing and revising (if required) the management plans and BMUs trench design and construction approach at the end of each stage to ensure adaptive management is adequately implemented in the processive stages of the Proposal. Noting this, it is unlikely that serious or material environmental harm will occur as a result of implementing the Proposal in a staged manner.

2.8 Brine Extraction and Processing

Brine deposits are fundamentally different from hard rock deposits in that the brine resource is subject to groundwater movement, recharge (from rainfall and runoff), physical advection and chemical dispersion. The Proposal's Ore Reserve is defined as the quantity of potassium and other elements in the brine that is extractable from the lake bed sediments after consideration of these processes and accounting for the long-term impacts of brine extraction.

As groundwater storage in the lake bed sediments is removed via brine extraction during operations, rainfall and runoff events will infiltrate the lake surface and recharge the groundwater system. This recharge water will mix with crystallised salts and capillary groundwater still found within the near surface sediment and through the hydrogeologic and mass transport processes of mixing, advection, dispersion and diffusion, further potassium will be mobilised from this sediment. The Mineral Resource within Lake Mackay has been modelled as five layered brine zones that overlie a solid basement, as shown in the cross-section in (Figure 2-7).

Trenches will be progressively extended into new BMU areas over the Proposal's LoM as potassium is depleted from the lake bed due to ongoing brine extraction. Brine extraction will include gravity drainage into east-west orientated infiltration trenches. The brine will then flow into larger north-south orientated second order trenches that will gravity feed into the main feed canal. Brine will then be transferred along the main feed canal to the evaporation ponds with the assistance of six pumping stations.

The conceptual hydrogeological model provides a representation of the brine extraction process and general recharge regime (Figure 2-7). Plate 2-1 provides a photograph of a current trial trench located in the Proposal area.

The trenches have been designed so that the material excavated will be placed and built up around the trench perimeter to form a 2 m high external bund. This bunding is designed to act as a barrier to stop direct surface water ingress into the trenches following rainfall events. A detailed hydrological model to support the trench bund design was developed as part of the basin-wide surface water assessment (Section 9).

A main feed canal will be excavated along the southern limits of the trench network (Figure 2-3). Brine will be pumped along the main feed canal to the solar evaporation ponds with the assistance of pumping stations. The design of the trench network has focussed on retaining natural surface water flow patterns wherever possible and include strategic drainage cross-overs' that are designed to remove impediments to surface water flows.

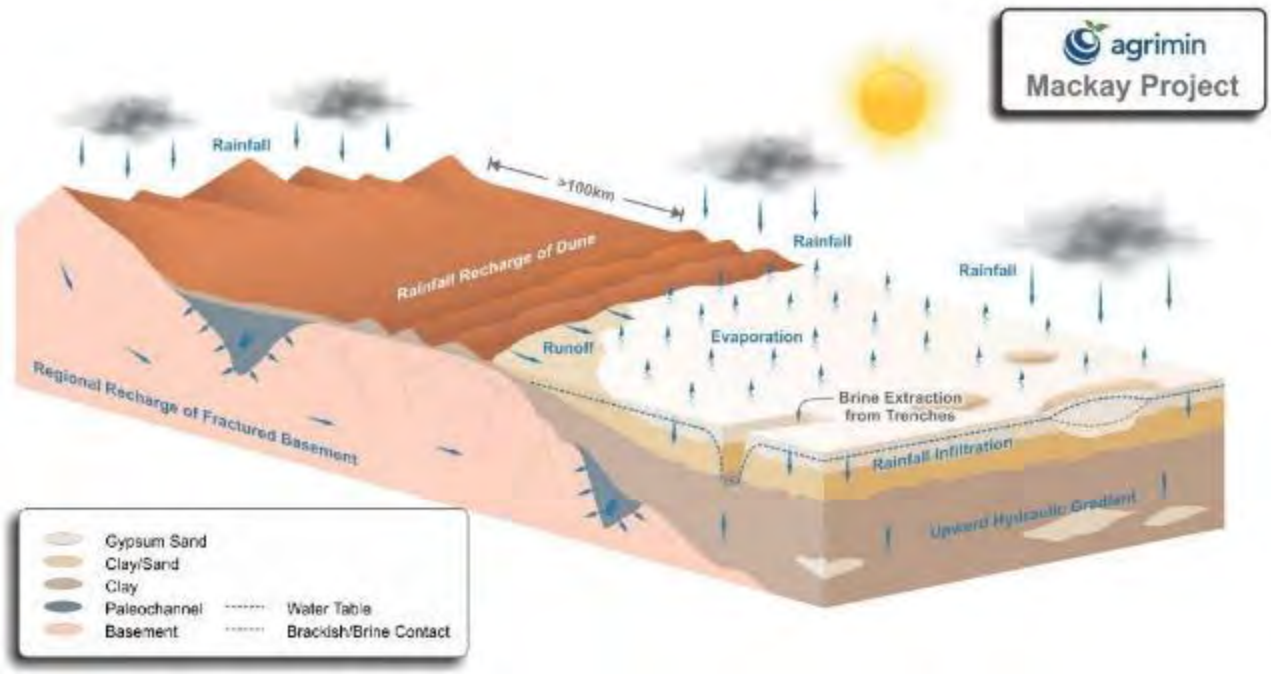


Figure 2-7: The Proposal's conceptual hydrogeological model (Note: brine extraction trenches are not drawn to scale)

Plate 2-1: The Proposal's trial brine extraction trench

2.8.1 Salt Harvesting

The Proposal will target potassium bearing salts through an initial process of evapoconcentration. This process will see brine enter the evaporation ponds from the feed channel, with waste salts including halite (NaCl), thenardite (Na_2SO_4) and epsomite ($MgSO_4{\cdot}7H_2O$) precipitating out as the brine progresses through the ponds. The final pond will accumulate the targeted kainite salt (KCl $MgSO_4$ $2.75H_2O$), which will then be wet harvested and pumped to the processing plant for conversion to the final SOP product.

The evaporation pond process is as follows:

- Ponds P1-P5: Brine from the lake is transferred to the pre-concentration ponds which are constructed on top of the native clay bed. The goal of the pre-concentration ponds P1 to P5 is to concentrate the brine while precipitating waste material while avoiding precipitation of any potassium bearing minerals. As water evaporates from the brine, the concentration of salt species within the brine increases and large amounts of halite and other waste salts are precipitated. These minerals accumulate in the ponds throughout the LoM. The precipitated material is not harvested, and the pond berms are periodically raised to accommodate the rising pond floor.
- Ponds P6-P7: Pre-concentration ponds P6 and P7 perform a similar function to P1-P5; however, precipitated waste salts will be harvested to enable the recovery of entrained potassium rich brine. Harvested waste salt will be wet stacked on dedicated drainage pads where entrained brine will be collected and recycled back to P6 and P7 for further evapoconcentration. Removal of waste salts from these ponds will reduce potassium losses to entrainment in the precipitated salts.
- Harvest Ponds H1-H2: The H1 production pond will produce raw potash salts in the form of kainite along with waste minerals, principally halite. The H1 brine is transferred from pond H1 to the final harvest pond H2. The brine is concentrated in H2 to precipitate carnallite ($KCl.MgCl_2.6H_2O$), with waste minerals halite and hexahydrate. The kainite salts from H1 and the carnallite salts from H2 are recovered using floating harvesters and are pumped to the wet plant via independent slurry pipelines for processing.

Five wet (floating) harvesters will operate 24/7 year-round in the P6, P7, H1 and H2 ponds, with P6 assigned two harvesters due to the larger area of the pond. The harvesters are 22 m long and 6 m wide with cutting augers on either end. The machines will be remotely controlled from a central control room and have an estimated 200 tonne per hour harvest capacity. Reticulated power will be used for the electric harvesters, removing the need to use diesel. The harvesters in P6 and P7 are designed to harvest waste salts to enable the recovery of entrained brine to reduce potassium losses. The harvesters in H1 and H2 will harvest the final precipitated salt and transfer it to the processing plant via two slurry pipelines for further beneficiation into SOP product. Brine returning to the ponds from the processing plant will be recycled in P7.

2.8.2 Waste Salt Stockpiles

Waste salts harvested from P6 and P7 will be deposited in waste salt stockpiles immediately adjacent to these ponds. It is expected around 6 Mtpa of waste salts will be moved to these stockpiles. The piles are expected to reach an average of 20 m high and will cover an area of 500 ha at year 20. Salt will be stacked in 200 m^2 cells consisting of a 2 m deep cut-off trench with the trench spill used to create a berm on the outside of the trench. Brine draining from the cell will be collected in the trench and pumped back into the ponds. Dozers will be used to heap and profile the waste salt stockpiles. Waste salt deposition on the lake surface, including both the evaporation ponds and the waste salt stockpiles, will be up to 18 mtpa.

2.8.3 Processing Plant

The processing plant will be located to the west of the evaporation ponds and on the western shore of the lake in the Off-LDE (Figure 2-4). The processing plant has been designed for a steady-state production rate of 450,000 tonnes per annum (tpa) grading to 52% potassium oxide(K_2O). Based on test work and process modelling, an overall potassium recovery of 82.6% has been estimated for the production process, including both the evaporation ponds and processing plant.

A simplified process flow diagram for the processing plant is shown in Figure 2-8. The plant is designed to receive 3.0 Mtpa of raw potash salts, being fed from the evaporation ponds via two slurry pipelines. The salts will be crushed to ensure adequate liberation of brine to allow the downstream unit operations of the plant to operate efficiently. The slurry from the crushing circuit will be fed into a thickener to minimise the amount of brine that moves forward into the next stages of the process.

The salt slurry exiting the thickener will be transferred to a series of conversion vessels where the raw potash salts will be converted into a single potash-bearing salt mineral in the form of schoenite ($K_2SO_4.MgSO_4.6H_2O$). The resulting slurry exiting the conversion circuit will contain only schoenite and halite and will be transferred to the flotation circuit.

The salt slurry exiting the conversion circuit will then be mixed with flotation reagents in the conditioning tanks prior to being transferred to the flotation cells where the schoenite is preferentially floated from the halite. The combination of the flotation and leach reactors ensures that the concentrate is of the right schoenite quality and the recovery from the tails is achieved. The resulting schoenite concentrate will be de-brined and fed to the first stage SOP crystalliser to initiate SOP production.

The SOP crystallisation step will take place at an elevated temperature to dissolve magnesium sulphate ($MgSO_4$) and crystallise SOP (K_2SO_4) within the SOP crystalliser vessels. The resulting SOP slurry will be transferred to a hydrocyclone followed by a centrifuge. The SOP will then be dried and stockpiled in a covered storage area prior to haulage to Agrimin's storage shed at Wyndham Port.

Three reagents will be used in the processing plant, all of which will be bought to site in liquid form and stored in bunded tanks close to point of need, comprising Flotigam 8122 (collector), methyl isobutyl carbinol (frother) and kerosene (extender oil). The residue discharged from the flotation circuit is composed of halite and a minor amount of residual schoenite and are mixed with brine from pond P6 to dissolve and recover any residual schoenite.

2.9 Infrastructure Corridors

The haul road will be constructed over a two and a half year period. Construction activities will include site establishment, vegetation clearing along the entire haul road length, bulk cut and fill earthworks, and construction of water bore drilling. Contruction of the 346 km long haul road will commence at the southern end and progress northward. The haul road will be constructed using base course material sourced from suitable borrow sources adjacent to the haulage corridor within the NIDE. Each borrow source will provide enough material for between 2.5 km and 10 km of road construction, and will be progressivley developed as the construction work front moves north. Borrow pits behind the work front will be progressively made safe.

The NIDE is defined as the Development Envelope within which the Proposal's haulage corridor will be contained (Figure 2-1). The haul road will extend north from the Proposal's processing plant to the public Tanami Road. Approximately 30% of the proposed new 346 km haul road will occur along the existing cleared track that currently links the Proposal area to the Tanami Road. The haulage corridor will involve disturbance of up 1,000 ha within the 33,928 ha NIDE, with an average cleared width of 16.5 m and a running surface of 6.5 m. Clearing in the NIDE for the haulage corridor will include areas for off-shoot drains, borrow pits, wider clearing when traversing dune landforms and temporary cleared areas during construction.

The haulage corridor includes the proposed new haul road, followed by 205 km and 390 km of improvements along the existing public Tanami Road and Great Northern Highway, respectively (Figure 2-1). The Tanami Road is currently an unsealed road with Commonwealth and State government funding allocations for upgrade to a dual-lane sealed road. The Great Northern Highway is a high-quality dual-lane sealed road which has been recently upgraded with improved width and drainage.

Agrimin is intending to seal a single lane of the haul road, pending final review of the feasibility of this approach. Sealing would occur after an initial period (12 to 18 months) of operations to allow compaction of the running surface prior to sealing. The haul road will be designed to facilitate sheet flow crossing the road during flood events and removing the need for culverts.

2.10 Supporting Infrastructure

2.10.1 Power Supply

Due to the remoteness of the Proposal, all electrical power required by the facility will need to be generated on site. A hybrid power supply solution has been developed by a consultant with experience in constructing standalone, multi megawatt power (MW) stations. The proposed power supply configuration, located in the Off-LDE (Figure 2-4), consists of the following;

- 12 x 2 MW reciprocating gas-engine type generators for 22 MW installed generation capacity;
- 12 MW AC peak Photo Voltaic (Solar) generation;
- 5 x 4.5 MW wind turbines for 13.5 MW generation capacity; and
- 4 MW at 2C & 2 MWh battery energy storage system (BESS).

The processing plant presents the main power demand for the permanent operations. Other power demands at the processing plant site include the accommodation village and supporting infrastructure including, the borefield, reverse osmosis (RO) plant, waste-water treatment plant, brine pond transfer pumps, offices, salt harvesters and other site non-process infrastructure. Peak running demand from the operation is estimated to be 20,083 kW. Natural gas will be required by the processing plant to generate process steam and heat product dryers. Gas consumption for non-electrical power gas consumption is estimated to be 183,915 gigajoule per annum (GJ/a). Total LNG consumption for the Proposal is 735,573 GJ/a.

Liquefied natural gas (LNG) will be trucked from an established LNG production facility in Karratha via the Great Northern Highway, Tanami Road and Agrimin's haul road, a total distance of 2,000 km. Gas will be offloaded to a site-based LNG storage and regassification facility with a storage capacity of up to seven days.

The proposed use of wind and solar energy is expected to reduce Scope 2 carbon dioxide equivalent (CO_2-e) emissions, compared to a fully gas-fired power station. A detailed assessment of greenhouse gas emissions from the Proposal is provide in Appendix M and Section 11.4.

The six intermediate pumping stations located on the lake and 28 bores located at the process water borefield will be powered by dedicated diesel generators. Fuel supply for each generator will be provided by a self-bunded fuel tank.

2.10.2 Water Supply

The Proposal's operating water supply will be abstracted from a borefield comprising approximately 28 operating bores within the SIDE (Figure 2-5). The bore water will be collected into a nearby tank and then pumped via a pipeline to the raw water pond at the processing plant.

Approximately 35 shallow bores are proposed to be drilled within the NIDE for construction use, for approximately one to two months per haul road construction segment. Temporary water containment will be used for construction purposes and dust suppression supplied from water sourced from these bores. Once construction within each segment of the haul has been completed and bores are no longer required to support the Proposal, cleared areas will be rehabilitated. Bore infrastructure such as bore casing will remain in place and be capped as per DMIRS requirements.

2.10.3 Proposal Water Demand

The Proposal requires 3.17 GL/a of raw water for the production of SOP. Hydrogeological studies, including drilling of exploration and test bores, have identified a suitable fresh to brackish aquifer approximately 45 km south east of the processing plant to provide water in sufficient quantity and quality for the Proposal. Analysis of the bore water quality showed total dissolved solids (TDS) values range from 2,500 to 7,000 parts per millions (ppm). The raw water borefield has been designed to be capable of providing up to 3.5 GL/a which translates to a borefield production rate of 111 litres per second (L/s).

Bore water will be supplied to the processing plant without any treatment. A Reverse Osmosis (RO) plant will treat 0.2 GL/a to potable water quality. The potable water requirement estimate is based on the following assumptions:

- 50 L/person per day of potable water required at the operations area;
- 2500 L/hr for use by the boiler system within the processing plant;
- 250 L/person per day at the at the accommodation village;
- maximum of 100 people on site at any one time; and
- RO plant yield of 75%.

2.10.4 Borefield Design and Infrastructure

The borefield development is planned to be staged over a two year period. Initially four bores in the field will be developed to provide sufficient water for construction activities. Towards the end of mine year 1 the remaining 24 bores will be drilled and completed, and the water pumping and storage infrastructure constructed. The full bore field will be completed in time for commissioning of the process plant.

The SIDE is the envelope within which a borefield and water supply pipeline will be contained (Figure 2-5). The SIDE will extend south from Proposal's processing plant location and to the eastern extent of the proposed borefield area. A disturbance footprint of 300 ha will be required within the 11,799 ha SIDE.

The borefield is proposed to consist of a total of 28 bores (26 duty and 2 standby) drilled in one row, at 1 km spacing (Figure 2-5). The preliminary bore design has a maximum bore depth of 102 m and a drilled hole diameter of 12" for installation of 8" steel casing. Each bore will be equipped with an electric submersible pump capable of delivering up to 5 L/s.

All bore pumps will deliver to a collector tank via a common collection header pipeline. Two electric centrifugal pumps (1 duty, 1 standby) will be installed at the collector tank to pump the bore water to the raw water storage pond. The transfer pump power will be provided from a diesel generator, with a single 4,000 Litre (L) fuel tank installed beside the transfer pump station to supply fuel.

A 43 km long transfer pipeline will be constructed between the transfer pump station and the plant raw water pond. The pipeline will be buried to a shallow depth, to provide protection from bushfires. Pipe crossing points will be provided at several locations for vehicle access to both sides of the pipeline. Air release valves will be installed at high points in the pipeline. The raw water pond be located at the processing plant site and is designed to have a storage capacity of two days' supply.

2.10.5 Water Treatment

A reverse osmosis (RO) water treatment plant will be installed at the processing plant site to provide demineralised water for the boiler and potable water for the facilities and camp. The potable water produced by the RO plant will be collected in a storage tank at the processing plant and will then be reticulated to the processing plant in the Off-LDE (Figure 2-4). Potable water will be delivered to the accommodation camp using two transfer pumps, one duty and one standby. An additional potable water storage tank will be located at the accommodation camp.

2.10.5.1 Other Raw Water Uses

Raw water will be used for dust suppression on access roads and around earthworks activities from time-to-time. A water truck will be available throughout the LoM for these tasks. The water truck will be filled via a standpipe located adjacent to the raw water pond.

2.10.6 Workforce Accommodation

The accommodation village will be located in close proximity to the airstrip to allow for a sheltered pedestrian walkway direct to accommodation for check-in in the Off-LDE (Figure 2-4). Within the village, accommodation units will be arranged in blocks of three (28 modules) and four (four modules), 100 rooms total.

Initially, the accommodation village will be powered from temporary standalone diesel-fired generators. The accommodation village will be connected to the permanent power supply when it becomes available during the early stages of the processing plant commissioning. A single generator will remain as back-up power supply. The permanent camp will be initially set up with a RO facility which will enable potable water for camp residents until the main processing plant RO is completed and operational in the Off-LDE (Figure 2-4).

2.10.7 Waste Management

2.10.7.1 Sewage

A containerised wastewater treatment plant (WWTP) will be used to treat the black, grey and wastewater from the accommodation village, processing plant area and power station in the Off-LDE (Figure 2-4). These units are activated sludge sewage treatment plants suitable for remote areas and can be monitored remotely and serviced periodically.

Grey water and effluent from all water fixtures will drain to gravity sewerage systems at the accommodation village, power station and plant site. The WWTP will dispose of the treated effluent via a sprinkler system discharging to a designated area some distance from the camp. The irrigation pumping head will be sized to suit the pressure and distance required for effective, safe irrigation.

2.10.7.2 Solid Waste

Solid and putrescible waste will be disposed of in a locally established landfill site operated under full environmental licensing requirements. Wastes not suitable for general landfill will be reused and / or recycled. A local contractor will be engaged to remove the segregated waste to the Alice Springs Regional Waste Management Facility.

2.10.7.3 Hydrocarbon Waste

Oil and grease captured in the mobile fleet washdown facility will be managed using oil and water separators at the processing plant workshop. Waste lubricating oils will be stored and transported back to the supplier for recycling.

Any other hydrocarbon and chemical wastes will be transported off site to the Alice Springs Regional Waste Management Facility via backloading of supply trucks.

Agrimin proposed to install a bioremediation facility for any hydrocarbon contaminated materials created from construction or operational activities. The bioremediation facility will be located near the proposed landfill site and will be constructed and operated under full environmental licensing requirements.

2.10.8 Transport

The Proposal's SOP will be loaded onto customised triple road trains with a capacity of 122 t via the load-out facility at the processing plant. The SOP will then be transported offsite 941 km north to a storage shed located at Wyndham Port (Figure 2-1). A total of 12 trucks per day full; and 12 return trucks empty per day will depart site daily and will drive during daytime hours only. It will take approximately 13 hours to reach Wyndham Port.

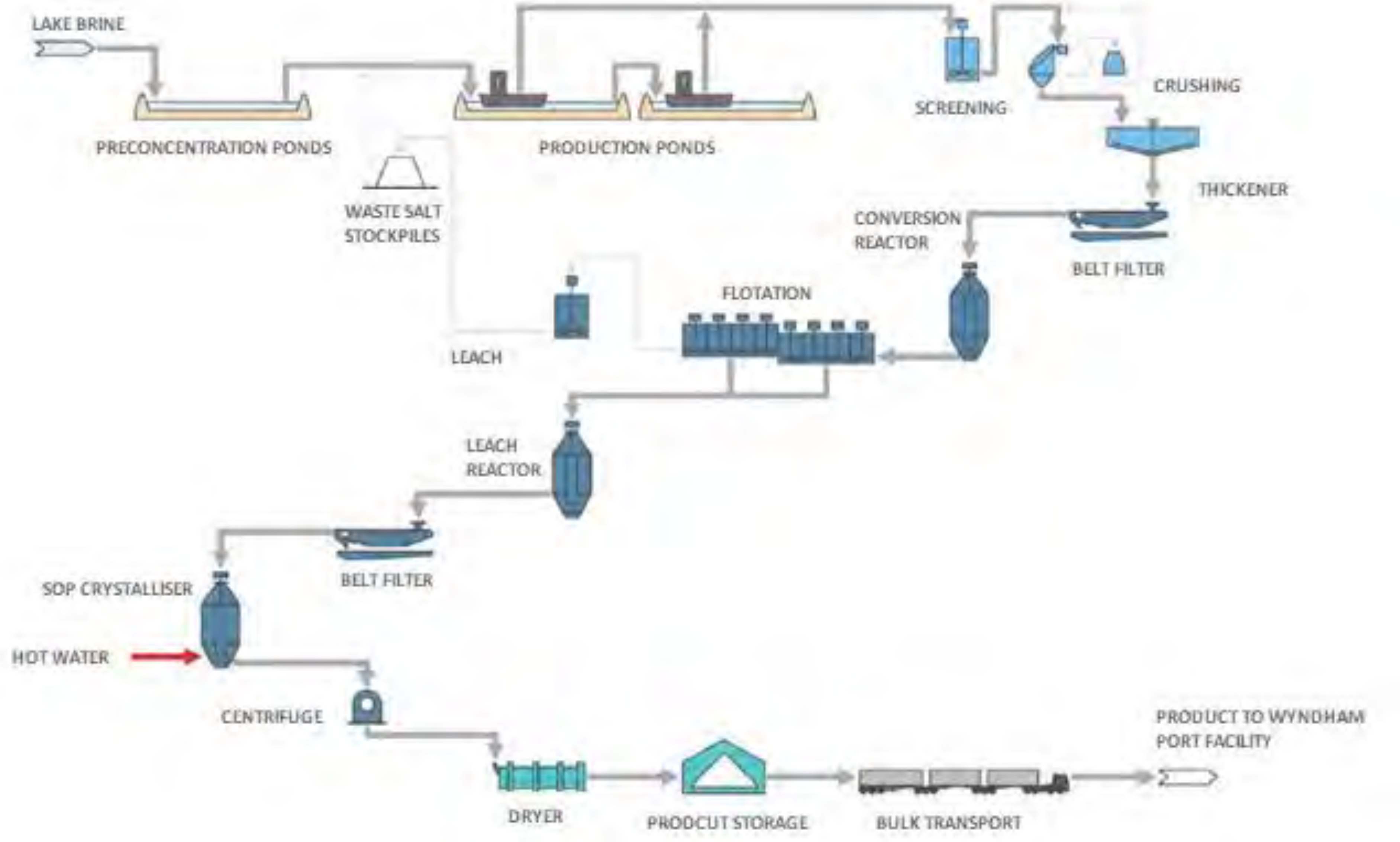


Figure 2-8: Simplified process flow diagram for the processing plant

2.10.8.1 Airstrip

The Proposal will include the construction of a 1,650 m long and 30 m wide sealed all-weather airstrip located in proximity to the accommodation camp and processing plant in the Off-LDE (Figure 2-4). There will be no terminal building as check-in facilities will be at the accommodation village.

The Proposal will be serviced by direct day time flights from Perth or other selected supply and labour centres. The airstrip will be equipped with suitable facilities and equipment to accommodate the operation and refuelling requirements of the aircraft.

A helipad will be incorporated into the design of the air strip to accommodate helicopter operations that will support construction and operation activities for the Proposal's LoM. The airstrip will include a refuelling facility with a 55,000 L tank.

2.10.8.2 Communication System Infrastructure

The Proposal's communication system infrastructure is currently being designed (likely to be located within the NIDE) and will be implemented with the appropriate approvals. Once connected with the network it will provide capacity to the internet and to the corporate office for voice and data. In the event of microwave or fibre network failure, a backup auto failover satellite service to site will be in place.

2.10.8.3 Ancillary Facilities

The following facilities and buildings are required to support the overall operation in the Off-LDE (Figure 2-4):

- control building, within the processing plant (Off-LDE). Building is to be prefabricated and preassembled off-site;
- heavy and light vehicle workshop;
- vehicle washdown bay and oil/water separator at the mobile plant workshop;
- warehouse;
- general yard;
- first aid facility;
- product storage shed;
- chiller building/shed;
- boiler shed; and
- compressor shed (13 m x 7 m).

2.11 Timing

The mine plan has been based solely on shallow trench extraction of brine from the near-surface zones. Brine extraction from deeper zones of the Mineral Resource represents a future opportunity for the Proposal.

The ore reserve and mine plan for the Proposal has been determined based on the outputs of detailed numerical groundwater modelling simulations for brine extraction via surface trenches with a modelled drawdown depth of up to 3.0 m below ground surface.

The mine plan has an average brine extraction volume of 82 GL/a with an average potassium grade of 2,976 milligrams per litre (mg/L). Throughout the LoM, 20 years for this referral with further modelling for up to 40 years, extraction and recharge processes are expected to gradually dilute the potassium grade from approximately 3,280 to 2,784 mg/L. This grade dilution will be offset by increasing the annual brine extraction rate from 74 to 87 GL/a in order to maintain a constant feed rate of SOP into the evaporation ponds. The proposed mine plan is shown in Figure 2-9.

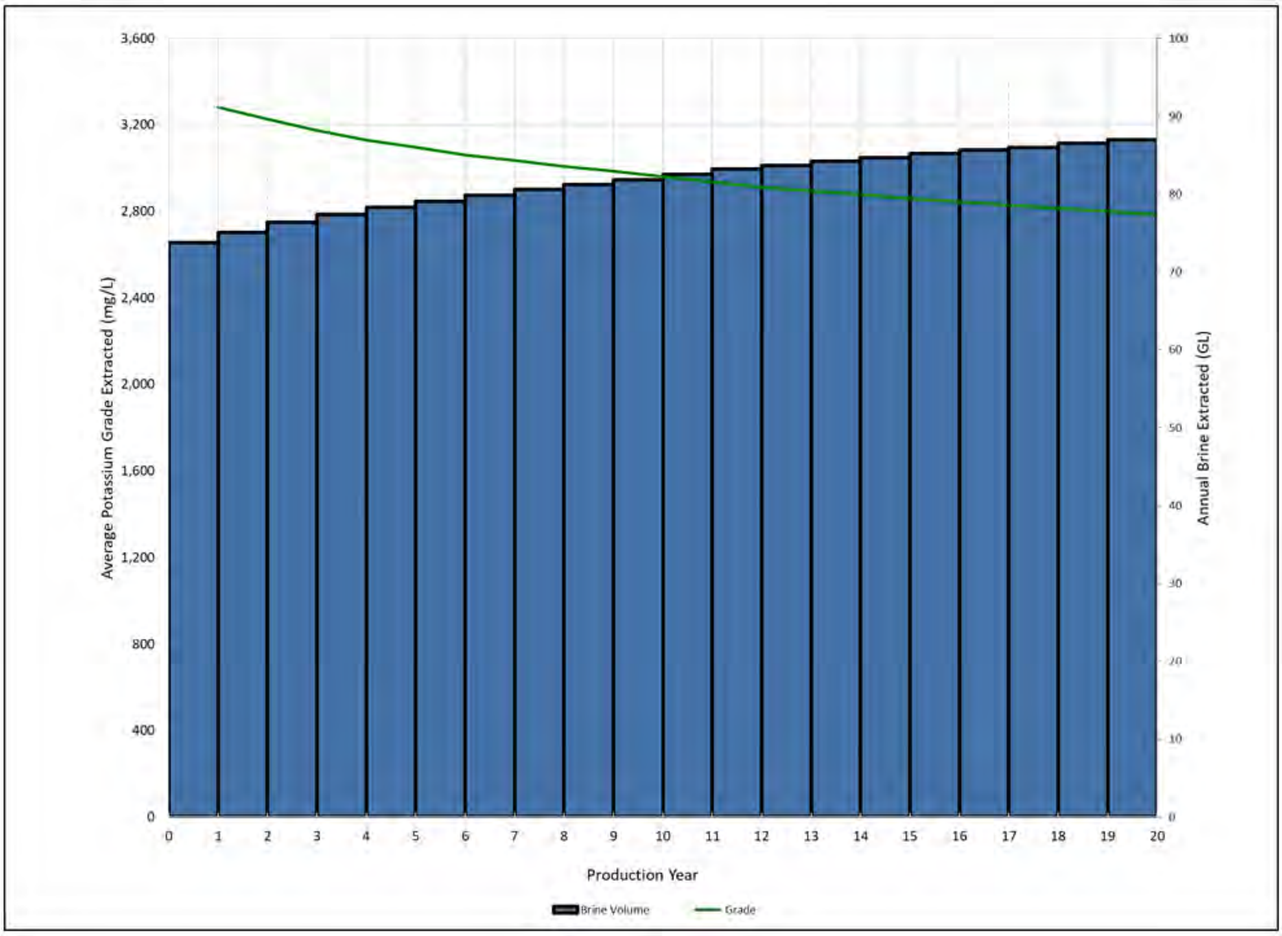


Figure 2-9: The Proposal's Mine Plan (brine extracted and grade)

A DFS for the Proposal was completed in July 2020 and will form the basis for finalising financing for the construction of the Proposal and to inform a Final Investment Decision (FID). After FID, funding approval and regulatory approvals processes, the Proposal's construction and commissioning is estimated to take 36 months. A production ramp-up to 70% of full production is expected in the first 12 months of operations before progressing to the full production target of 450,000 tonnes per annum of SOP.

The indicative timeline for delivery through to first SOP production is provided in Figure 2-10. The following key activities will be completed prior to the commencement of construction:

- off-take agreements;
- Proposal funding and strategic partnership process;
- execution planning and contracting;
- environmental approvals;
- mining tenements and secondary approvals; and
- front-end engineering and design, and early works to facilitate Proposal-critical path activities.

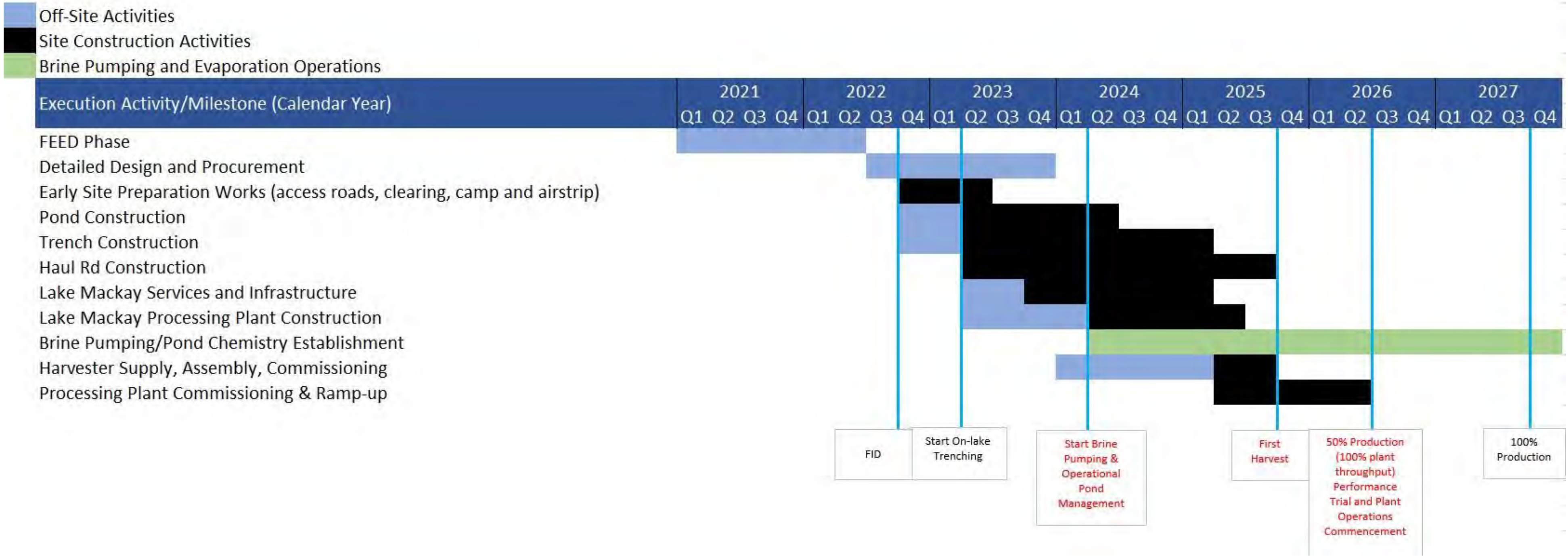


Figure 2-10: Proposed start up timeline for the Proposal

3. Local and Regional Context

3.1 Locality Context

An overview of the local and regional context of the Proposal is provided in (Figure 3-1). The Proposal is situated on Lake Mackay in WA approximately 450 km south of Halls Creek, adjoining the Northern Territory border. It is located within the Kimberley Mineral Field 80, and the Shire of East Pilbara Local Government Area. Current road access to Proposal area is via the Gary Junction Road which is south of Lake Mackay. The Proposal includes a new haul road north of Lake Mackay to provide a haulage corridor to Wyndham Port (Figure 3-1, Figure 3-2). Lake Mackay hosts the largest SOP deposit in Australia and covers an area of approximately 3,513 km^2.

3.2 Heritage Context

The Proposal area lies within three of Native Title Determination Areas, Kiwirrkurra, Ngururrpa and Tjurabalan as well as three Aboriginal Land Titles (Kearney Reserve 26399, Ngaanyatjarra Central Australia Reserve 24923 and Balgo Reserve 46573) as shown in Figure 1-3 and discussed in detail in Section 10.

The Proposal area further lies within three Aboriginal Land Titles under the Aboriginal Land Rights Act 1976 (NT Act), including the Kearney Reserve (26399), Ngaanyatjarra Central Australia Reserve (24923) and the Balgo Reserve (46573) which are shown in Figure 14) and include a culturally and socially distinct mix of Aboriginal Groups.

There are a number of Aboriginal communities located within the vicinity of the Proposal area. The Kiwirrkurra community, with a population of approximately 200 people is the closest community to Lake Mackay and the Proposal's operations, located 120 km south-west by road. Balgo is located 2.6 km west of NIDE with a population of approximately 350 people. A population of 150 people reside in the Billiluna community which is located 45 km north west of the NIDE and the Mulan community is located 43 km west of NIDE (41 km west of Balgo) with a population of 110 people.

There are also a number of ex-Aboriginal outstations running along the NIDE, including Yagga Yagga, Bibarrd and Lamanbanghah. These outstations no longer house permanent communities however, some basic infrastructure and cleared areas remain in these locations.

In 2017, Agrimin became the first company to sign a Native Title Agreement (WAD6019/1998) with the Tjamu Tjamu (Aboriginal Corporation) RNTBC for the Kiwirrkurra Native Title holders and has committed to develop a relationship that is mutually beneficial for both parties. By constructing and operating the Proposal, Agrimin seeks to encourage jobs, economic benefits, and opportunities for local Indigenous people.

3.3 Environmental Assets and Sensitive Areas

No Conservation Reserves (including National Parks, Conservation Parks and Nature Reserves) occur within the Proposal area, or in close proximity. The Wolfe Creek Meteorite Crater National Park (also an Environmentally Sensitive Areas (ESA)), situated approximately 72 km north of the northern-most extent of the NIDE, and within the Ord Victoria Plain bioregion, is the nearest conservation reserve to the Proposal area. There are no Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) within or in close proximity to the Proposal area. The nearest mapped PEC from the Proposal area is the Wolfe Land System (P3) PEC, located 55.5 km from the NIDE.

The Proposal does not intersect any ESAs; the closest ESA is the Lake Gregory system. The Lake Gregory system (WA096) is described as a nationally important wetland, and plays an important role in supporting waterbird populations as a major drought and non-breeding refuge (Environment Australia 2001). Lake Gregory is a major stopover for migratory shorebirds (Daniel et al. 2009), and is located 51 km west of the northern end of the Proposal area.

The Gibson Desert Nature Reserve is the located approximately 450 km south west of the Proposal area and the nearest conservation reserve is the Karlamilyi National Park located approximately 600 km west of the Proposal.

Lake Mackay and surrounding peripheral wetlands within a 200 km buffer are not declared as wetlands of international importance under the Convention on Wetlands of International Importance, also known as the Ramsar Convention ("Ramsar wetland"), or as wetlands of national importance under the Directory of Important Wetlands in Australia (DIWA) ("wetland of national importance").

The closest Ramsar wetland is the Lake Argyle and Kununurra wetland site (approximately 350 km from the Study Area and 600 km from Lake Mackay), and the closest nationally important wetland is Lake Gregory (DotEE 2020). For regional context, a brief description of both of these important wetlands are provided below. Lakes Argyle and Kununurra are large freshwater lakes that cover approximately 117,000 ha and were formed by the construction of dams on the Ord River for the supply of irrigation water to the Ord River Irrigation Area (Hale and Morgan 2010).

The Lake Gregory system is a nationally important wetland that is recognised as one of the best examples of a large brackish system, with inland (terminal) drainage lakes in Australia which has regular inflow and is near-permanent (DEC 2009). Lake Gregory comprises several interconnected waterbodies totalling 38,700 ha, fed primarily from the southeast Kimberley by Sturt Creek (DEC 2009) which originates 170 km north-east (DAWE 2020n). The lake is of particular importance for waterbirds of which 80 species have been recorded including 20 species under international agreements and 21 species that have been recorded breeding at the lake. Lake Gregory is also considered the most important inland wetland in Australia in terms of waterbird numbers (up to an estimated 650,000 recorded in 1988)(DEC 2009). Lake Gregory has been nominated as a Ramsar wetland (DEC 2009); however, is not currently listed as a Ramsar wetland.

3.4 Mining and Industrial Developments

The closest industrial activity to the Proposal is Newmont's Tanami Gold Operations in the Northern Territory, located 300 km north-east of the Proposal area and Cummins Range Rare Earth Mine, located over 380 km to the north of the Proposal area. Three major potash projects surround the Proposal area; Lake Disappointment Potash Project, located 600 km west; Lake Wells Potash Project, located 756 km southwest; and Beyondie Sulphate of Potash Project, located 928 km west of the Proposal area (Figure 3-2).

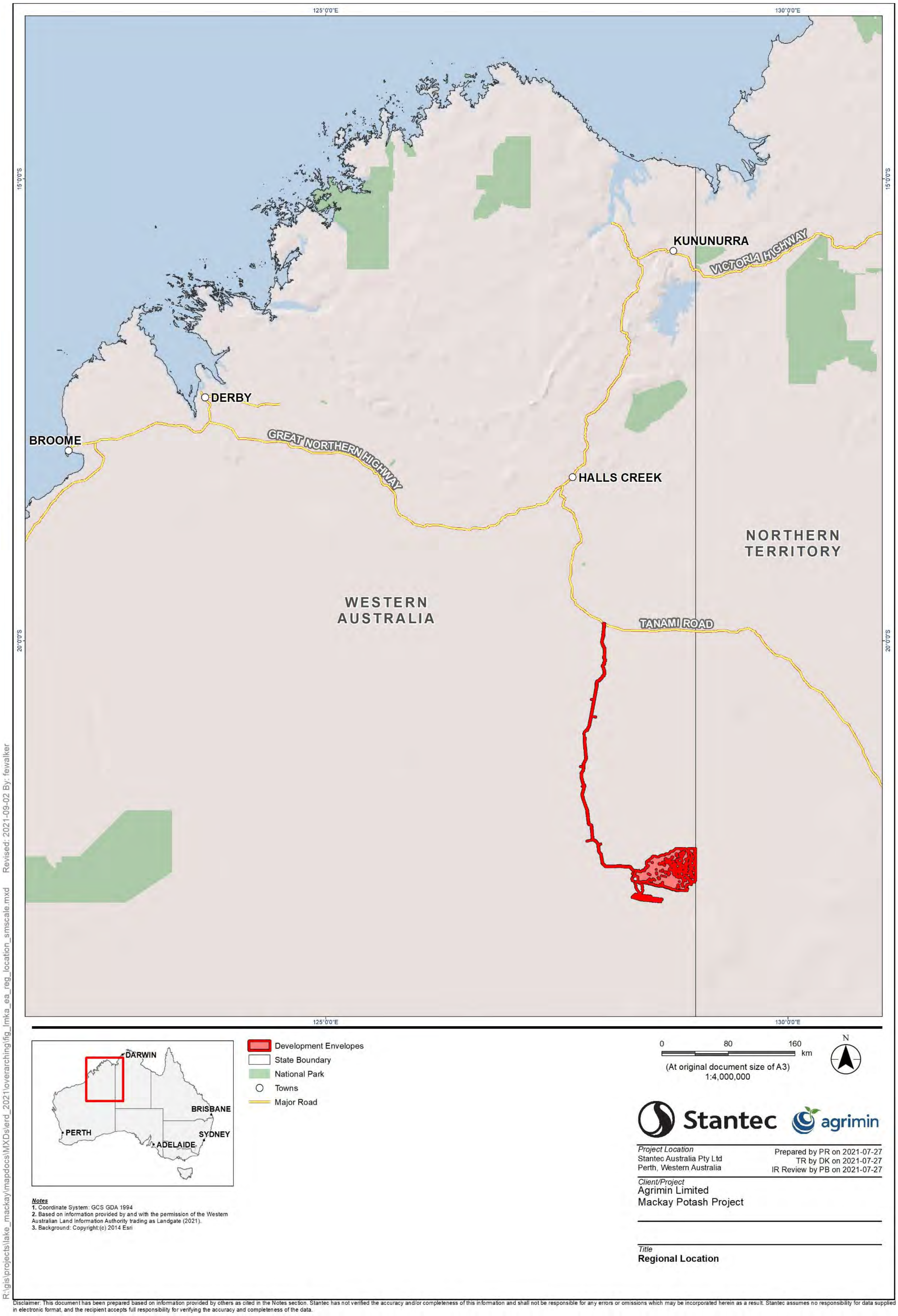


Figure 3-1: Regional location of the Proposal

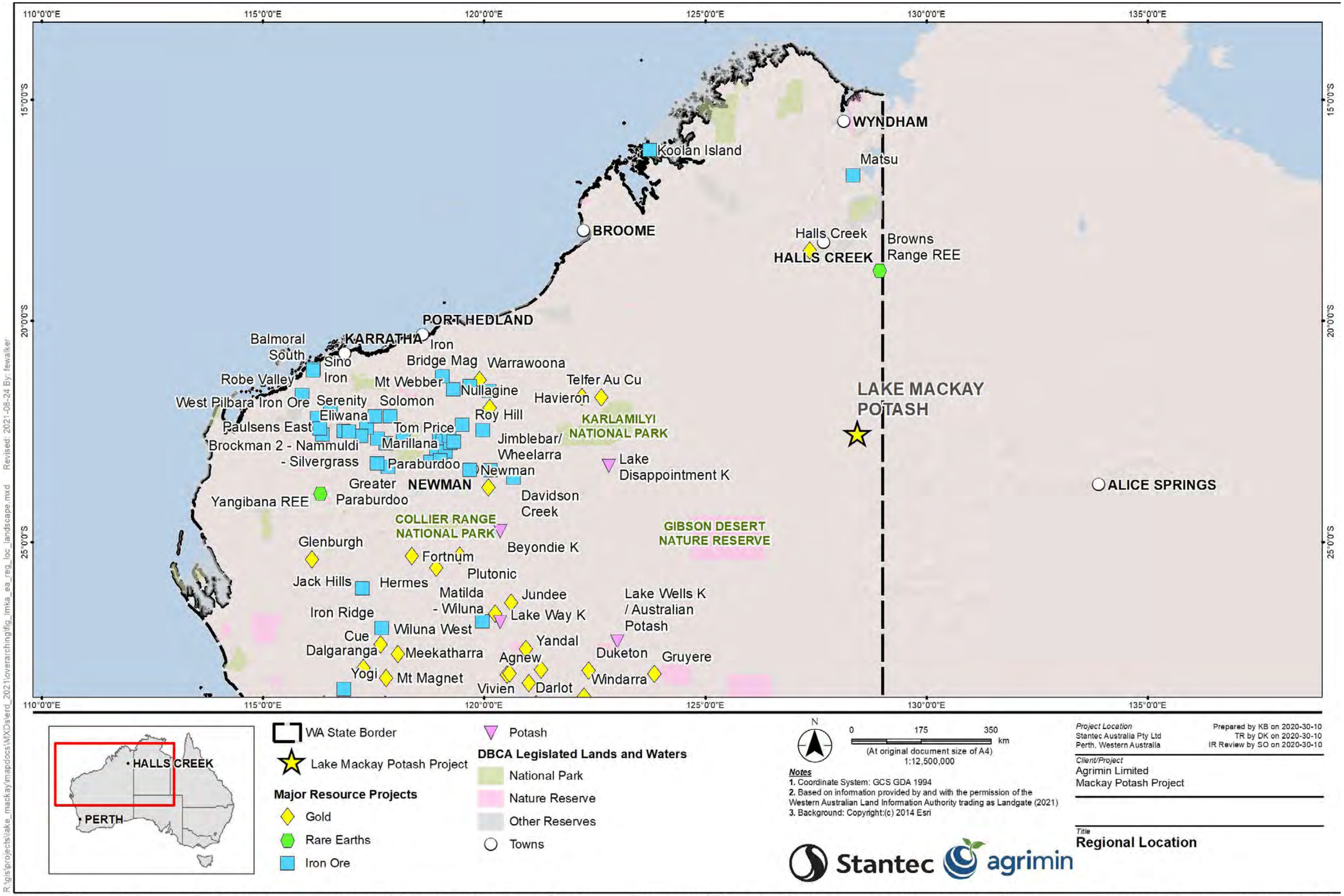


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Figure 3-2: Local and regional context of the Proposal

3.5 Physical characteristics

3.5.1 Climate

Walungurru Airport (Kintore) is the closest active weather station to the On-LDE, Off-LDE and SIDE. It is located approximately 80 km southeast of Lake Mackay's southeast extremity and approximately 136 km from the Off-LDE on the western edge of the lake. Balgo is the closest source of historic climate records to the NIDE and is located to the north of the proposed haul road.

The southern portion of the Proposal area experiences an arid tropical climate, characterised by cool mild winters and very hot summers. Daily temperatures in the summer months from November to February exceed 37°C and temperatures above 42°C are common. The winter season occurs from June to August with mean daily maximum and minimum temperatures of about 23°C and 10.5°C respectively (Figure 3-5).

The northern portion of the Proposal area experiences a similar arid tropical climate to the southern portion. The average maximum daily temperatures in the summer months from November to February is 38.3°C. The winter season occurs from June to August with mean daily maximum of 27°C and an average minimum of 13°C.

The average rainfall for the region is 300 mm and typically occurs within the summer months with minimal rainfall occurring during the cooler months (Figure 3-3) (Beard 1990; Kendrick 2001). Long-term average rainfall for Walungurru and Balgo weather stations are shown in Figure 3-5 and Figure 3-6. On average Balgo receives more rainfall over the summer months when compared with rainfall data recorded for the same period at Walungurru. The annual average evaporation rate for the region is between 2,800 – 3,200 mm/year (Figure 3-4).

Wind data recorded at Walungurru Airport during 2018 is presented in Figure 3-5. The 9am wind direction is predominantly from the east-northeast (ENE); the wind direction was between northeast and southeast for 77% of the 9am data points recorded during the year. The 3pm wind direction is highly variable, with northerly and easterly wind directions being recorded for 10% of the 3pm data points.

The closest Bureau of Meteorology (BoM) weather station with wind data to the Proposal is Giles Weather Station, located approximately 250 km away. Figure 3-7 shows that the wind prevails east to south around the general Proposal area.

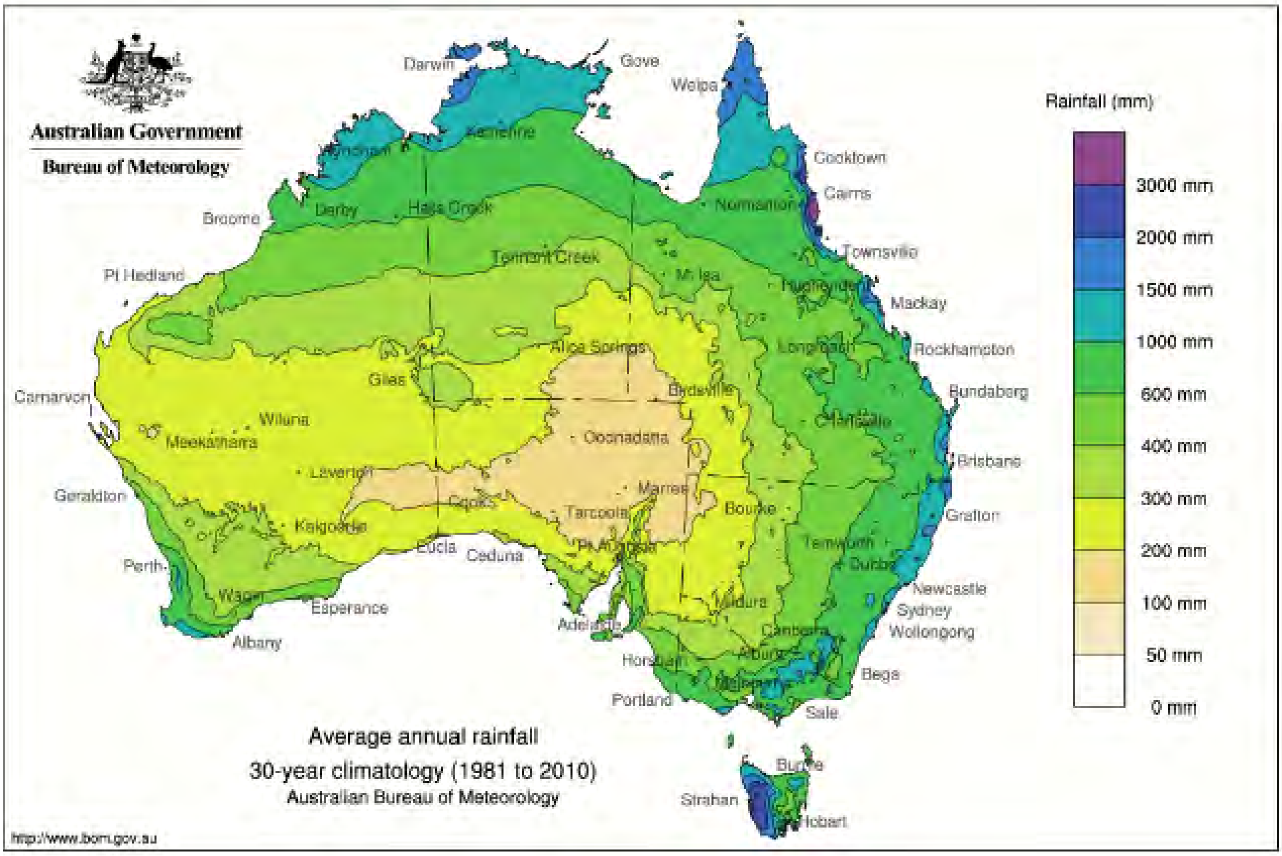

Figure 3-3: Average annual rainfall (BoM 2021b)

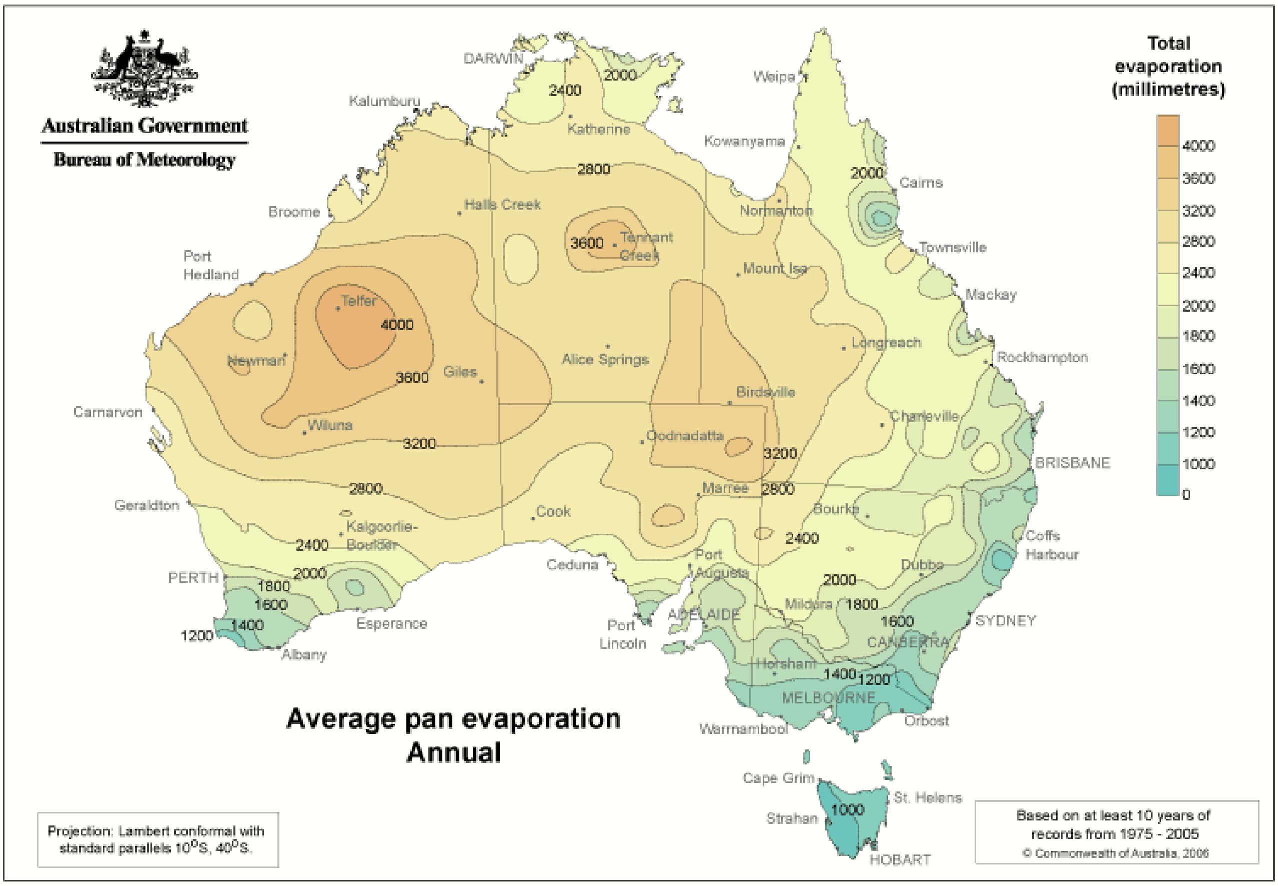

Figure 3-4: Average evaporation rates (BoM 2021a)

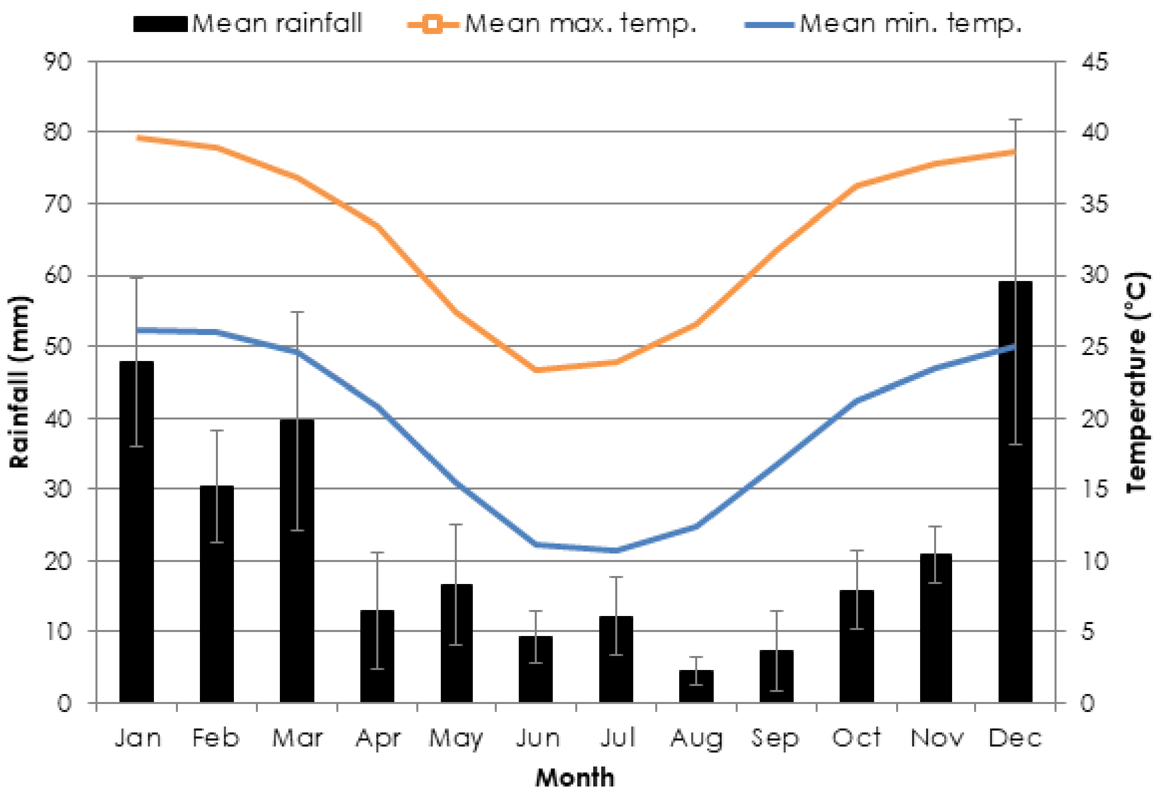

Figure 3-5: Long term mean rainfall (1998-2020) and mean temperature (2001-2020) recorded at Walungurra Airport weather station (No. 015664) (BoM 2021c)

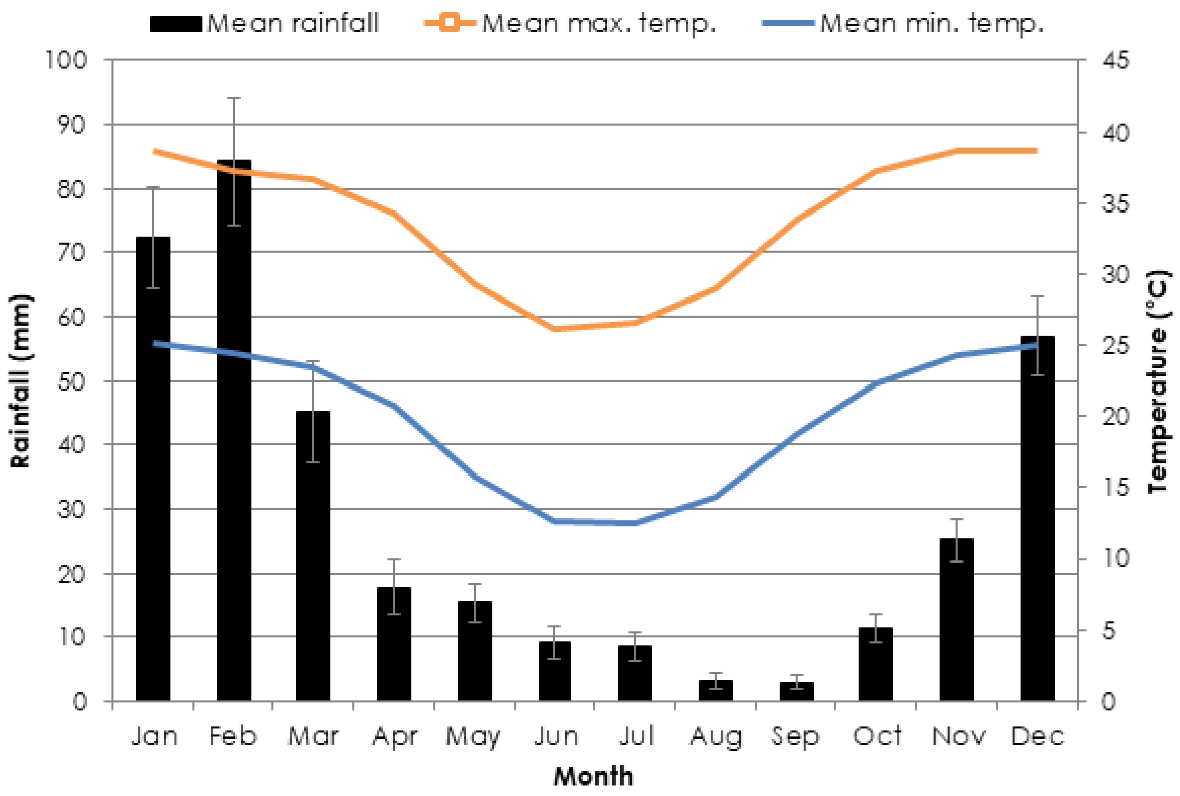

Figure 3-6: Long term mean rainfall (1940-2016) and mean temperatures (1950-2016) recorded at Balgo weather station (No. 013007) (BoM 2021c)

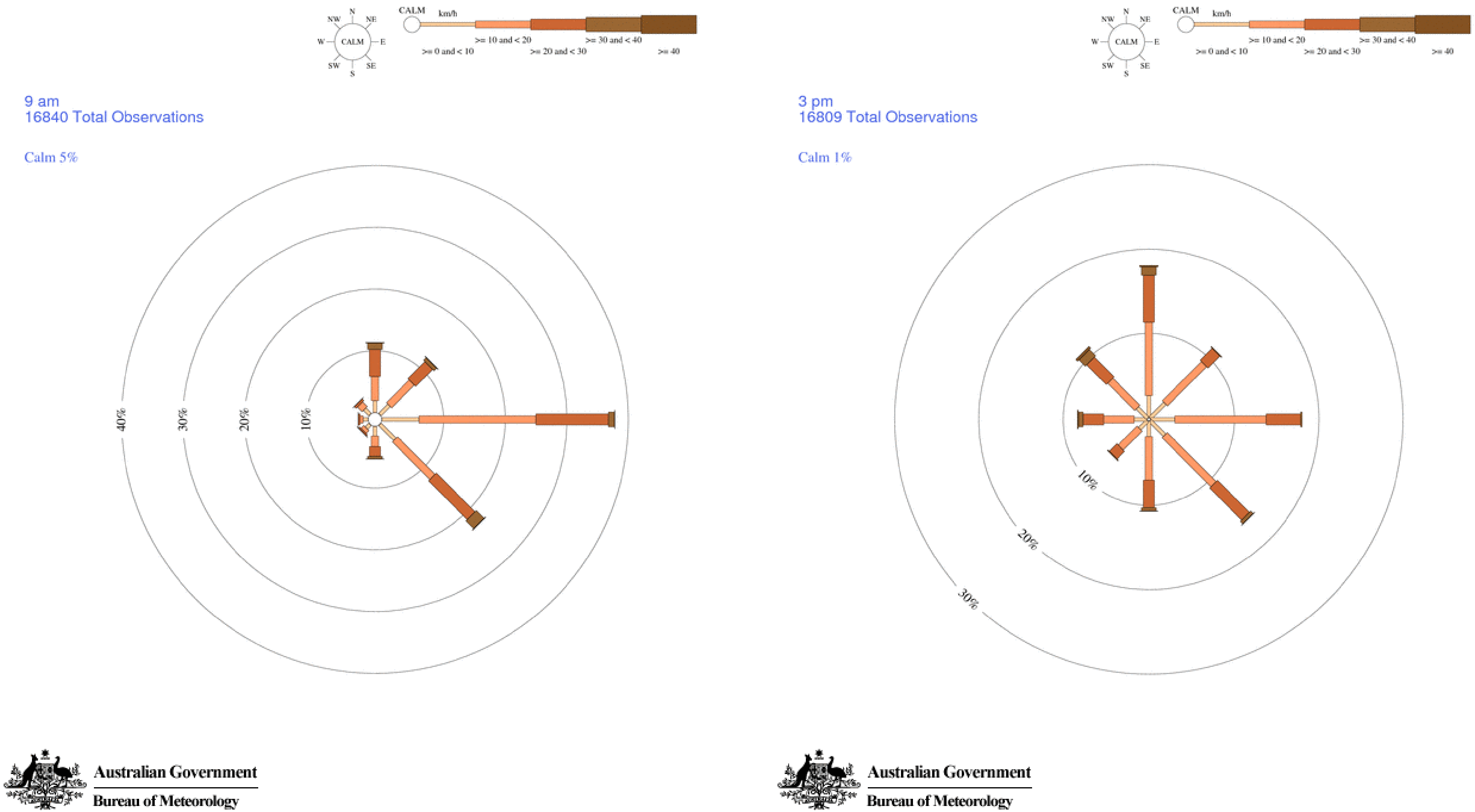

Figure 3-7: Wind rose from Giles weather station at 9am and 3pm (BoM 2021d)

3.5.2 Land Systems

Land systems in the rangelands and arid interior of WA have been mapped by the Department of Primary Industries and Regional Development (DPIRD) and provides a comprehensive description of biophysical resources within the area (Tille 2006). The Proposal area lies predominantly within the SV12 land system of low to steep hilly country with mesas and buttes with extensive valley plains (Table 3-1) (Figure 3-8). The impact of the proposal on the SV12 Land System will be the 15,000 ha, which equates to approximately 6.8%. Given the low percentage of other land systems within the proposal area, with all but one being less than 4%, the impacts on these systems will be negligible.

Table 3-1: Land Systems and their extent within the Proposal area

Land System	Description	Extent within Proposal area	
		ha	Proportion (%)
SV12	Plains studded with salt pans, seasonal lakes; calcrete (kunkar) platforms; and fringing dunes	219,928.17	83.41
AB56	Plains extensively covered with longitudinal dunes; some hilly residuals with rock outcrops	10371.12	3.93
My98	Low to steep hilly country with mesas and buttes sometimes capped with pisolitic ironstone and laterite on ferruginized and silicified sandstone and greywacke with extensive valley plains	9,728.42	3.69
AB54	Gently undulating plains with linear dunes in some areas; there are also variable areas of calcrete (kunkar); pans, depressions, and lakes; and some isolated hilly residuals	6,266.79	2.38
AB39	Gently undulating plain dominated by longitudinal dunes of varying frequency; some exposures of ironstone gravels on low rises occur in the dune swales	5,664.45	2.15
AB53	Dunefields – gently undulating plains with linear dunes. There are areas of calcrete (kunkar) of variable extent, pans, lakes, depressions, and springs; and some isolated hilly residuals	5,122.53	1.94
AB29	Gently undulating plains	3,417.03	1.30
AB55	Broad, very gently undulating upland (tableland) elevated above adjacent dunefields; some low laterite-capped residuals showing exposures of sedimentary rocks; some dunes, some salt lakes, and pans	2,228.10	0.85
Winnecke System	Low linear or rounded hills and associated valley floors and marginal sandplains, supporting soft spinifex hummock grasslands or sparse low snappy gum woodlands with spinifex.	660.88	0.25
BA5	Stony hills and ranges largely derived from sandstone and having flanking sand plains	150	0.06

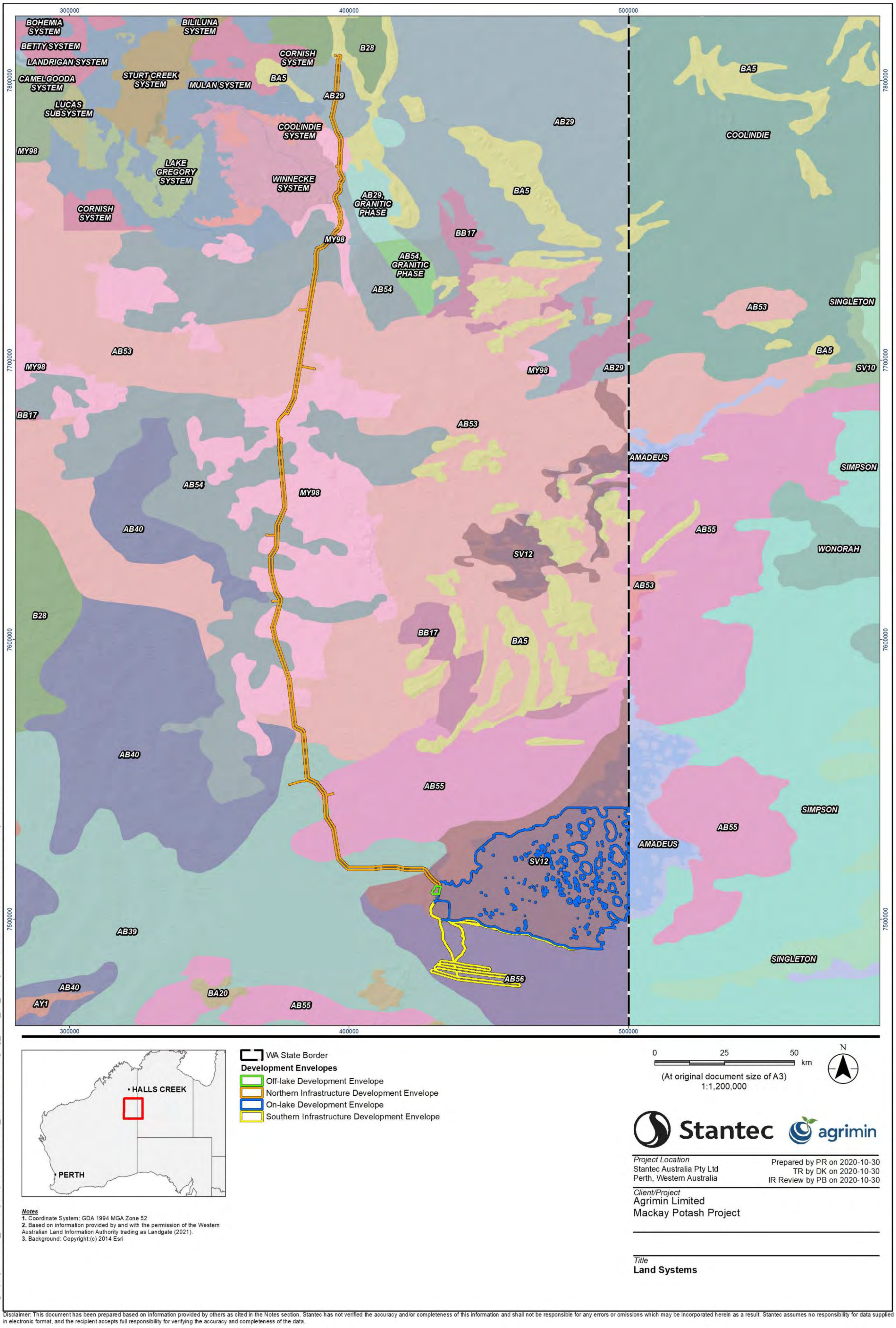

Figure 3-8: Land systems associated with the Proposal

3.5.3 Geology

The region surrounding the Proposal area is characterised by longitudinal sand dunefields, primarily running east to west, with swales opening into sandplains, as well as isolated residual breakaway sandstone hills (Tille 2006). Nine geological units have been mapped within the Proposal area (Figure 3-9). The 'Cenozoic regolith 76542' unit is the most widespread of the geological units. This unit broadly represents surficial or regolith units; poorly consolidated alluvial, colluvial, aeolian, lacustrine; and residual deposits. The red Quaternary sand dunes sit atop Jurassic and Cretaceous sandstones of the Canning and Amadeus Basins, with gently undulating laterised uplands and hills present (Kendrick 2001; Tille 2006). In addition to Lake Mackay, small claypans and depressions are present in the GSD2 (Tille 2006). The TAN1 consists of red Quaternary sandplains atop Permian and Proterozoic strata that can be exposed as hills and ranges (Graham 2001). Aspects of the TAN1 contain ironstone gravels and some breakaways that are capped by laterite duricrust (Tille 2006). The 'Cenozoic regolith 76542' unit is the most widespread of the geological units within the Proposal area. This unit broadly represents surficial or regolith units; poorly consolidated alluvial, colluvial, aeolian, lacustrine and coastal deposits; and residual deposits.

The northern portion of the Proposal area traverses Palaeozoic and Mesozoic rocks of the Canning Basin in the west and Precambrian rocks of the Granites-Tanami and Arunta regions in the east and southeast respectively (Blake and Yeates 1976). Permian sedimentary rocks of the Grant Formation, Poole Sandstone, Noonkanbah Formation and Lightjack formation outcrop extensively in the west of the area and are well exposed along the Stansmore Range. Much of the remainder of the area is covered by Cainozoic deposits which largely conceal the per-Tertiary lithologies (Blake and Yeates 1976).

Table 3-2: Geological units of the Proposal area.

Geological code	Name	Geological Description	Extent within Proposal area	
			ha	%
Czu	Cenozoic regolith 76542	Surficial or regolith units; poorly consolidated alluvial, colluvial, aeolian, lacustrine and coastal deposits; residual deposits (e.g., laterite).	237,701.09	90.15
Ps	Permian sedimentary rocks 76693	Predominantly sedimentary rocks; includes sedimentary rocks of low metamorphic grade and diapiric breccias	10,230.07	3.88
Ps	Permian sedimentary rocks 76691	Predominantly sedimentary rocks; includes sedimentary rocks of low metamorphic grade and diapiric breccias	5,460.56	2.07
Ls	Paleoproterozoic sedimentary rocks 76605	Predominantly sedimentary rocks; includes sedimentary rocks of low metamorphic grade and diapiric breccias	3,989.00	1.51
Ly	Paleoproterozoic amphibolite-facies metamorphics 76621	Medium-grade metamorphic rocks, generally with amphibolite-facies assemblages; may have a greenschist overprint	2,076.73	0.79
Ns	Neoproterozoic sedimentary rocks 76676	Predominantly sedimentary rocks; includes sedimentary rocks of low metamorphic grade and diapiric breccias	1,735.88	0.66
Os	Ordovician sedimentary rocks 76683	Predominantly sedimentary rocks; includes sedimentary rocks of low metamorphic grade and diapiric breccias	1,432.95	0.54
Rs	Triassic sedimentary rocks 76703	Predominantly sedimentary rocks; includes sedimentary rocks of low metamorphic grade and diapiric breccias	669.49	0.25
Ls	Paleoproterozoic sedimentary rocks 76610	Predominantly sedimentary rocks; includes sedimentary rocks of low metamorphic grade and diapiric breccias	378.87	0.14

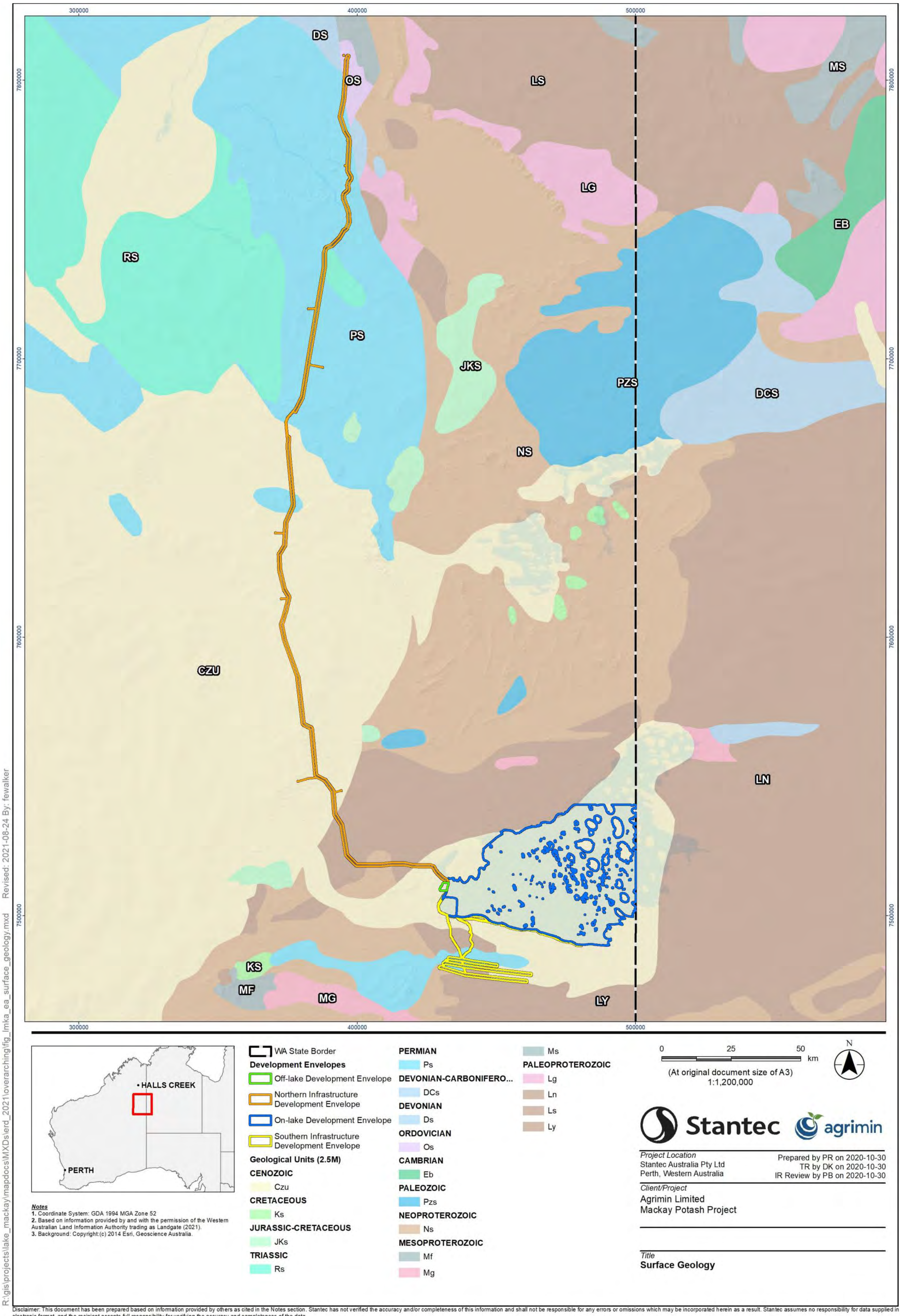

Figure 3-9: Surface geology of the Proposal area

3.5.4 Soils

The Proposal area encompasses two soil-landscape regions (Tille 2006). The Off-LDE, On-LDE and SIDE are in the southern extent of the Lander-Barkley Region and intersect the Wiso Sandplain and Redvers Dunefield Zones. The NIDE passes through the Lander-Barkley and Sandy Desert Regions, intersecting the Wiso Sandplain, Stansmore and Tanami soil-landscape zones of the Stuart Plateau Province and the Stansmore Dunefield and Ranges Zone of the Canning Province.

A desktop review of the Australian National Acid Sulfate Soil Risk Map (ASRIS 2020) indicates that the majority of the Proposal area has a high probability/very low confidence of acid sulphate soils (ASS) being present in some parts, and extremely low probability/very low confidence of ASS being present in other parts. However, Lake Mackay, and some sediment within peripheral claypans and drainage lines, have a high probability/low confidence of ASS being present.

3.5.5 Geomorphology

The primary drivers behind the geomorphological evolution of Australia's arid zone in which Lake Mackay is situated are long term geological processes and climate change. Much of the Australian continent has experienced limited tectonic activity in recent geologic history allowing for slow geomorphological process to fully develop (Wakelin-King 2011). Weathering, erosion and deposition of sediment are the primary geomorphological processes active in the arid zone of Australian and have resulted in the relatively low topographic relief landscape that is present today. Lake Mackay and the surrounding area contain a diverse range of different landform types.

Climatic setting and hydrologic processes are important factors that contribute to the geomorphology and evaporite mineralogy of salt lake systems. Geomorphological features identified in the On-LDE include strandlines from former high-lake stands, islands of gypsiferous aeolian landforms, playa-fringing dunes and encroaching linear sand dunes. Arid climatic conditions and high evaporation rates have resulted in the concentration mineral salts in the sediment of Lake Mackay.

3.5.6 Topography and Catchment

Lake Mackay is the fourth largest salt lake in Australia and the largest in WA, covering an area of approximately 3,513 km^2, extending more than 100 km east-west and 80 km north-south. The topography of Lake Mackay and surrounds is subdued and flat. Lake bed elevations range from approximately 360 metres Australian Height Datum (mAHD) in the east to 364 mAHD in the west. This corresponds to the deepest parts of the basin that are located in the south-eastern extremities during inundation, while the western half of the lake is comparatively shallow. The eastern portion of the lake is also characterised by more than 270 islands varying in size from less than 100 ha to >2,000 ha. The largest of these, classified as landform islands, are more than 10 m in height above the lake surface and support a diverse range of geology and biodiversity (Stantec 2021b).

A comprehensive surface water assessment (Stantec 2020a) determined that the total catchment area of Lake Mackay is approximately 87,000 km^2, of which only 20% is considered effective. The catchment stretches more than 550 km east of the lake into the MacDonnell Ranges and comprises three sub-catchments (Figure 3-11). The east to west drainage line is uncoordinated along its length, comprising hundreds of small playas that superficially resemble a river flow path, although a dune system significantly impedes surface water movement. Flow paths meander longitudinally along the dunes, with surface water movement only likely to occur at topographic lows.

3.5.7 Hydrology

Lake Mackay lies within the internally draining Mackay Basin. The lake is a closed system with no outflow or historic evidence of spilling into adjacent lakes. There are small ephemeral creeks and watercourses along the margins of the lake that drain the surrounding landscape and potentially contribute surface water runoff to the lake during periods of extreme rainfall (Figure 3-10). These features are localised and tend to be more common in the southeast portion of the lake. There are no major channels that appear to reach the lake (Agrimin Ltd 2018).

The lake is predominantly dry and is rarely subject to inundation. Rainfall events of approximately 30 mm typically occur several times throughout the year (Stantec 2020), resulting in the formation of isolated, pooled surface water usually within the southern half of the lake. However, these shallow bodies of water (<0.1 m) are strongly influenced by prevailing winds, infiltration, and evaporation, rarely persisting on the lake for longer than a few days (Agrimin, pers. comm. 2020).

More widespread inundation occurs in response to large rainfall events, which are unreliable. While extended dry conditions can prevail, storms and cyclones that move inland from the northern coastline of WA have the potential to generate intensive rainfall, particularly during the wet season. Given the size of the catchment and surface area of the lake, peak inflows generally result from longer duration storms (thre e to four days of storm activity). During peak flows there are some areas of concentrated flow between islands and/or, where inflow from external runoff enters the lake. While typically negligible, flow velocities of up to 0.5 m/s may occur under peak conditions.

Based on a long-term dataset of available satellite imagery (dating back to the early 1980's) as part of the surface water assessment (Stantec 2020a), the lake mostly fills (along the visible perimeter) on average, once every 10 years, following rainfall events that exceed 250 mm. Under this scenario the depth throughout most of the lake is initially predicted to range from 0.5 m to 1.0 m, reaching a maximum of approximately 2 m in the south eastern extremity (Figure 3-12). While subject to major flooding however, the persistence of surface water is variable and dependent on preceding conditions, although typically the lake may remain inundated for several months.

The longest inundation of Lake Mackay based on the available records occurred in 2001. This followed well-above average annual rainfall (at Balgo) during the preceding wet season of 2000 (768 mm), and again in 2001 (796 mm), causing flooding of the lake equivalent to a 1:40-year event. Water levels were initially predicted to reach over 2 m across most of the playa (up to 4 m in the south-east), spilling into the surrounding riparian vegetation zone (Figure 3-12). During this period, surface water persisted for more than 12 months between December 2000 and early March 2002 and appeared to peak in April 2001. Most recently in December 2016, more than 400 mm of rainfall was received at Walungurru Airport, causing a major flood, with surface water lasting on the lake for approximately six months until June 2017. However, in comparison to the 2001 event, prior to rainfall at the end of 2016, dry conditions were prevalent.

Lake Mackay is also surrounded by numerous smaller peripheral wetlands (claypans), irregularly spaced between the longitudinal dunes. These claypans are also typically inundated during the wet season, by direct rainfall and surface water runoff from the immediate catchment area, however, they can also hold water for short periods (less than one week) following 10 mm or more of rain (Agrimin, pers. comm. 2020). They are perched surface water features isolated from groundwater due to the low permeability of their substrate. Infiltration is negligible, demonstrated by the persistence of surface water several weeks following a rainfall event. The discharge of water from the claypans is by evaporation.

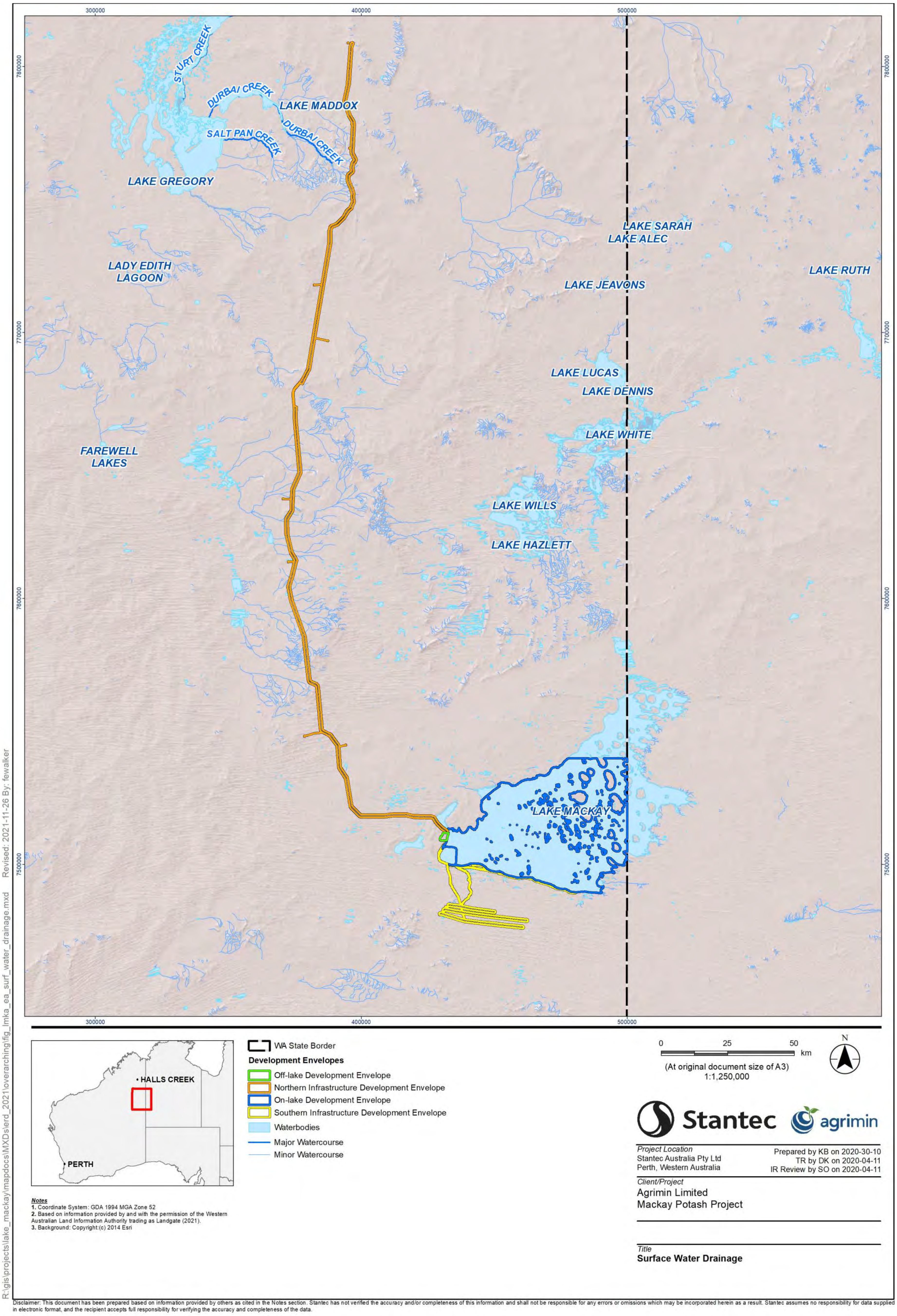

Figure 3-10: Watercourses within and surrounding the Proposal area

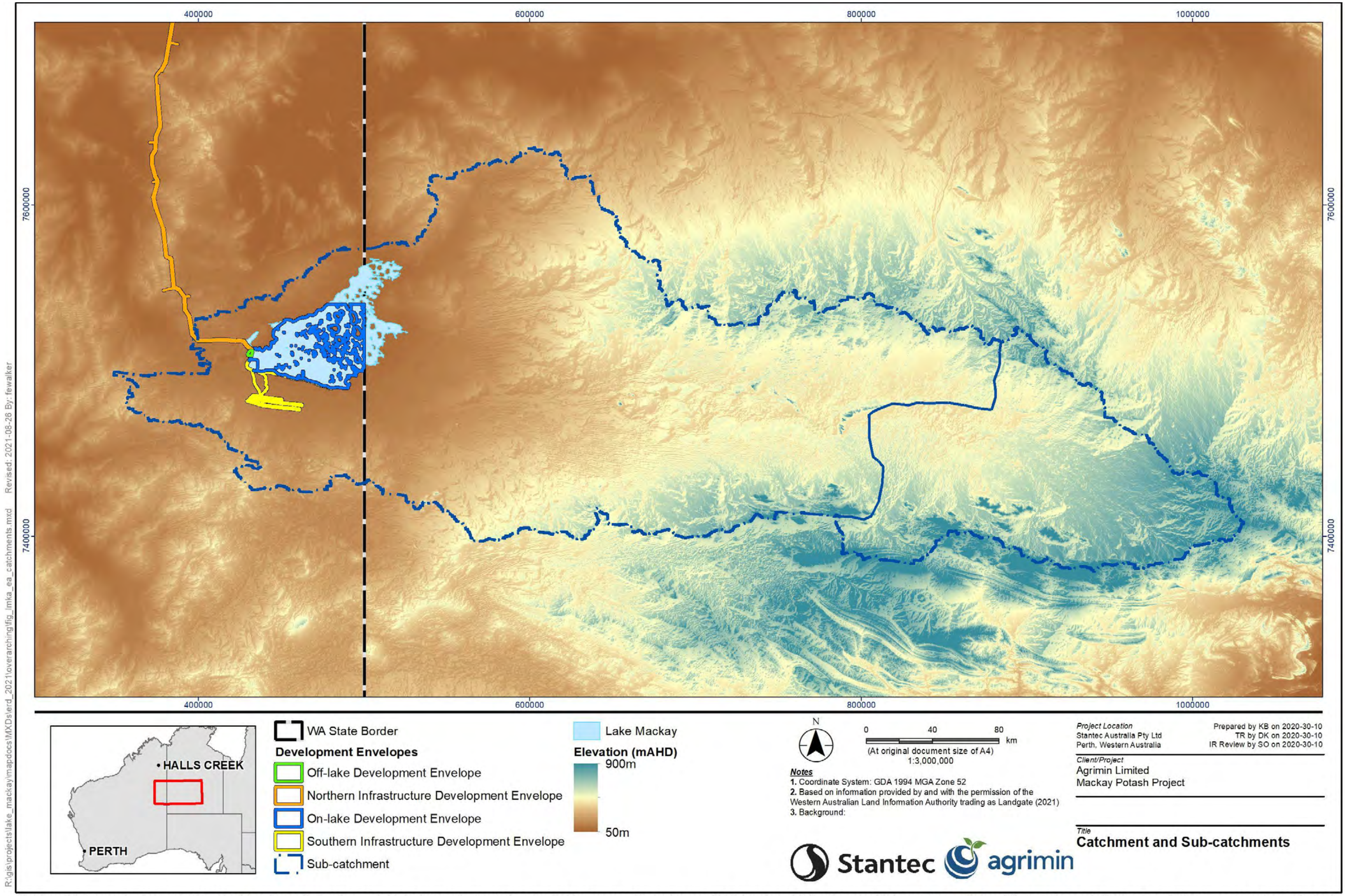

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Figure 3-11: Lake Mackay catchments and sub-catchments

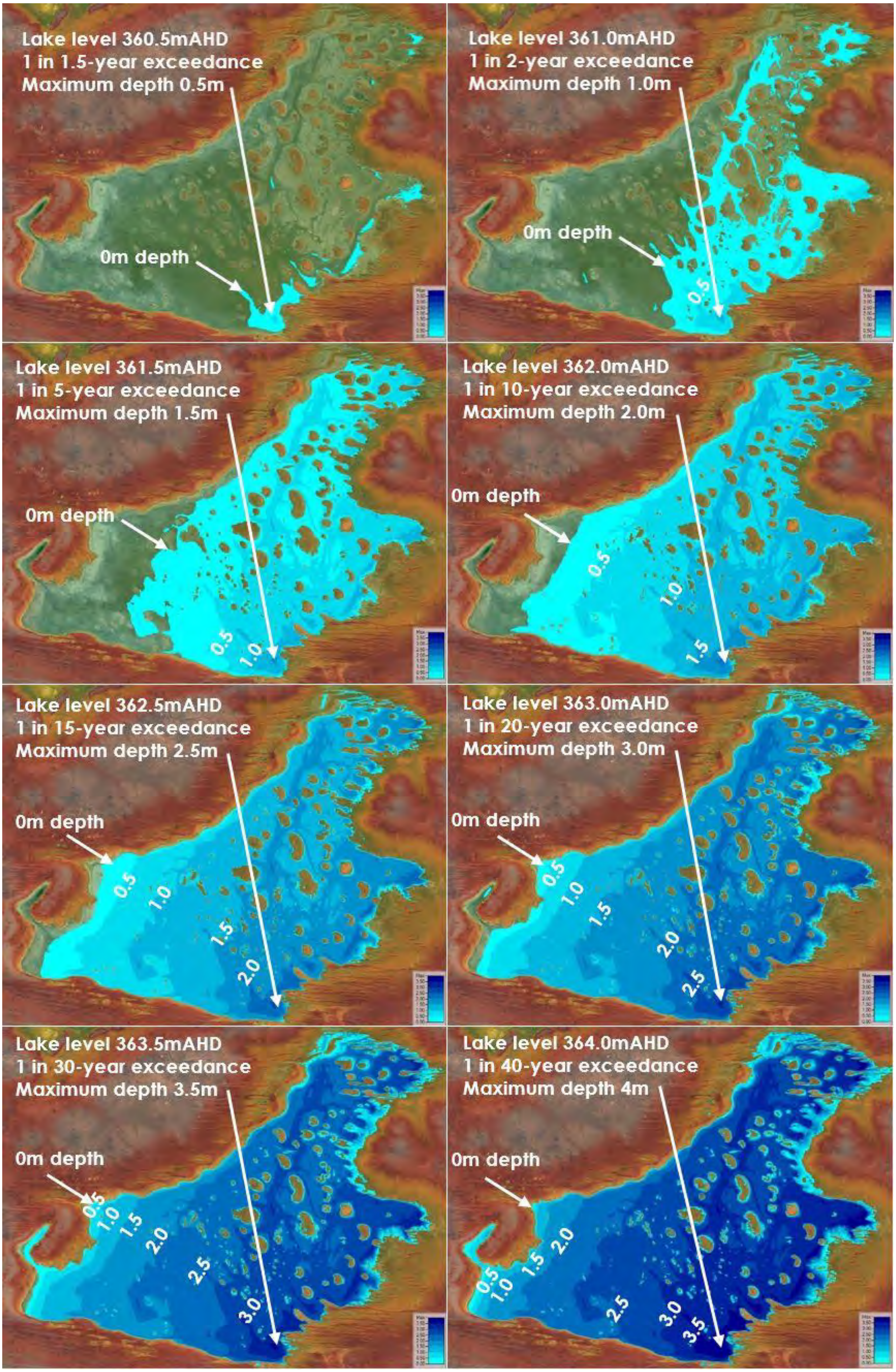

Figure 3-12: Surface water levels on Lake Mackay, based on topography

3.5.8 Hydrogeology

Lake Mackay is an ephemerally flooded lacustrine system which hosts hypersaline groundwater in a shallow surficial aquifer. The lake bed sediments sequence is made up of silt, gypsiferous sand and silty clay with interspersed gypsum crystals. The lake water table occurs at 0.5 m below ground level on average and experiences some fluctuations during the wet and dry seasons.

Groundwater recharge to the lake is predominately from direct rainfall onto the lake surface. Surface water contributions from the immediate catchment areas surrounding the lake are infrequent and only occur as a result of significant rainfall events. As the lake is a terminal drainage point for surrounding watershed, discharge is solely from evaporation and evapotranspiration.

Lake Mackay experiences periodic inundation following rainfall events however due to the high infiltration and evapotranspiration rates, water dissipates from the surface rapidly. The water table typically occurs at 0.5 m below ground level and experiences some fluctuations during the wet and dry seasons. Groundwater salinity of the surficial lake aquifer is hypersaline with TDS concentrations ranging from between 250,000 to 350,000 mg/L.

The off lake regional water table sits at a depth of between 4 m to 11 m depending on the immediate topography. Groundwater is hosted in unconfined calcrete and weathered sandstone aquifers of the Amadeus Basin. Groundwater salinity adjacent to the lake ranges between 6,200 and 47,000 mg/L, increasing with depth. Further away from the lake the salinity drops to between 1,200 and 6,300 mg/L.

Groundwater in the northern portion of the Proposal area occurs in fractured basement rocks, secondary porosity in weathered and chemically altered units and alluvial and eolian deposits (Johnson 2006). Groundwater is recharged by rainfall and is likely enhanced by localised runoff and flooding due to heavy rainfall events during the wet season. Groundwater discharge is primarily due to evaporation. Groundwater recharge to aquifers of the Canning Basin that occur in the northern portion is by major 1 in 10 to 1 in 100-year flood events (Johnson 2006).

3.6 Ecological Characteristics

3.6.1 Biogeographic Location

The majority of the Proposal is located within the Mackay subregion (GSD2) of the Great Sandy Desert (GSD) bioregion, within the Eremaean Botanical Province of WA (Figure 3-13). The GSD is characterised by gently undulating plains dominated by longitudinal dunes of varying frequency, comprising tree-steppe degrading to shrub-steppe in the southeast and open hummock grasslands with scattered trees (*Owenia reticulata, Eucalyptus* spp.) and shrubs (*Acacia* spp. and *Grevillea* spp.) (Beard 1990). The GSD2 subregion comprises 18,636,695 ha within the GSD, encompassing palaeodrainage systems including salt-lake chains with samphire low shrublands, and areas of sand dunefields over sandstones (Kendrick 2001). The landscape is built up of laterised uplands that support *Acacia* shrublands over *Triodia pungens* hummock grass (Kendrick 2001).

The northern portion of the Proposal extends into the Tanami Desert 1 subregion (TAN1) of the Tanami Desert bioregion (Figure 3-13). The Tanami Desert bioregion is characterised by gently undulating sandy plains with longitudinal dunes with shrub-steppe of *Triodia pungens*, and the occasional low rocky ranges and laterite-crusted uplands, comprising tree-steppe and plains of grass savanna (Beard 1990). The TAN1 subregion comprises 3,214,599 ha, encompassing sandplains that support *Hakea* spp., desert bloodwoods, *Acacia* spp. and *Grevillea* spp. over spinifex, with calcareous deposits from rivers and lakes throughout the landscape (Graham 2001). In the north of the subregion, the calcareous deposits support ribbon grass (*Chrysopogon* spp.) and Flinders grass (*Iseilema* spp.) and short-grasslands with river red gum (*Eucalyptus camaldulensis*) (Graham 2001).

3.6.2 Vegetation

3.6.2.1 Botanical Regions

The Proposal area occurs in the Canning Botanical District of the Eremaean Botanical Province (Beard 1990). The Canning Botanical Province is described as tree-steppe grading to shrub-steppe communities, comprising open hummock grasslands of *Triodia pungens* and *Plectrachne schinzii* (now *Triodia schinzii*) with scattered trees of *Owenia reticulata, Eucalyptus* spp. and *Acacia* and *Grevillea* shrubs.

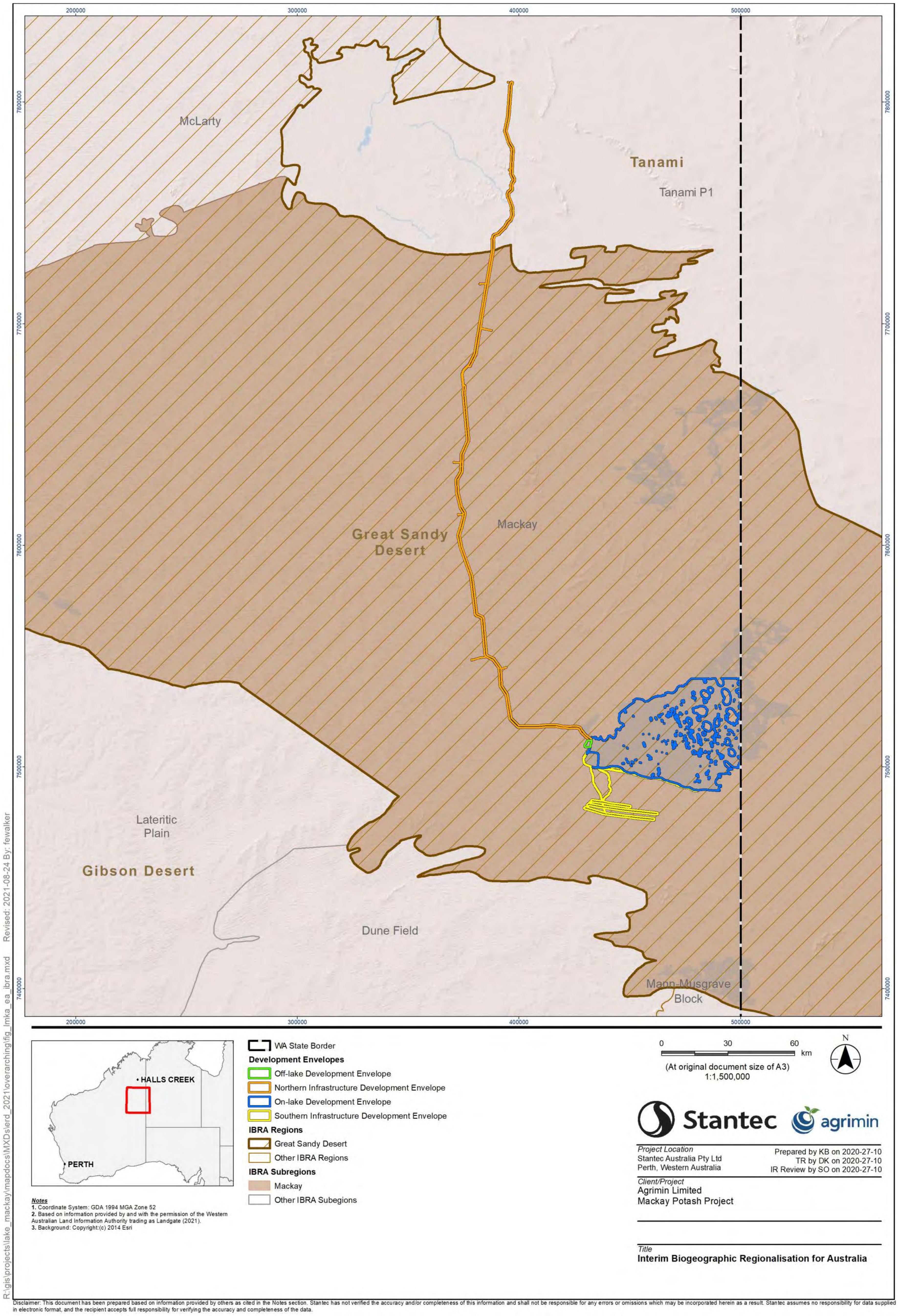

Figure 3-13: Interim Biogeographic Regionalisation for Australia for the Proposal area

3.6.2.2 Pre-European Vegetation Associations

Eight pre-European vegetation association systems have been mapped over the Proposal area, based on Shepherd *et al.* (2002) (Figure 3-14, Table 3-3). Within each of these associations, minimal land clearing has occurred across the four scales of assessment (State, bioregion, subregion and Local Government Area (LGA)). The majority (approximately 82%) of the Proposal area comprises vegetation association 125 which is described as salt lake, lagoon and clay pan association. This represents approximately 85% of the vegetation associations' extent within the Proposal area.

Table 3-3: Pre-European vegetation system associations and extent within the Proposal area. Vegetation system associations described by Shepherd et al. (2002) correspond with that of Beard (1975)

System Code	Description	Extent remaining in WA (ha)	Extent remaining in WA (%)	Extent within Proposal area (ha)	Extent within Proposal area (%)
Great Sandy Desert (GSD2)					
125	Salt lake, lagoon, clay pan	672,380	99.71	216,078.72	81.95
134.1	Sparse low tree-steppe / Sparse shrub-steppe	1,1239,390	99.98	17,046.68	6.47
174.1	Shrub-steppe; Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp.	1,435,903	99.93	13,659.33	5.18
2041.1	Samphire with thicket/scrub; *Tecticornia* spp. with *Melaleuca* spp. *Acacia* spp.	343,650	99.83	8,136.60	3.09
117	Grass-steppe; Hummock grassland *Triodia* spp.	219,618	99.95	422.72	0.16
Tanami (TAN1)					
101.2	Shrub-steppe; Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp.	227,656	100	5,496.25	2.08
218.1		700,691	100	1,710.46	0.65
895.1		1,160,999	99.16	1,027.71	0.39

3.6.3 Significant Flora

Georeferenced searches of Department of Biodiversity, Conservation and Attractions (DBCA) databases and literature reviews conducted prior to the (Stantec 2021c) (Appendix D) flora and vegetation survey resulted in 48 significant flora species being identified as having previously been recorded within 150 km of the Proposal area. This includes 11 Priority 1, six Priority 2 and 23 Priority 3 flora species. One database record of an EPBC-Act listed species, *Eleocharis papillosa* (Vulnerable), which is also listed as a Priority 3 species under the BC Act, is located approximately 36 km east of the Proposal area boundary, within the NT.

3.6.4 Groundwater-dependent Ecosystems

The Groundwater Dependent Ecosystems Atlas (GDEs Atlas) indicates that 21,442 ha of the Proposal area has the potential to contain GDEs, approximately 8% of the Proposal area (BoM 2021e). Table 3-4 and Figure 3-15 show the breakdown of where potential GDEs lie within each of the Development Envelopes. It should be noted that GDEs have been mapped by using remote sensing and it is likely that no ground-truthing of these results has occurred in the more remote locations such as the Great Sandy Desert and Tanami bioregions. Coarse mapping of potential GDEs (BoM 2021e), compared to the fine scale delineation of the On-LDE has resulted in some mapping of terrestrial GDEs occurring on the lake.

Table 3-4: Potential GDEs mapped within the Proposal area (BoM 2021e)

Development Envelope	Extent (ha) within the Proposal area	
	High Potential GDE (Succulent steppe with scrub; teatree over saltflats)	Low Potential GDE (Hummock grasslands, shrub steppe; mixed shrubs over soft spinifex)
On-LDE	1,256^	0
Off-LDE	661	0
SIDE	2,302	0
NIDE	3,564	13,659
Proposal Area Total	7,782	13,659

Note: ^ indicates coarse mapping of potential GDEs compared to the fine scale delineation of the On-LDE is likely to misrepresent this area calculation.

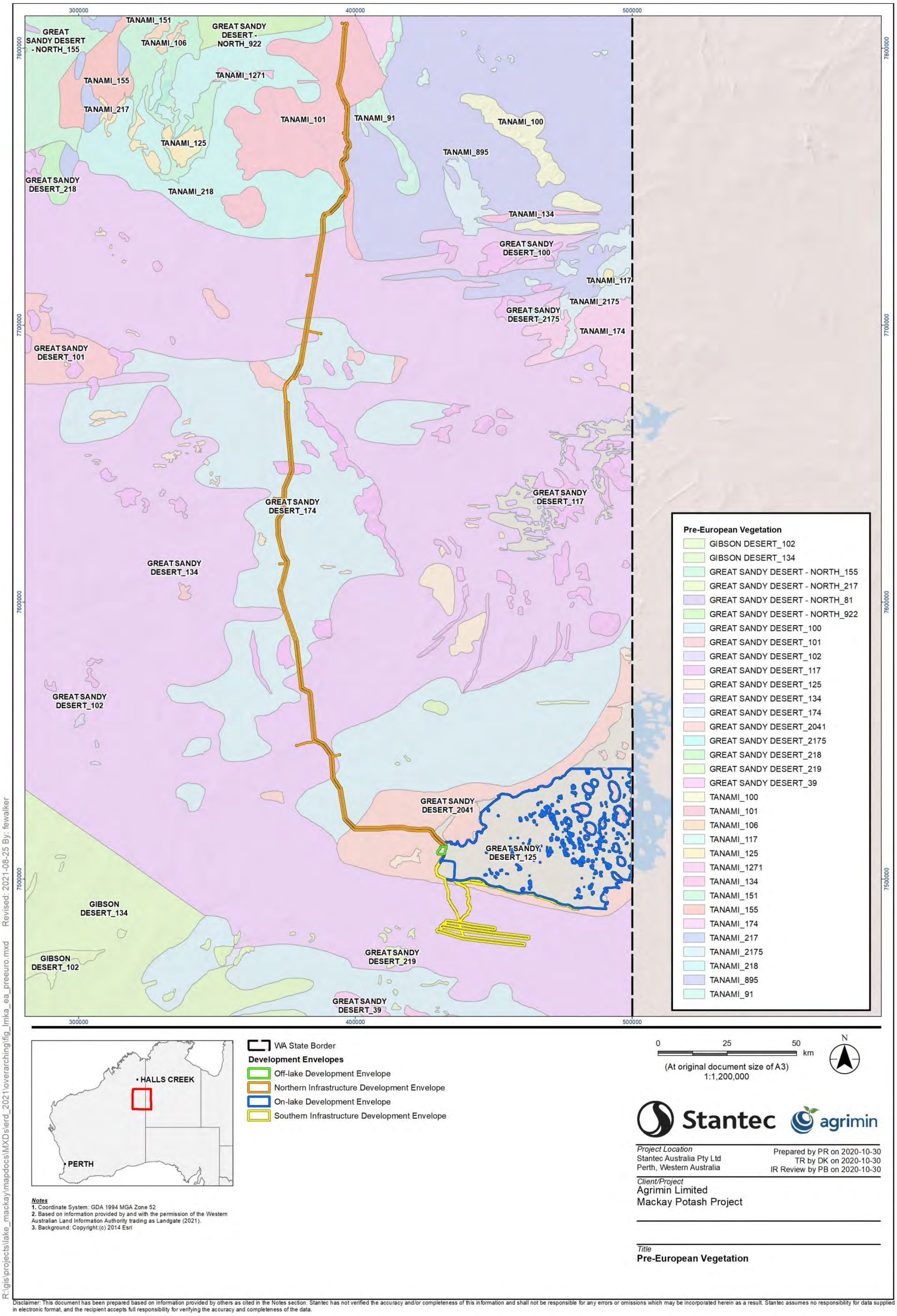

Figure 3-14: Pre-European vegetation associations intersecting the Proposal area

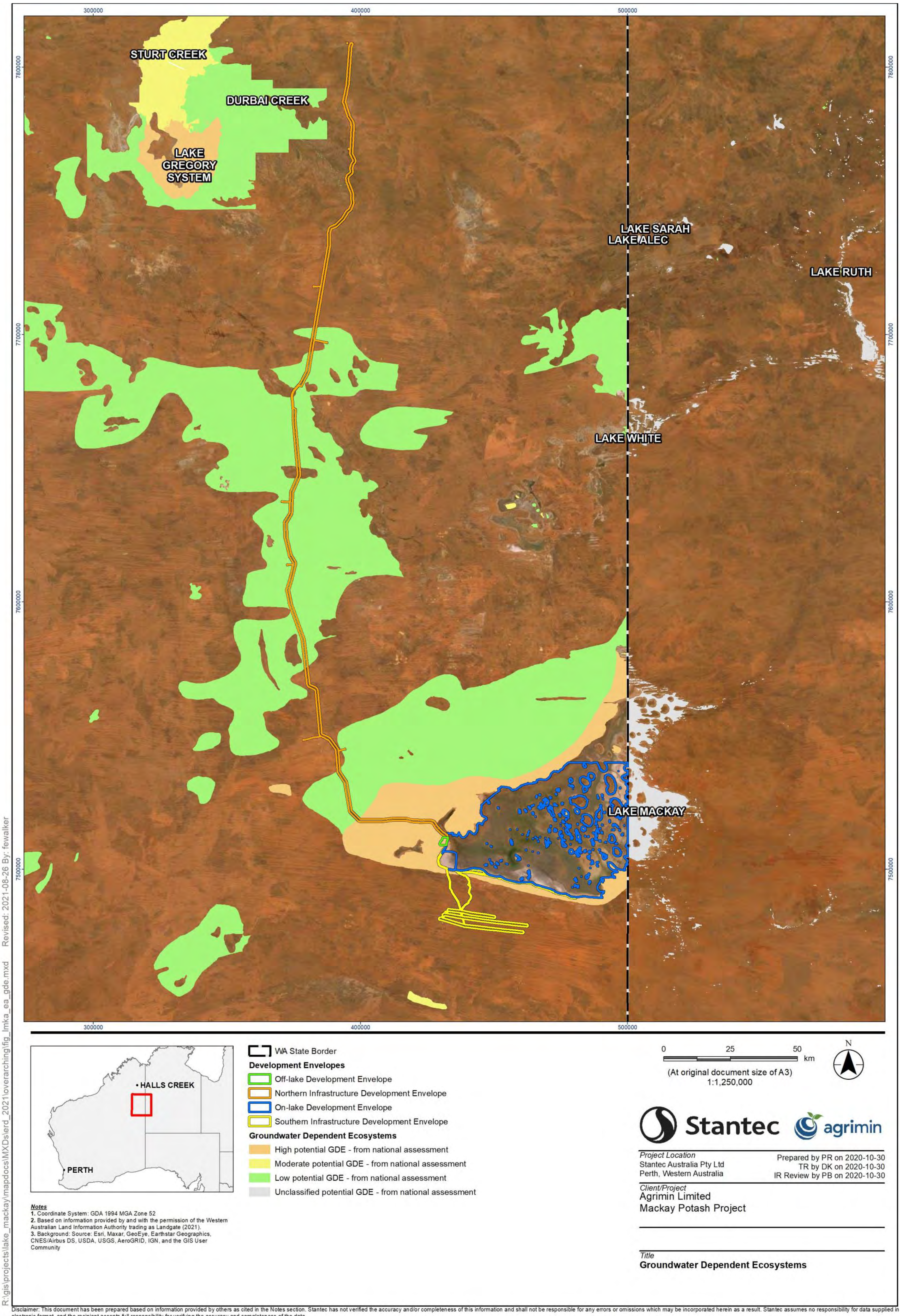

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Figure 3-15: Groundwater Dependent Ecosystem Atlas mapping of potential GDEs within, and adjacent to, the Proposal area (BoM 2021e)

3.6.5 Fauna Habitats

Stantec (2021d) undertook consolidated fauna habitat mapping which resulted in the delineation of 12 broad fauna habitats within the Proposal area. These habitats were delineated on the basis of location, landform, substrate, vegetation type and their importance to different faunal groups, in particular their importance to fauna of significance. The habitats described and delineated across the Proposal area include:

- salt lake;
- lake margin;
- claypans and claypan mosaic;
- saline flats and depressions;
- dunefield;
- dune; and
- spinifex sandplain;
- gravel spinifex plain;
- rocky ridge and gorge;
- outcropping and stony rise;
- ridge slope;
- drainage line.

There were three unique landscape features identified within the Proposal area, Lake Mackay, island outcropping and water sources, which provide important sources of shelter, food, and water for fauna, including significant fauna.

3.6.6 Terrestrial Fauna

A total of 245 terrestrial vertebrate fauna species were identified with the potential to occur within the Proposal area. These comprised:

- 22 native mammals;
- 9 introduced mammals;
- 129 native birds;
- 1 introduced bird;
- 6 amphibians; and
- 80 reptiles.

Of these, 21 species are classified as significant fauna under the EPBC Act or the BC Act, comprising:

- 4 mammals;
- 3 reptiles; and
- 14 birds.

3.6.7 Short-range Endemic Species

Terrestrial short-range endemic (SRE) invertebrate fauna are species are typically associated with sheltered and mesic microhabitats, such as the southeast aspect of slopes, trees, boulders and rock piles, outcrops, mesas, drainage systems, deep gorges, natural springs and fire refuges (EPA 2016g). As discussed in Section 3.6.5, 12 broad habitats were identified and delineated throughout the Proposal area. Seven of the 12 habitats are classified as having potential to support terrestrial SRE taxa within the Proposal area include salt lake playa, lake margin, saline flats, and depressions, claypan and claypan mosaic, rocky ridge and gorge, outcropping and stony rise, and drainage line. The remaining five habitats were classified as being of low potential for SRE taxa due to their widespread continuous occurrence and lack of significant microhabitat features that are conducive for short range endemism.

3.6.8 Lake Mackay

Lake Mackay consists of an immense, naturally saline playa which supports numerous islands and waterbodies on its periphery. The lake margins, and some of the larger islands also support dune systems. The lake is highly ephemeral and major flood events that lead to complete inundation are extremely rare, the most recent of which occurred in 2016 and prior to this was in 2001. There are numerous minor inflows around the lake, with a general westward flow due to prevailing east and southeast winds. The hydroperiod is largely governed by direct rainfall, evaporation and infiltration.

The geology of the lake bed is characterised by a salt, sand and silt substrate, overlain with gypsum crystals, particularly in the east. The topography of the playa is generally flat, with low lying sandy dunes and islands providing some relief of over 10 m. The islands also show varying characteristics, depending on their size and geology.

Aquatic habitat types on the lake include embayments, peninsulas and open playa, with tributaries, the shoreline and islands contributing to variation. Typically, however, the playa is undisturbed, with only a minor influence from feral animals such as camels, and from activities associated with mining exploration. The riparian zone is characterised by a range of samphires (*Tecticornia*), and other salt tolerant chenopods, dominating the lake margins and islands.

3.6.9 Peripheral Wetlands

Along its periphery, Lake Mackay has a multitude of ephemeral wetlands and drainages, including floodplains, salinas (salt flats) and claypans. The salinas range from 500 m to 11.5 km in length and are generally discrete from Lake Mackay, although support a similar low-lying primary dune system and samphire-dominated riparian zone. Claypans are comparably smaller and more regular in shape (400 m to 1.8 km in diameter) and may show a greater diversity of species among the riparian zone, although are still characterised by samphires.

3.6.10 Subterranean Fauna

Limited subterranean fauna (stygofauna and troglofauna) studies have been undertaken in the vicinity of salt lakes and claypans in central arid Australia. Lake Mackay's surface consists of lacustrine sediment of mud, clay and gypsiferous evaporates geologies. Lake Mackay hosts hypersaline groundwater at approximately 0.5 m below the lake's surface, that is hypersaline (≥250,000 mg/L TDS). Geology in the unsaturated zone above groundwater and elevated salinity are non-conducive habitat for subterranean fauna. However, prospective subterranean habitat likely exists in lower salinity groundwater associated with some of the larger islands on Lake Mackay, where calcrete deposits occur.

There are two aquifers south of Lake Mackay in the proposed SIDE area; the surficial calcrete aquifer, and an underlying deep alluvial aquifer. While the SIDE borefield occurs in saturated Neogene alluvials which host fresh to low salinity groundwater, the relatively fine textured lithology is likely to restrict subterranean fauna.

3.6.11 Aquatic Biota

Few studies of aquatic biota from salt lakes and claypans in central arid Australia exist, with a paucity of records from this region. Much of the data on central Australian salt lakes is from Lake Eyre, the largest salt lake in Australia (Williams *et al.* 1990). Salt lake biota are extremely resilient and well adapted to their temporary environments, employing specialised life history stages to cope with conditions (Williams *et al.* 1990). To date, there is no published literature available on Lake Mackay and its peripheral wetlands.

Typically, salt lakes will initially support an abundance of algae, macrophytes and aquatic invertebrates (mostly crustaceans) with the onset of the hydroperiod, during major flood events, when salinities are lowest. This high productivity (boom phase) provides a food source for higher order consumers such as waterbirds (including migratory species) and in some instances fish. However, as salinity increases over the course of the hydroperiod, becoming hypersaline, these lakes enter the drying phase, and diversity decreases. As water levels recede, aquatic biota completes their lifecycles (bust phase), depositing resting stages (dormant propagules and eggs) in the sediment that are resistant to extended dry periods. The cycle is repeated when the lake is flooded, triggering emergence of aquatic biota and recovery. These boom-and-bust phases are highly dependent on the amount of rainfall received and lake inundation levels, which regulate biological productivity.

3.6.12 Waterbirds

Ornithological surveys of Lake Mackay immediately following major rainfall and flooding events suggest Lake Mackay and surrounding smaller freshwater claypans may provide important breeding habitat for waterbird populations. A total of at least 34 confirmed waterbird species were recorded at Lake Mackay including 12 Threatened and Priority waterbird species (360 Environmental 2017b).

There were no direct observations of waterbirds on waterbodies of the islands. The Stantec 2021 targeted waterbird survey recorded 4,200 Banded Stilts (*Cladorhynchus lecocephalus*) displaying breeding behaviour on a lake island (Stantec 2021d). Furthermore, Banded Stilts with juveniles were observed on the lake from three other surveys including in internationally important numbers in 2001 (due to islands providing protection from predators) (360 Environmental 2017b; Pedler 2017). In addition, several significant species were recorded from the lake and its peripheral wetlands, including internationally important numbers of Sharp-tailed Sandpipers (*Calidris acuminata*) (Mi: Migratory shorebird), nationally important numbers of Red-necked Stints (*Calidris ruficollis*) (Mi: migratory shorebird) and the Australian Painted Snipe (*Rostratula australis*) (En) (360 Environmental 2017b). Therefore, it is possible that these species may also utilise the islands and their waterbodies when foraging and/or breeding during major flood events.

3.7 Heritage Characteristics

3.7.1 Aboriginal Heritage

As discussed in Section 1.4.1, the Proposal area lies within the Kiwirrkurra, Ngururrpa and Tjurabalan Determination Areas (Figure 1-3). The majority of the Proposal lies within the Kiwirrkurra IPA. There are also several State and Territory IPAs within 200 km of the Proposal area including Katiti Petermann (NT), Kiwirrkurra (WA), Newhaven (NT), Ngaanyatjarra (WA), and Southern Tanami (NT) (Table 3-5).

Table 3-5: Indigenous protected areas within 200 km of the Study Area.

Reserve Name	Distance from Proposal area
Katiti Petermann	5 km south
Newhaven	30 km southeast
Ngaanyatjarra	45 km south-southwest
Southern Tanami	50 km east

3.7.2 Other Heritage Places

The region of the Proposal area has been subjected to exploration activities historically, since the 1930s, particularly in the northern areas. There are no known non-indigenous heritage places listed on the State Registered Places or Heritage Places register within the Proposal area. The closest State Registered Places or Heritage Places is / are located are over 900 km away at Corunna Downs Station near Marble Bar to the west and Broome in the north west.

3.8 Socio-economic Characteristics

3.8.1 Biographical context

In 1897, explorer David Carnegie predicted Lake Mackay's existence when he passed by the lake to the west. The lake was formally discovered in 1930 during an expedition led by Donald George Mackay, an explorer who conducted several expeditions to the remotest areas of Australia.

The broader Lake Mackay region has historically been explored for uranium, along with precious and base metal deposits. However, due to the Proposal's remoteness in outback Australia, the lake itself had been overlooked as a potential deposit of valuable salt minerals.

3.8.2 Surrounding land uses

Land surrounding the Proposal area continues to be utilised for a variety of purposes by traditional owners. Historical and current mining exploration activities include diamond, gold, and uranium exploration. The closest agricultural use to the Proposal area is cattle stations Mount Doreen and Newhaven located approximately 150 km east, in the Northern Territory.

3.8.3 Recreation and Tourism

Due to the remoteness of the Proposal area, visitors to the area for recreation and tourist purposes are limited. The current road that links the Kiwirrkurra community in the south to Balgo in the north is infrequently travelled by tourists due to the limited facilities, condition of the road and remoteness of the area.

4. Stakeholder Engagement

4.1 Key Stakeholders

All stakeholders provided in Table 4-1 have been (or are planned to be) consulted during the exploration, feasibility, and design stages of the Proposal. Agrimin will undertake ongoing consultation with key stakeholders during the construction, operational and closure planning stages of the Proposal.

Table 4-1: Key Stakeholder Groups

Stakeholder Groups	
State and Commonwealth Government	Traditional Owners
Department of Agriculture, Water and the Environment	Kiwirrkurra Native Title holders and Tjamu Tjamu Aboriginal Corporation (RNTBC)
Department of Planning, Lands and Heritage	Ngururrpa Native Title holders and Parna Ngururrpa Aboriginal Corporation (RNTBC)
Department of the Premier and Cabinet (Ministers for Water and Environment)	Tjurabalan Native Title holders and Tjurabalan Native Title Land Aboriginal Corporation (RNTBC)
Department of Water and Environmental Regulation (Environmental Protection Authority Services Division)	IPA Rangers
Department of Mines, Industry Regulation and Safety	Indigenous Business Australia
Department of Water and Environmental Regulation	Non-Government Organisation (NGOs) and Interest Groups
Department of Aboriginal Affairs	Central Desert Native Title Services
Department of Biodiversity, Conservation and Attractions	Central Land Council
Department of Primary Industries and Regional Development	Desert Support Services
Department of Health	Kimberley Land Council
Department of Treasury, Western Australia National Native Title Tribunal	Conservation Council of Western Australia
Local Government And Key Organisations	Birdlife Australia
Kimberley Land Council	Waterbird Conservation Group.
Shire of Wyndham-East Kimberley	Night Parrot Recovery Team
Shire of Halls Creek	Shire of East Pilbara

4.2 Stakeholder Engagement

Agrimin's objective is to continue to build long-term and meaningful relationships with the Tradition Owners located in and around the Proposal area. Stakeholder and community engagement for the Proposal commenced in 2014 and has been conducted in several formats, including on-country meetings in Kiwirrkurra, Balgo, Billiluna, Wangjakjungta, Halls Creek, and Broome, as well as in Perth. A complete list of stakeholder engagement details is provided in Appendix B. No official stakeholder concerns have been lodged to the Company's knowledge at the time of completing the ERD.

A CHMP exists between the Tjamu Tjamu Aboriginal Corporation (RNTBC) and Agrimin (Agrimin 2020).

There will be ongoing consultation with stakeholders throughout the construction, operational, and closure planning phases of the Proposal, generally through direct engagement, NGOs such as Desert Support Services, Central Desert Native Title Services and Kimberley Land Council, public presentations, ASX releases, and Proposal reporting requirements.

5. Environmental Principles and Factors

5.1 Identification of key factors and their significance

Agrimin has assessed the environmental factors relevant to this Proposal in accordance with the EPA's *Statement of environmental principles, factors, objectives and aims of EIA (EPA 2021d)* and the EPA's environmental factor technical guidelines. The key environmental factors relevant to this Proposal, as outlined in the EPA's decision for assessment (Assessment No 2193, 30 January 2019), are considered in Table 5-1.

Table 5-1: Key Environmental Factors, their significance and relationship to the Proposal

EPA Theme	EPA Factor	Significance	Relationship to the Proposal
Sea	Not considered for this Proposal		
Land	Flora and Vegetation	Key environmental factor	There are potential impacts from the Proposal on flora and vegetation from clearing of up to 1,500 ha of native vegetation for the development of the Proposal infrastructure. Indirect impacts from the Proposal may include habitat fragmentation, impacts on habitat that supports the flora and vegetation, impacts on other species with important ecological function, introduction, or promotion of weeds, altered hydrology and changed fire regimes.
	Landforms	Not considered a key environmental factor	The Proposal is not considered to have a significant impact on Landforms.
	Subterranean Fauna	Key environmental factor	Abstraction of 100 GL/a of brine to develop the SOP product, and abstraction of up to 3.5 GL/a of water for supply may impact upon subterranean fauna and their values through the removal of habitat, drawdown of groundwater, inundation, and water quality changes. Indirect impacts include from the Proposal may include changes to hydrology, siltation, void collapse, alteration to nutrient balance and contamination.
	Terrestrial Environmental Quality	Not considered a key environmental factor	The Proposal is not considered to have a significant impact on Terrestrial Environmental Quality.
	Terrestrial Fauna	Key environmental factor	Clearing of up to 1,500 ha of native vegetation for the development of the Proposal infrastructure has the potential to impact terrestrial fauna. Construction and operation of infrastructure and transport of product and supplies, has the potential to cause fragmentation or modification of habitat, and mortality or displacement of fauna individuals or populations. Indirect impacts on fauna from Proposal activities include the introduction or promotion of weeds, introduced fauna, reduced or prevention of access to feeding or roosting habitats, disruption of the dispersal of individuals required to colonise new areas inhibiting maintenance of genetic diversity between populations or disruption of pollinators and seed dispersal vectors.
Water	Inland Waters	Key environmental factor	Disturbance of up to 15,000 ha of the surface of Lake Mackay for the construction of trenches and evaporation ponds to extract 100 gigalitres per annum (GL/a) of brine will impact upon Inland Waters in terms

EPA Theme	EPA Factor	Significance	Relationship to the Proposal
			of distribution, connectivity, movement, and quantity (hydrological regimes) of Lake Mackay including its chemical, physical, biological and aesthetic characteristics (quality).
Air	Air Quality	Not considered a key environmental factor	The Proposal is not considered to have a significant impact on Air Quality.
	Greenhouse Gas Emissions	Not considered a key environmental factor	The Proposal is not considered to have a significant impact on Greenhouse Gas Emissions.
People	Social Surroundings	Key environmental factor	The Proposal has the potential to impact upon social surroundings due to the presence of Aboriginal heritage sites within the Development Envelopes, and proximity of the Proposal to local communities.
	Human Health	Not considered a key environmental factor	The Proposal will not significantly impact Human Health.

5.2 Environmental Protection Principles

The five core principles of environmental protection under the EP Act have been applied to the Proposal, in accordance with the EPA's *Statement of environmental principles, factors, objectives and aims of EIA (EPA 2021d)*. Each of the environmental protection principles have been considered in the development of this Proposal. A summary of how each principle relates to the Proposals is provided in Table 5-2.

Table 5-2: Environmental Protection Principles (EP Act)

Environmental Principle	Consideration for the Proposal
1. The 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 application of this precautionary principle, decisions should be guided by: • careful evaluation to avoid, where practicable, serious, or irreversible damage to the environment; and • an assessment of the risk-weighted consequences of various options.	Agrimin has used a risk-based approach to assess significant environmental impacts of implementing the Proposal. Where the potential for significant environmental harm was identified, mitigation measures to avoid, minimise, manage, monitor, or rehabilitate impacts have applied. Management measures are addressed within the construction and operational suite of environmental management plans. Technical studies and investigations have been undertaken across the Development Envelopes to ensure the environment has been characterised in accordance with the work requirement of the EPA's ESD. The findings of the studies and investigation have been used to inform the EIA presented in this ERD. This information has reduced the uncertainty surrounding the impact assessment and prediction of impacts and their significance. Information gained from the findings of the technical studies have been fed back into robust proponent-led avoidance measures and modifications made, where feasible, to reduce or mitigate potential environmental impacts. In the design of the Proposal, Agrimin considered a range of alternatives to avoid and minimise any potential environmental impacts. All potential environmental impacts have been evaluated in this ERD. Where there were areas of uncertainty regarding potential impacts, conservative assumptions were made. A conservative assessment approach was taken with regard to calculating the disturbance area within the Development Envelopes. The actual clearing impacts for the haul road will reduce significantly as the corridor will attempt to avoid significant species/communities and align with previously cleared areas.
2. The 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.	Agrimin has committed to developing and operating the Proposal in alignment with the United Nations Sustainable Development Goals, which will drive sustain practices and support the principle of intergeneration equity. After the implementation of mitigation measures, at this stage, there is no confirmed significant residual impact that require offsets; however, Agrimin will continue discussions with the State and Commonwealth agencies to ensure *suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012). A Mine Closure Plan (MCP) has also been developed to ensure that the Proposal planned with consideration of post-mining land use and is closed in a manner to ensure that the environment is maintained for the benefit of future generations.
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Comprehensive baseline studies and investigations have been undertaken to understand the existing biological diversity in the area, and to inform a detailed assessment of the potential impacts and threats to ecological integrity. Avoidance and mitigation of impacts has been applied where practical and environmental management strategies will be implemented to minimise impacts to biological diversity and ecological integrity, including: • Realigning the haulage corridor of the NIDE to avoid the local Yagga Yagga Great Desert Skink population; • Reducing the width of the haulage corridor and prohibiting borrow pits in sensitive habitats, where the Great Desert Skink and Night Parrot habitats occur; • Refinement of the NIDE; • Relinquishment of the proposed western 'dog leg' access route within the SIDE and addition of an alternative access track alignment and water pipeline leading from the Off-LDE to the borefield, allowing for essential infrastructure to be progressively relocated away from areas of elevated heritage significance; and • Decreased abstraction volumes of groundwater from the SIDE's borefield from 5.0 GL/a to 3.5 GL/a. • modification of site layout of processing infrastructure and supporting facilities, placing at a minimum 500 m off the lake, therefore avoiding impacts to riparian vegetation and potentially conservation significant species of Tecticornia; • mine planning will focus on retaining surface water movement patterns on the lake's surface wherever possible, and Agrimin will review the option for progressive excavation and rehabilitation of trenches during the LoM; • culturally sensitive areas have been, and are planned to be, avoided within the Proposal area; • sealing of the haul road and managing haulage operations to avoid night-time driving; • power to be supplied via a hybrid gas, solar, wind and battery solution which has a modelled up to 84% renewable energy penetration; and • water supply pipelines will be placed within existing and planned access road corridors wherever possible.
4. 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 principles – 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 services, including the use of natural resources and assets and the ultimate disposal of any waste. d) Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, 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.	Agrimin acknowledges that the costs for environmental mitigation and management are part of the overall Proposal construction, operating and closure costs. This includes any identified rehabilitation and/or residual impact management/offset actions that may be required. The Proponent has and will continue to evaluate opportunity to reduce impact to the land and to reduce consumption of water, energy and other materials during the implementation, operation, and closure of the Proposal. Agrimin will operate under an Operating Licence, issued under Part V of the EP Act, which will ensure that pollution (if generated) is paid for in line with legislation.
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	The Proponent's approach to waste is consistent with the waste management hierarchy ('avoid, reduce, reuse, recycle'). The key ongoing waste item for the Proposal is the storage of waste salts (halite, thenardite and hexahydrate on the lake). A number of ponds have been designed to recover some of the high potassium entrained brine from the waste salt. The natural lake bed surface has a very low vertical permeability, low seepage losses are therefore expected making it suitable for the construction of un-lined pond floors. Potential horizontal seepage will be addressed by lining the pond embankments with HDPE.

5.3 EPA Mitigation Hierarchy

In their assessment, and proposed management of potential impacts to environmental factors from the proposal, Agrimin has given consideration to the EPA's mitigation hierarchy (EPA 2021d). This hierarchy is founded on a serious of control measures focussed on reducing adverse impacts to the surrounding environment. The sequence of these actions is as follows:

- Avoid: The EPA's most preferred approach of the hierarchy is to avoid causing an environmental impact entirely.
- Minimise: Where an impact cannot be avoided, the EPA suggests that a proponent should seek to limit the degree or magnitude of the impact.
- Rehabilitate: In the case of an adverse impact being unavoidable and has been minimised as far as practicable, the results of the impact should be repaired, rehabilitated or restored at the earliest opportunity. The preparation for rehabilitation relies heavily on early identification of knowledge gaps and risks to meeting objectives.
- Offset: The last option to manage an adverse impact, where the other mitigation measures are not possible, is to provide compensatory environmental benefit or reduction in environmental impact to counterbalance significant adverse environmental impacts. The suitability of offset measures are determined on a proposal-by-proposal basis and may not always be appropriate.

6. Flora and Vegetation

6.1 EPA Objectives

The EPA's environmental objective for flora and vegetation is "*To protect flora and vegetation so that biological diversity and ecological integrity are maintained*" (EPA 2016b).

6.2 Policy and Guidance

The State and Commonwealth legislative instruments, policy, guidelines, and advice relevant to the Proposal and their application are presented below. Table 6-1 also summarises the scope of each guide as relevant to the Proposal.

Table 6-1: Legislative instruments, policies and guidelines relevant to flora and vegetation impact assessment

Legislative Instruments	
Biodiversity Conservation Act 2016	
Biosecurity and Agricultural Management Act 2007	
Environment Protection and Biodiversity Conservation Act 1999	
Environmental Protection Act 1986	
EPA Policy or Guidance	**Considerations**
Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA.	This Statement provides guidance to ensure that a Proposal addresses the holistic view of its environmental impact relevant to the EP Act.
Environmental Protection Authority. (EPA 2006). Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems.	A guideline that references terrestrial habitats and wetlands where cleared land is to be reinstated with natural ecosystem, which helps to establish completion criteria for measuring rehabilitation success.
Environmental Protection Authority. (EPA 2016b). Environmental Factor Guideline – Flora and Vegetation.	The EPA's advice on the flora and vegetation factor was considered for the EIA of the Proposal's activities and Development Envelopes.
Environmental Protection Authority. (EPA 2016i). Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment.	Vegetation surveys to support the Proposal were undertaken in accordance with this guideline's methodologies and reporting requirements.

Environmental Protection Authority. (EPA 2021a). Environmental Impact Assessment (Part IV Divisions 1 and 2 Administrative Purposes).	Describes the principles and practices of EIA within the context of Part IV of the EP Act and how these processed are applied to the impact assessment of the Proposal upon flora and vegetation.
Other Policy or Guidance	**Considerations**
Government of Western Australia. (Government of Western Australia 2011). WA Environmental Offsets Policy.	This document aims to address the protection and conservation of environmental and biodiversity values for present and future generations.
Department of Environmental Regulation. (DER 2014b). A guide to the assessment of applications to clear native vegetation under the *Environmental Protection Act 1986.*	Used to develop the approach to addressing vegetation clearing for the Proposal, with particular focus on clearing permits.
Environmental Protection Authority. (EPA 2021c). How to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans: Instructions.	A guide for preparing Environmental Management Plans that may be required in conjunction with the Proposal.

6.3 Overview of Studies

6.3.1 Supporting Flora and Vegetation Surveys

Stantec was commissioned by Agrimin to undertake a two-phase detailed flora and vegetation survey, and to consolidate the findings from previous flora and vegetation surveys. Surveys for the Proposal focusing on the lake and surrounds were completed previously by ecologia Environment (2017a), 360 Environmental (2017a) and Strategen Environmental (2018b). The aquatic ecology study (Appendix J) conducted for the Proposal included vegetation sampling within the riparian zone (Figure 6-1 and Table 6-3). Two additional flora and vegetation surveys have been conducted either intersecting with, or entirely within, the Proposal area with applicable findings incorporated within the consolidation of studies for the Proposal (Figure 6-2 and Table 6-4).For the purposes of EIA, the environmental values of both the local and regional context of the Proposal area are considered.

The Study Area contains four previous survey areas surveyed for the Proposal (360 Environmental 2017a; ecologia Environment 2017c; Strategen Environmental 2018a) along with the Stantec survey area. Additionally, the Outback Ecology (2012c) (conducted for Toro Energy) survey area occurs within the Study Area, and available Priority flora records from BushBlitz (2015) from within the Study Area were included in the overall dataset. Information from these previous surveys was combined with the findings of the Stantec Survey and consolidated into a single report which has been used to describe the flora and vegetation values within the Proposal area in the following sections and to inform the impact assessment for the Proposal (Appendix F).

6.3.1.1 Survey Effort

Across all surveys conducted for the Proposal, and the Outback Ecology (2012c) survey, there have been 216 quadrats, 42 relevés and 30 transects sampled (Table 6-2). Data from an additional 32 relevés sampled by ecologia Environment (2017a) was not available, therefore these relevés were not considered further. Of the 129 sample sites (122 quadrats and 7 relevés) installed in Phase 1 of the Stantec Survey, 85 quadrats and 4 relevés were resurveyed in Phase 2. Additionally, two Strategen Environmental (2018b) sample sites (one quadrat and one relevé) were resampled in the Stantec Phase 2 survey. A total of 16 quadrats and nine relevés were installed in Phase 2 and were therefore only subject to one (post-rainfall) season of survey. 360 Environmental (2017a) resampled six quadrats and one transect originally installed by ecologia Environment (2017a). Opportunistic flora records of additional species beyond those recorded within quadrats and relevés were taken to maximise the floristic inventory of the Study Area.

Vegetation types were described and mapped using the data collected from quadrats and relevés, and in-field observations. Mapping notes (brief annotations of dominant species, stratum, and other habitat attributes) were recorded to refine the descriptions. Vegetation condition was mapped according to vegetation type boundaries, using a combination of quadrat and relevé data, opportunistic observations, and the mean condition rating for each vegetation type.

Table 6-2: Summary of the flora and vegetation survey effort within the Study Area

Reference	New sample sites			Resample of previous sites		
	Quadrats	Relevés	Transects	Quadrats	Relevés	Transects
Phase 2 (Appendix F)	16	9	0	86	5	0
Phase 1 (Appendix F)	122	7	0	0	0	0
Strategen Environmental (2018b)	10	0	2	0	0	0
360 Environmental (2017a)	28	11	3	6	0	1
ecologia Environment (2017a)	31	32	6	0	0	0
Outback Ecology (2012c)	9	15	0	0	0	0
Baseline Aquatic Ecology Report 2021 (Appendix J)	NA	NA	19	NA	NA	0

Table 6-3: Flora and vegetation studies for the Proposal

Project (Reference)	Study details	Scope	Survey / study effort	Flora and Vegetation recorded	Key findings within the Stantec 2020 Study Area
Lake Mackay Potash Project: Detailed Flora and Vegetation Survey and Consolidation (Appendix F)	• Survey Area: 34,622 ha • Study Area: 443,664 ha • Study Type: Dual phase detailed flora survey and targeted flora survey Survey date: • 5-21 October 2019 and 7-25 March 2020; 21-29 April 2021 • Seasonal conditions: Average (Phase 1), Above average to below average (Phase 2), Above average (targeted survey)	Dual phase detailed flora and vegetation survey, and consolidation of previous surveys. Targeted flora survey with a focus on Priority flora known, or likely to occur	• 138 quadrats (50 m by 50 m) • 16 relevés • Mapping notes • Targeted searches • Opportunistic collections. One quadrat and one relevé were re-surveyed Strategen sample sites from 2018. Consolidation of data from a total of: • 216 quadrats • 42 relevés • 11 transects • Mapping notes • Targeted searches • Opportunistic collections	The consolidated data from all survey results conducted with the Study Area included: • 541 taxa from: • 58 families • 189 genera • 14 Broad Floristic Formations • 50 Vegetation Types Vegetation Condition: Excellent (approximately 99% of vegetated component of the Study Area).	Five Priority flora species recorded during the Stantec Survey: • *Stackhousia* sp. Lake Mackay (P.K. Latz 12870) (P)1 • *Goodenia virgata* (P2) • *Comesperma sabulosum* (P3) • *Eragrostis lanicaulis* (P3) • *Indigofera ammobia* (P3) A review and consolidation of all Priority flora recorded in previous surveys included: • *Goodenia anfracta* (P1) • *Stackhousia* sp. Lake Mackay (P.K. Latz 12870) (P1) • *Tecticornia globulifera* (P1) • *Goodenia virgata* (P2) • *Thysanotus* sp. Desert East of Newman (R.P. Hart 964) (P2) • *Bergia occidentalis* (P3) • *Goodenia halophila* (P3) • *Goodenia modesta* (P3) • *Rothia indica* subsp. *australis* (P3) • *Senna artemisioides* subsp. *alicia* (P3) • *Stackhousia clementii* (P3)
Lake Mackay Potash Project: Baseline Aquatic Ecology Study (Appendix J)	• Study Type: Riparian vegetation sampling • Survey date and seasonal conditions: • (1) 1 – 20 May 2019 (average);	Baseline aquatic ecology study with riparian vegetation sampling	• 27 riparian vegetation transects around Lake Mackay and within the peripheral wetlands that were 30 m in length, comprising	56 taxa including: • 16 families; and • 30 genera	Flora of 'other significance': • *Lawrencia* aff. viridigrisea • *Tecticornia* aff. *calyptrata* (NT form) • *Tecticornia* sp. sterile 1 • *Tecticornia* sp. sterile 2 • *Tecticornia* sp. sterile 3 • *Tecticornia* sp. sterile 4 • *Tecticornia* sp. sterile 5 • *Tecticornia* sp. sterile 6

Project (Reference)	Study details	Scope	Survey / study effort	Flora and Vegetation recorded	Key findings within the Stantec 2020 Study Area
	• (2) 25 – 28 February (below average) 2020; • (3) 21 February 2021 (above average); and • (4) 28 March - 1 April 2021 (above average).		270 quadrats (3 m by 3 m); and • Opportunistic sampling *Tecticornia* from around Lake Mackay		• *Tecticornia* sp. sterile 7 • *Tecticornia* sp. sterile 8
Lake Mackay Sulphate of Potash Project Detailed Flora and Vegetation Assessment at Lake Mackay (Strategen Environmental 2018b)	• Area: 1,403 ha • Study Type: Single phase detailed flora survey • Survey date: 10-15 November 2017 • Seasonal conditions: Above average	Single phase detailed flora survey	• 10 quadrats (50 m by 50 m) • 2 transects consisting of six 3 m by 3 m quadrats established in transitional vegetation.		Priority flora species: • *Stackhousia* sp. Lake Mackay (P.K. Latz 12870) (P1) Flora of 'other significance' (bearing affinity to recognised species): • *Tecticornia* aff. *halocnemoides* subsp. *longispicata*
Lake Mackay Sulphate of Potash Project Detailed Flora and Vegetation Assessment at Lake Mackay (360 Environmental 2017a)	• Area: 297,195 ha • Study type: Single phase detailed flora and vegetation survey • Survey date: 14-23 April 2017 • Seasonal conditions: Below average	Single phase detailed flora and vegetation survey	• 34 quadrats (50 m by 50 m) six quadrats were re-surveyed ecologia quadrats from 2016. • 4 transects comprising of 3 m by 3 m quadrats (one transect was a re-surveyed ecologia transect from 2016) • 24 transect quadrats 3 m by 3 m (six quadrats were re-surveyed ecologia quadrats)	253 taxa including: • 42 families • 117 genera 10 vegetation sub-formations Vegetation Condition: Excellent	Priority flora species: • *Tecticornia globulifera* (P1) • *Goodenia virgata* (P2) • *Goodenia modesta* (P3) Flora of 'other significance' (sterile material): • *Tecticornia* sp. sterile 8

Project (Reference)	Study details	Scope	Survey / study effort	Flora and Vegetation recorded	Key findings within the Stantec 2020 Study Area
			• 11 relevés • Mapping notes • Targeted searches, and opportunistic collections.		
Mackay Project Level 1 Fauna and Single-Phase Level 2 Flora Assessment (ecologia Environment 2017a)	• Area: 400,138 ha • Study type: Single phase level 2 flora assessment • Survey date: 6-13 September 2016 • Seasonal conditions: Above average	Single phase level 2 flora assessment	• 31 quadrats (50 m by 50 m) • Six transects consisting of six 3 m by 3 m quadrats (36 quadrats) established in transitional vegetation.	214 taxa including; • 44 families • 115 genera 12 vegetation sub-formations	Priority flora species • *Tecticornia globulifera* (P1) • *Goodenia virgata* (P2) • *Thysanotus* sp. Desert East of Newman (R.P. Hart 964) (P2) • *Stackhousia clementii* (P3)

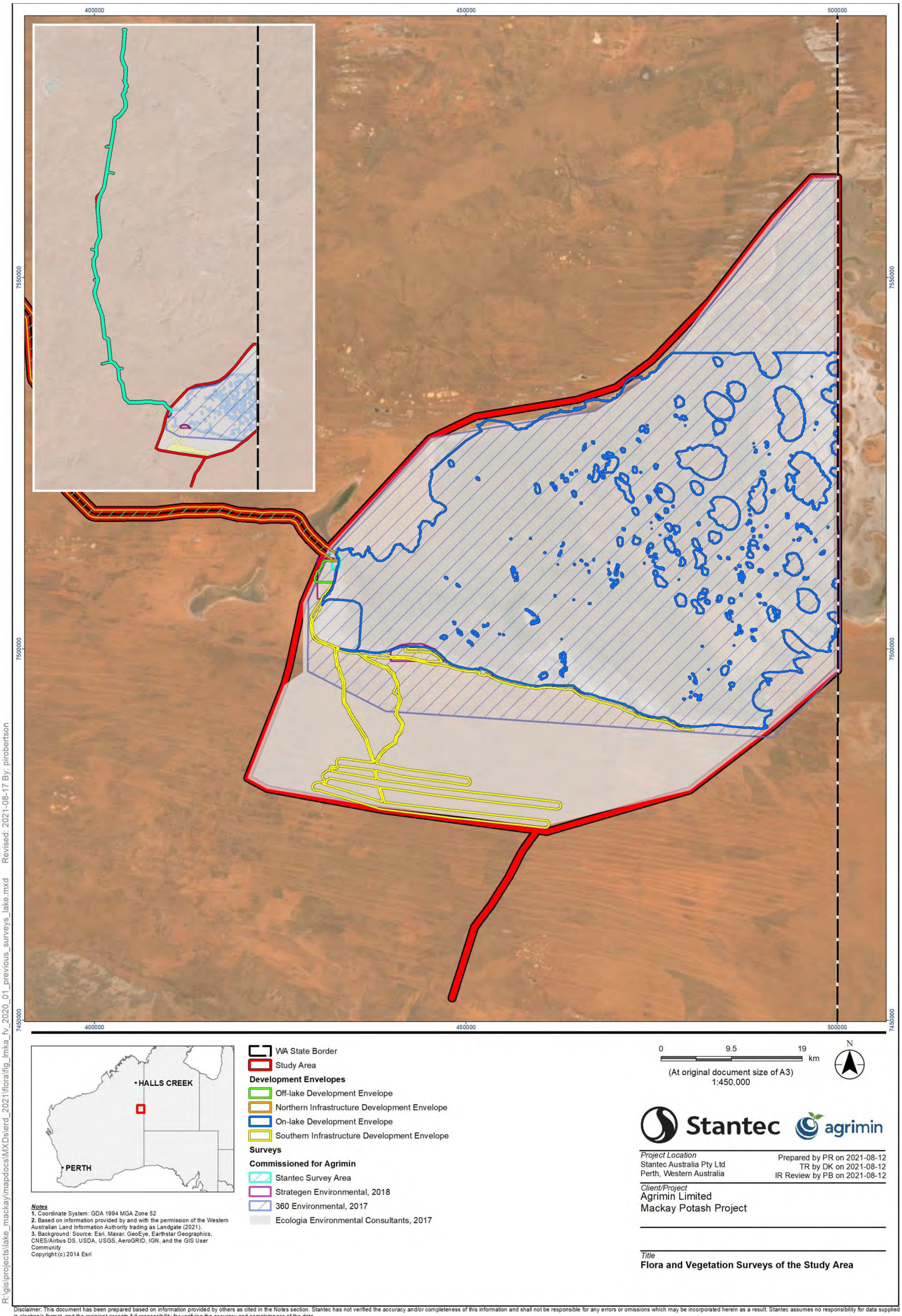

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Figure 6-1: The Study Area, Proposal area and flora and vegetation surveys commissioned by Agrimin

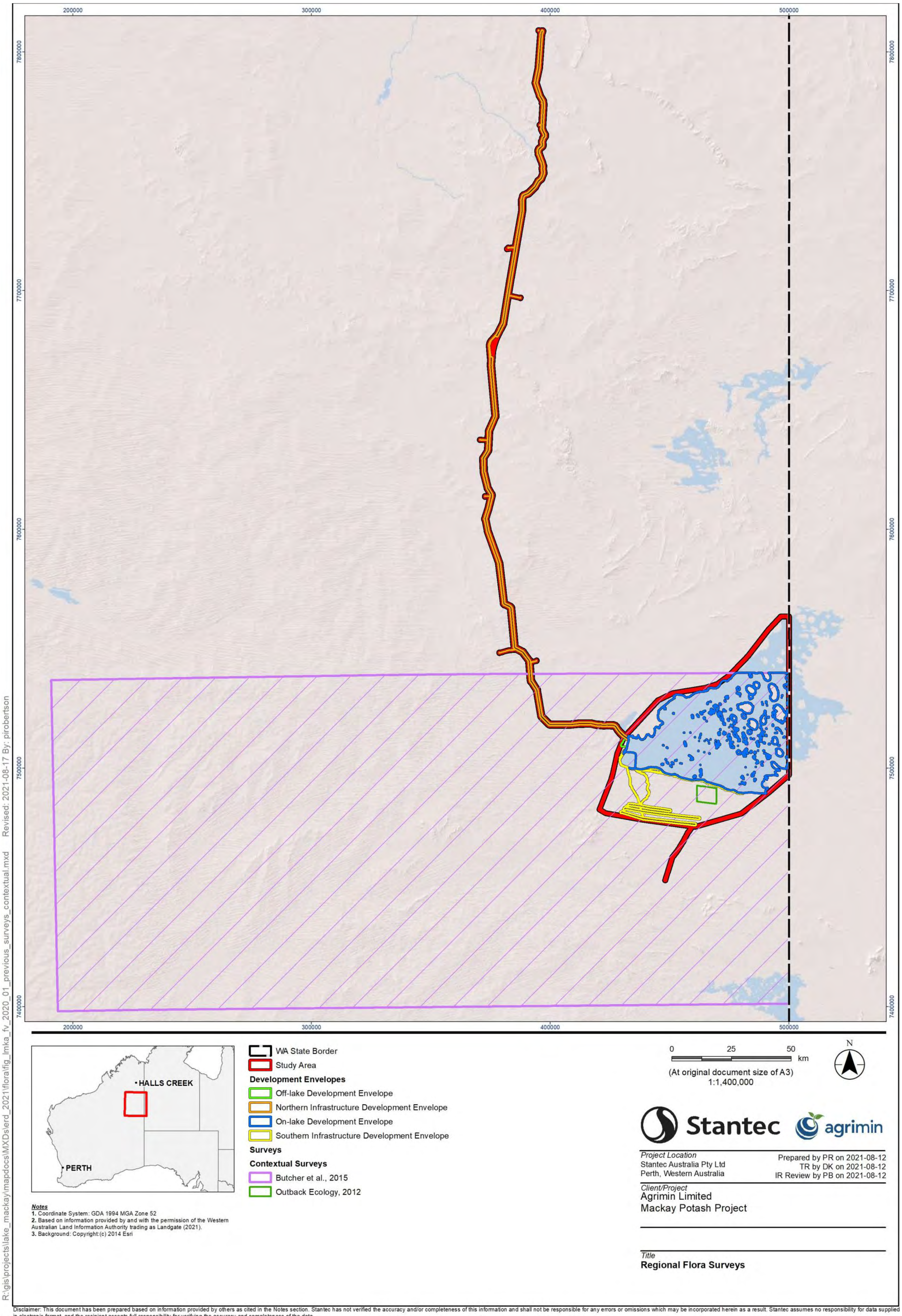

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Figure 6-2: The Study Area, Proposal area and regional flora and vegetation surveys

Table 6-4: Additional flora and vegetation surveys conducted within the Proposal area

Project (Reference)	Study details	Scope	Survey / study effort	Flora and Vegetation recorded	Key findings within the Stantec 2020 Study Area
Bush Blitz: Kiwirrkurra Indigenous Protected Area Western Australia survey (BushBlitz 2015)	• Area: 4,586,700 ha • Study type: Bush Blitz Flora survey/species inventory • Survey Date: 6-18 September 2015 • Seasonal conditions: below average	Flora survey (species inventory (Bush Blitz)	• Vascular flora collections by hand • Specimens were generally pressed in the field to maximise quality • DNA samples were collected from targeted taxa (e.g. *Calandrinia*, *Lawrencia*, *Peplidium*, *Ptilotus*, *Stylidium*, *Tephrosia*; and groups in Asteraceae and Cyperaceae); flowers were placed into ethanol. • By sampling the soil below plants, small seedlots of all available *Tephrosia* taxa were collected for taxonomic research.	Georeferenced species information was limited No vegetation mapping occurred.	Priority flora species: • *Stackhousia* sp. Lake Mackay (P.K. Latz12870) (P1) • *Bergia occultipetala* (P3) • *Goodenia halophila* (P3) • *Goodenia modesta* (P3) • *Rothia indica* subsp. *australis* (P3) • *Stackhousia clementii* (P3)
Theseus Project - Level 1 Flora and Vegetation Assessment (Outback Ecology 2012c)	• Area: 5,366 ha • Study Type: Level 1 flora survey • Survey Date: 8-13 June 2012 • Seasonal conditions: below average	Level 1 flora survey	• 11 relevés (unbounded) covering each vegetation community identified • Nine circular plots of 50 m radius centred on proposed water monitoring and production bores. • Four relevés sampled in comparable vegetation adjacent to drill lines and tracks outside of the Study Area for use of reference areas.	141 taxa including: • 35 families • 82 genera Seven Vegetation Types Vegetation Condition: mostly in excellent condition	Priority flora species: • *Goodenia anfracta* (P1) • *Senna artemisioides* subsp. *alicia* (P3)

6.3.1.2 Survey Limitations

There are a number of potential limitations and constraints that can affect the adequacy of flora and vegetation surveys. Survey limitations and constraints are comprehensively discussed for all surveys within Appendix F, with key limitations and constraints summarised below:

Timing, weather, and season: The Proposal is located in the Great Sandy Desert and Tanami Bioregions where the occurrence and detectability of ephemeral flora species is strongly influenced by climatic conditions, in particular, rainfall events. Surveys for the Proposal have covered multiple years and seasons; however, due to the infrequency of rainfall events, not all surveys were able to be conducted in optimal conditions. Furthermore, the large expanse of the NIDE (approximately 350 km in length) can result in significant differences in rainfall at the northern extent compared to the southern extent.

Overall, seasonal conditions were considered adequate to achieve the aims and objectives of *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016i). Seasonal conditions were considered either average or above average for the majority of the surveys commissioned for the Proposal.

Remoteness / access constraints: The Study area is large (443,985.37 ha), crosses two bioregions and includes a proposed haulage corridor that is approximately 350 km long and 1 km wide. The Study Area is in a remote region of WA, with very few established roads, tracks, and other infrastructure; dunes and thick vegetation slowed the progress of travelling the NIDE. The remoteness of the Proposal area limited access to many portions of the Survey Area and challenging terrain constrained the intensity and completeness of the surveys. For portions of the Proposal area that could not be accessed due to time or logistical constraints, vegetation type and condition mapping was inferred and extrapolated from high-quality aerial imagery, undertaken by experienced senior botanists (360 Environmental 2017a; ecologia Environment 2017b); however, no islands will be directly impacted by the Proposal as all have been excluded from the on-LDE.

The survey intensity is considered adequate to define the flora and vegetation values of the Study Area and survey effort was focused on areas proposed to be impacted.

Adequacy of the survey intensity and proportion of survey achieved: A total of 216 quadrats, 42 relevés and 30 transects were sampled across all surveys within the Study Area. This is considered adequate within the Great Sandy Desert and Tanami Bioregions and to meet the aims and objectives of *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016i).

Due to the size of the Proposal area, extrapolation of the vegetation types was required in areas where there was an absence of quadrat, relevé or mapping note information and/or the local area was not traversed. For most broad regions of the Proposal area, there was adequate information to infer the broad floristic formation and vegetation present. Targeted searches were not possible in all locations considered likely to support significant flora; the populations recorded should be considered indicative rather than comprehensive.

During March 2020, the COVID-19 pandemic escalated, and due to travel and regional movement restrictions, Phase 2 of the Stantec (2020) Survey was reduced. Additionally, above average rainfall in the region causing access constraints delayed the start of the survey by two days.

Burnt vegetation: A large portion of the Proposal area has been subject to repeated fires. This constrained the installation of quadrats in unburnt vegetation and therefore the vegetation type mapping. Some extrapolation was applied when mapping recently burnt areas. Therefore, this mapping should be considered somewhat indicative rather than an exact representation of the climax vegetation type.

6.4 Receiving environment

6.4.1 Climate

The Proposal area has been surveyed, in part, on eight occasions, with a further four surveys of the riparian zone conducted as a component of the Baseline Aquatic Ecology Study. This section provides an overview of these surveys in relation to season and rainfall to inform adequacy of survey work completed within the Study Area as a whole. Table 6-5 lists the dates and seasonal conditions pertaining to each survey. Figure 6-3: presents long term average and recorded rainfall at Walungurru Airport weather station between April 2012 and April 2021.

Table 6-5: Seasonal conditions for each survey conducted within the Study Area

Figure 6-3: Ref.	Project	Survey dates	Seasonal Conditions	
			Season	Rainfall
A	Outback Ecology (2012a) Toro Energy Ltd Theseus Project: Level 1 Flora and Vegetation Assessment	7 – 14 June 2012	Mid-year survey	Average
B	BushBlitz (2015) Vascular Plants Report, Kiwirrkurra Indigenous Protected Area Western Australia	6 – 8 September 2015	Dry season survey	Below average
C	ecologia Environment (2017a) Agrimin Mackay Project: Single Phase Level 2 Flora Assessment	6-13 September 2016	Dry season survey	Above average
D	360 Environmental (2017a) Lake Mackay Sulphate of Potash Project: Detailed Flora and Vegetation Assessment at Lake Mackay	14 – 23 April 2017	Post-wet season survey	Above average
E	Strategen (2018) Lake Mackay Sulphate of Potash Project: Detailed Flora and Vegetation Assessment at Lake Mackay	10 – 15 November 2017	Dry season survey	Average
F	Stantec (2021c) Lake Mackay Potash Project: Phase 1 Detailed Flora and Vegetation Survey and Consolidation	5 – 21 October 2019	Dry season survey	Below average
G	Stantec (2021c) Lake Mackay Potash Project: Phase 2 Detailed Flora and Vegetation Survey and Consolidation	7 – 25 March 2020	Post-wet season survey	Above average in northern half, but below average in the southern half of the Survey Area
H	Stantec (2021c) Lake Mackay Potash Project: Targeted flora survey	21-29 April 2021	Post-wet season survey	Above average
I	Stantec (2021a) Baseline Aquatic Ecology Study Of Lake Mackay And Peripheral Wetlands	Field survey 1 17 – 20 May 2019	Post-wet season survey	Average
		Field survey 2 25 – 28 February 2020	Dry season survey	Below average
		Field survey 3 21 February 2021	Post-wet season survey	Above average
		Field survey 4 28 March- 1 April 2021	Post-wet season survey	Above average

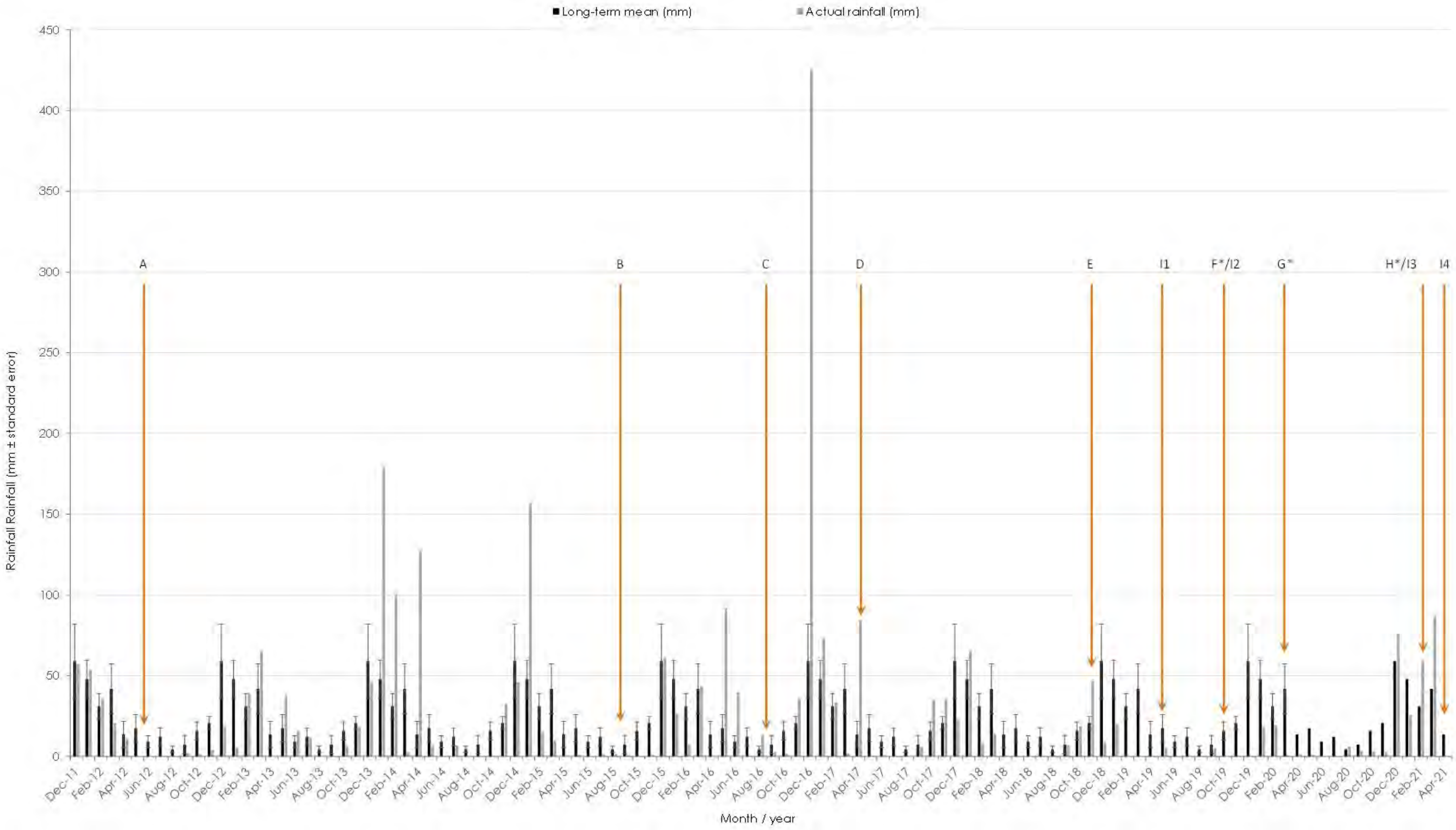

Figure 6-3: Long-term (1998-2021) mean monthly rainfall and actual rainfall (2012-2021) at Walungurru Airport weather station (No. 015664) (BoM 2021c). Arrows indicate survey timing as detailed in Table 6-5, * indicates Stantec survey Trip I1 to I4 represent the four riparian vegetation sampling surveys undertaken as part of the Proposal's *Baseline Aquatic Ecology Study* (Appendix J).

6.4.2 Vegetation

6.4.2.1 Vegetation Types

A total of 50 vegetation types have been recorded within the Study Area, none of which represent a Threatened Ecological Community, Priority Ecological Community, or groundwater-dependent vegetation. Riparian zone vegetation occurs within the Study Area, primarily in association with Lake Mackay and its islands. Chenopod shrublands, dominated by *Tecticornia* spp. fringe the lake, typically between the playa and hummock grassland communities. All 50 of the vegetation types described and delineated in the Study Area occur within the Proposal area. Of these 50 vegetation types, 39 occur in the NIDE, 15 in the SIDE, 11 within the On-LDE and five within the Off-LDE.

The 50 vegetation types were aligned with 14 broad floristic formations, that describe the most dominant genus and its growth form, cover and height within a given mapping polygon. Table 6-6 provides a brief description around characteristics of each of the various vegetation types and their associated broad floristic groups that have been identified in the Study Area, while Table 6-6, Figure 6-4 to Figure 6-7 and depict their locations and extent.

6.4.2.2 Vegetation of Significance

6.4.2.2.1 Vegetation of restricted distribution

Within the central portion of the NIDE, a relatively infrequent landform for the Study Area, supporting an uncommon species assemblage, was recorded. This location featured a representation of vegetation type ±SahDrAcAhhFdAvll (382.92 ha, 0.15% of the Proposal area). Although each of the dominant species comprising this vegetation type are common and widespread across arid regions of WA, the dominance of annual grasses, herbs and succulents (and the absence of *Triodia*) was relatively unique compared to majority of the Study Area. Additionally, a number of highly ephemeral species requiring moist soil were recorded in association with this vegetation type in localised pockets (such as *Marsilea hirsuta*). Within ±SahDrAcAhhFdAvll, a substantial range extension was also recorded (at quadrat NH138); *Euphorbia papillata* var. *laevicaulis*. This portion of the Proposal area was described as a broad clay basin landform, where surface or sub-surface water is retained for longer periods following rainfall events.

Mesa breakaways, gorges and associated gullies and minor drainage lines occur within the NIDE, approximately 10 km south of Balgo. The vegetation type associated with breakaways and gorges, CcdCaDpTiPa, comprises 46.38 ha and represents a small amount of both the Study Area (0.01%), and the Proposal area (0.02%). There were a number of species strongly associated with only these landforms, and several substantial range extensions were recorded in these vegetation types.

6.4.2.2.2 Refuge vegetation

Within the central portion of the Proposal area, and collectively comprising approximately 160 ha of the NIDE, a combination of relatively unique landforms and habitats were noted. This area was characterised by a relatively unique mix of species and substrates which provides important refuge habitat for significant fauna. The features of this area, include:

- occasional Mulga groves (*Acacia aneura* complex) in clay soils generally without *Triodia*;
- *Acacia cuthbertsonii* subsp. *cuthbertsonii* open shrublands with considerable amount of bare ground that would be temporarily waterlogged after significant rainfall events; and
- broad gravelly plains supporting large, mature unburnt spinifex hummock grasslands (generally dominated by *Triodia basedowii*).

A soak landform occurs immediately to the west of the NIDE at this location. Following rainfall events, water from the surrounding elevated area collects in the low-lying clay soils and is retained for longer periods. Subsequently, high species diversity was noted with a rich array of herbs and annual grasses.

6.4.2.2.3 Vegetation supporting Priority Flora

A total of 19 vegetation types support Priority flora within the Proposal area and are therefore considered to be locally significant (Table 6-7). Of the 19, two support Priority 1 species and both are highly associated with the margins of Lake Mackay and dominated by chenopods including a number of *Tecticornia* species. However, given the broad vegetation type mapping and extrapolation required in relation to the extent of the significant flora, it is likely that the full extent of each of the 19 vegetation types are not locally significant. The vegetation types considered to be of highest local significance include:

- TsppEf –*Stackhousia* sp. Lake Mackay (P.K. Latz 12870) (P1) was recorded on the saline margins of Lake Mackay. This vegetation type typically represented riparian vegetation at the interface between the playa and terrestrial vegetation types , and dominated by a suite of *Tecticornia* spp.
- MlGcSdFcTspp(TsaTp) – a vegetation type supporting riparian flora and mapped in close proximity to the margins of Lake Mackay, and on most islands. This vegetation type is dominated by a number of halophilic species, including *Stackhousia* sp. Lake Mackay (P.K. Latz 12870) (P1), *Eragrostis lanicaulis* (P3) and *Stackhousia clementii* (P3), and also supported a suite of *Tecticornia* spp.

Figure 6-4 to Figure 6-7 show the locations of recorded significant flora within their respective vegetation types.

Table 6-6: Summary of vegetation types

Broad Floristic Formation	Vegetation Type Code	Vegetation Type Description and Associated Species	Vegetation Condition	Extent in Study Area		Extent in Proposal Area		Extent in Indicative Footprint	
				(ha)	(%)	(ha)	(%)	(ha)	(%)
Triodia hummock grassland	EgEp(Co)AsppTb	*Eucalyptus pachyphylla* and/or *Eucalyptus gamophylla* (± *Corymbia opaca*) low open woodland over mixed *Acacia (Acacia adsurgens, Acacia elachantha, Acacia ancistrocarpa, Acacia ligulata*) over *Triodia basedowii* hummock grassland. Associated species: *Acacia cuthbertsonii, Acacia inaequilatera, Acacia tenuissima, Triodia salina* and *Triodia schinzii.*	Excellent	63,076.43	14.21	8,253.63	13.09	143.47	0.23
Triodia open hummock grassland	AstipGwaAancTbTe	*Acacia stipuligera*, *Grevillea wickhamii* subsp. *aprica* and *Acacia ancistrocarpa* tall open shrubland over *Triodia basedowii* (*Triodia epactia*) open hummock grassland. Associated species: *Acacia adsurgens, Acacia adoxa var. adoxa, Acacia elachantha, Acacia maitlandii, Acacia monticola, Corymbia candida subsp. ?dipsodes, Dampiera candicans, Dicrastylis doranii, Eucalyptus gamophylla, Eucalyptus pachyphylla, Gompholobium simplicifolium, Hakea macrocarpa* and *Triodia schinzii.*	Excellent	4,576.04	1.03	4,576.04	100.00	132.30	2.89
Triodia open hummock grassland	AhAaaTbTs	*Acacia hilliana* and *Acacia adoxa* var. *adoxa* low open shrubland over *Triodia basedowii* and *Triodia schinzii* open hummock grassland. Associated species: *Aristida holathera* var. *holathera, Calytrix carinata, Dampiera candicans, Fimbristylis oxystachya, Grevillea wickhamii* subsp. *aprica, Halgania solanacea* var. *solanacea, Hybanthus aurantiacus, Mirbelia viminalis, Ptilotus astrolasius* and *Triodia spicata.*	Very Good to Excellent	2,083.11	0.47	2,081.61	99.93	73.65	3.54
Triodia open hummock grassland	EpGwaAancTp	*Eucalyptus pachyphylla* scattered mallee over *Grevillea wickhamii* subsp. *aprica* and *Acacia ancistrocarpa* scattered tall shrubs over *Triodia pungens* open hummock grassland. Associated species: *Acacia elachantha, Acacia sericophylla, Dicrastylis doranii* and *Hakea lorea* subsp. *lorea.*	Excellent to Very Good	2,830.39	0.64	2,204.46	77.89	72.16	2.55
Triodia open hummock grassland	AdAlALMTs	*Allocasuarina decaisneana* open woodland over *Acacia ligulata* and *Acacia* sp. Lake Mackay (P.K. Latz 12836) open shrubland over *Triodia schinzii* open hummock grassland. Associated species: *Aristida holathera* var. *holathera, Dicrastylis doranii, Grevillea stenobotrya* and *Scaevola parvifolia* subsp. *parvifolia.*	Excellent	941.66	0.21	331.48	35.20	69.94	7.43
Triodia hummock grassland	AstipHmTe	*Acacia stipuligera* and/or *Hakea macrocarpa* tall open shrubland over *Triodia epactia* open hummock grassland. Associated species: *Acacia adsurgens, Acacia ancistrocarpa, Acacia melleodora, Acacia tenuissima, Aristida holathera var. holathera, Corymbia* sp., *Eucalyptus pachyphylla, Eragrostis eriopoda* and *Fimbristylis oxystachya.*	Excellent	2,319.05	0.52	2,262.76	97.57	65.84	2.84
Triodia open hummock grassland	GsAlALMMlNcTp	*Grevillea stenobotrya, Acacia ligulata, Acacia* sp. Lake Mackay (P.K. Latz 12836) tall open shrubland over *Melaleuca lasiandra* open shrubland over *Newcastelia cladotricha* low open shrubland over *Triodia pungens* open hummock grassland. Associated species: *Chrysocephalum eremaeum, Frankenia cordata, Pterocaulon sphacelatum* and *Stylobasium spathulatum.*	Excellent	6,413.68	1.44	404.61	6.31	62.94	0.98
Triodia hummock grassland	AancTb	*Acacia ?ancistrocarpa* tall shrubland over *Triodia basedowii* hummock grassland. Associated species: *Acacia eriopoda, Acacia hilliana, Stylobasium spathulatum, Triodia epactia and Hakea chordophylla.*	Excellent	2,122.25	0.48	2,015.24	94.96	62.92	2.96
Triodia open hummock grassland	AstipTsTe	*Acacia stipuligera* tall open shrubland over *Triodia schinzii* and/or *Triodia epactia* open hummock grassland. Associated species: *Acacia sericophylla, Comesperma sabulosum, Dicrastylis doranii, Dicrastylis exsuccosa, Eragrostis eriopoda, Jacksonia aculeata, Melaleuca lasiandra, Petalostylis cassioides, Triodia pungens* and *Yakirra australiensis* var. *australiensis.*	Excellent to Very Good (1.2 ha was mapped Poor)	2,176.92	0.49	2176.92	100.00	61.25	2.81
Triodia hummock grassland	(+/-Ev)EgAad(Sao)Tb	*Eucalyptus victrix* low open woodland and/or *Eucalyptus gamophylla* mallee over *Acacia adsurgens* and/or *Senna artemisioides* subsp. *oligophylla* open shrubland over *Triodia ?basedowii* and *Triodia pungens* hummock grassland. Associated species: *Acacia ?ligulata, Bonamia erecta, Indigofera ?georgei, Seringia elliptica* and *Stylobasium spathulatum.*	Excellent	2,104.25	0.47	2,104.25	100.00	57.31	2.72
Triodia hummock grassland	HmAeTp	*Hakea macrocarpa* and *Acacia eriopoda* tall open shrubland over *Triodia pungens* hummock grassland. Associated species: *Acacia melleodora, Acacia stipuligera, Aristida holathera* var. *holathera. Cassytha capillaris, Dicrastylis doranii* and *Scaevola parvifolia* subsp. *parvifolia.*	Excellent	1,818.27	0.41	1,808.83	99.48	54.98	3.02

Broad Floristic Formation	Vegetation Type Code	Vegetation Type Description and Associated Species	Vegetation Condition	Extent in Study Area		Extent in Proposal Area		Extent in Indicative Footprint	
				(ha)	(%)	(ha)	(%)	(ha)	(%)
Triodia hummock grassland	AhTbTe	*Acacia hilliana* low open shrubland over *Triodia basedowii* and *Triodia epactia* hummock grassland. <u>Associated species:</u> *Acacia monticola, Aristida holathera* var. *holathera, Calytrix carinata, Eriachne aristidea, Eucalyptus pachyphylla, Fimbristylis oxystachya, Grevillea wickhamii* subsp. *aprica, Senna notabilis* and *Sida Arenicola.*	Excellent	1,601.37	0.36	1,600.25	99.93	46.95	2.93
Triodia hummock grassland	EpAstipGwaCcarTb	*Eucalyptus pachyphylla* scattered mallee over *Acacia stipuligera* and *Grevillea wickhamii* subsp. *aprica* tall open shrubland over *Calytrix carinata* low scattered shrubs over *Triodia basedowii* hummock grassland. <u>Associated species:</u> *Acacia ancistrocarpa, Dicrastylis doranii* and *Grevillea eriostachya.*	Excellent	1,416.25	0.32	1,409.59	99.53	43.28	3.06
Triodia hummock grassland	HdSeTsTsp.	*Hakea divaricata* scattered tall shrubs over *Seringia elliptica* scattered low shrubs over *Triodia schinzii* (*Triodia* sp.) hummock grassland. <u>Associated species:</u> *Acacia ligulata, Androcalva ?loxophylla, Bonamia erecta, Carissa lanceolata, Indigofera ?georgei, Leptosema chambersii, Petalostylis cassioides, Stylobasium spathulatum* and *Triodia ?basedowii.*	Excellent to Very Good	4,423.51	1.00	1,308.24	29.57	39.26	0.89
Triodia hummock grassland	(Ep)AvAancAblSaoTpTe	*Eucalyptus pachyphylla* scattered mallee over *Acacia victoriae* and *Acacia ancistrocarpa* open shrubland over *Acacia bivenosa* x *?ligulata* and *Senna artemisioides* subsp. oligophylla low scattered shrubs over *Triodia pungens* and *Triodia epactia* hummock grassland. <u>Associated species:</u> *Acacia elachantha, Acacia sericophylla, Aristida holathera* var. *holathera, Atalaya hemiglauca, Arivela viscosa, Corymbia chippendalei, Grevillea wickhamii subsp. aprica, Hakea macrocarpa, Indigofera monophylla, Senna artemisioides* subsp. *helmsii, Tephrosia rosea* s.lat (small cuneate leaflet form), *Tephrosia* sp. Northern (K.F. Kenneally 11950), and *Triodia brizoides.*	Excellent	1,468.82	0.33	1,464.45	99.70	39.22	2.67
Triodia hummock grassland	(Eg)AlALMTb(Ts)	(± *Eucalyptus gamophylla*) *Acacia ligulata* and *Acacia* sp. Lake Mackay (P.K. Latz 12836) open shrubland over *Triodia basedowii* (*Triodia schinzii*) hummock grassland. <u>Associated species:</u> *Stylobasium spathulatum, Trianthema pilosa, Triodia salina and Triodia pungens.*	Excellent	2,233.67	0.50	428.27	19.17	33.08	1.48
Triodia open hummock grassland	EoAacTeTsTp	*Eucalyptus odontocarpa* scattered mallee over *Acacia acradenia* tall open shrubland over *Triodia epactia*, *Triodia schinzii* and/or *Triodia pungens* open hummock grassland. <u>Associated species:</u> *Acacia elachantha, Acacia sericophylla, Dicrastylis exsuccosa, Fimbristylis oxystachya, Grevillea wickhamii* subsp. *aprica, Halgania solanacea* var. *solanacea, Jacksonia aculeata, Melaleuca lasiandra, Mirbelia ?ramulosa, Tribulopis angustifolia* and *Yakirra australiensis* var. *?australiensis.*	Excellent to Good	1,132.87	0.26	1,132.81	100.00	27.94	2.47
Triodia open hummock grassland	EpEgAblAancTbTe	*Eucalyptus pachyphylla* and *Eucalyptus gamophylla* very open mallee over *Acacia bivenosa* x *?ligulata* and *Acacia ancistrocarpa* scattered shrubs over *Triodia basedowii* and/or *Triodia epactia* open hummock grassland. <u>Associated species:</u> *Acacia hilliana, Acacia tenuissima, Acacia stipuligera, Bonamia erecta, Hakea chordophylla* and *Triodia brizoides.*	Excellent	1,009.37	0.23	1,009.37	100.00	27.15	2.69
Triodia open hummock grassland	AadAeAancTbTs	*Acacia adsurgens, Acacia elachantha* and/or *Acacia ancistrocarpa*) open shrubland over *Triodia basedowii* and/or *Triodia schinzii* open hummock grassland. <u>Associated species:</u> *Acacia ligulata, Carissa lanceolata, Eucalyptus gamophylla, Senna notabilis* and *Senna artemisioides.*	Excellent	5,804.73	1.31	360.15	6.20	21.76	0.37
Maireana/ *Tecticornia* low shrubland	MlGcSdFcTspp(TsaTp)	*Maireana luehmannii, Goodenia collaris, Surreya diandra, Frankenia cordata, Tecticornia calyptrata* and *Tecticornia indica* subsp. *leiostachya* low shrubland over *Triodia salina* (*Triodia pungens* on islands) very open hummock grassland. <u>Associated species:</u> *Aristida holathera* var. *holathera, Eragrostis falcata, Lawrencia viridigrisea* and *Sclerolaena crenata.*	Excellent	7,673.33	1.73	678.34	8.84	21.68	0.28
Triodia hummock grassland	Ad(Eg)TpTb	*Allocasuarina decaisneana (± E. gamophylla)* low open woodland over *Triodia basedowii* and/or *Triodia pungens* hummock grassland. <u>Associated species:</u> *Acacia adsurgens, Melaleuca lasiandra, Stylobasium spathulatum,* and *Triodia schinzii.*	Excellent	12,625.80	2.84	472.43	3.74	18.81	0.15
Triodia open hummock grassland	CspGplAancTe	*Corymbia* sp. scattered mallees over *Grevillea pyramidalis* subsp. *leucadendron* tall open shrubland over *Acacia ancistrocarpa* scattered shrubs over *Triodia epactia* open hummock grassland. <u>Associated species:</u> *Acacia acradenia, Acacia adoxa* var. *adoxa, Acacia bivenosa x?ligulata, Aristida holathera var. holathera, Arivela viscosa, Dicrastylis exsuccosa, Dolichandrone occidentalis, Eragrostis eriopoda, Eriachne obtusa, Fimbristylis dichotoma, Grevillea wickhamii* subsp. *aprica,*	Excellent	633.07	0.14	633.07	100.00	17.42	2.75

Broad Floristic Formation	Vegetation Type Code	Vegetation Type Description and Associated Species	Vegetation Condition	Extent in Study Area		Extent in Proposal Area		Extent in Indicative Footprint	
				(ha)	(%)	(ha)	(%)	(ha)	(%)
		Indigofera monophylla, *Tribulopis angustifolia*, *Trigastrotheca molluginea* and *Yakirra australiensis* var. *?australiensis*.							
Aristida open tussock grassland	±SahDrAcAhhFdAvll	(±*Senna artemisioides* subsp. *helmsii* low scattered shrubs) *Dactyloctenium radulans*, *Aristida contorta* and/or *Aristida holathera* var. *holathera* open tussock grassland with *Fimbristylis dichotoma* scattered sedges and *Arivela viscosa* and *Indigofera linifolia* scattered herbs. Associated species: *Abutilon otocarpum*, , *Eragrostis eriopoda*, *Eragrostis xerophila*, *Evolvulus alsinoides* var. *villosicalyx*, *Marsilea hirsuta*, *Ptilotus exaltatus*, *Ptilotus xerophilus*, *Tephrosia* sp. Northern (K.F. Kenneally 11950), and *Tribulus hirsutus*.	Excellent to Very Good	382.92	0.09	382.92	100.00	16.80	4.39
Corymbia low open woodland	CcGsNsDdTpilTs	*Corymbia chippendalei* low open woodland over *Grevillea stenobotrya* scattered shrubs over *Newcastelia spodiotricha* and *Dicrastylis doranii* low open shrubland over *Trianthema pilosum* low scattered shrubs over *Triodia schinzii* very open hummock grassland. Associated species: *Acacia melleodora*, *Aristida holathera var. holathera*, *Eragrostis eriopoda*, *Paractaenum refractum*, *Thinicola incana* and *Triodia epactia*.	Excellent	563.46	0.13	562.26	99.79	15.59	2.77
Triodia open hummock grassland	CddEpAelAancTb	*Corymbia deserticola* subsp. *deserticola* scattered low trees and/or *Eucalyptus pachyphylla* very open mallee over *Acacia elachantha* tall open shrubland over *Acacia ancistrocarpa* scattered shrubs over *Triodia basedowii* open hummock grassland. Associated species: *Acacia eriopoda*, *Acacia hilliana*, *Acacia sericophylla*, *Grevillea wickhamii* subsp. *aprica*, *Hakea lorea* subsp. *lorea*, *Stylobasium spathulatum* and *Triodia pungens*.	Excellent	545.77	0.12	545.77	100.00	15.26	2.80
Triodia hummock grassland	AlTp	*Acacia ligulata* tall shrubland over *Triodia pungens* hummock grassland. Associated species: *Acacia trachycarpa*, *Eucalyptus gamophylla* and *Grevillea stenobotrya*.	Excellent	377.95	0.09	377.95	100.00	14.46	3.83
Triodia hummock grassland	AlMgTb(TpTs)	*Acacia ligulata* and *Melaleuca glomerata* scattered low shrubs over *Triodia basedowii* (± *Triodia pungens*, or *Triodia schinzii*) hummock grassland. Associated species: *Corchorus sidoides*, *Heliotropium glanduliferum* and *Ptilotus obovatus*.	Excellent	5,885.48	1.33	340.64	5.79	13.87	0.24
Triodia hummock grassland	CcdTeTb(Tp)	*Corymbia candida* subsp. *?dipsodes* low open woodland over *Triodia epactia*, *Triodia basedowii* and/or *Triodia ?pungens* hummock grassland. Associated species: *Acacia adsurgens*, *Eucalyptus pachyphylla* and *Mirbelia viminalis*.	Excellent	393.58	0.09	393.58	100.00	12.17	3.09
Frankenia / *Tecticornia* low open shrubland	FcTsppEf(TsaTs)	*Frankenia cordata* and *Tecticornia* spp. low open shrubland over *Eragrostis falcata* scattered tussock grasses and/or *Triodia salina* and *Triodia schinzii* very open hummock grassland. Associated species: *Aristida holathera* var. *holathera*, *Calocephalus platycephalus*, *Fimbristylis dichotoma*, *Melaleuca glomerata*, *Osteocarpum salsuginosum* and *Sclerolaena crenata*.	Excellent	6,090.96	1.37	146.99	2.41	11.20	0.18
Triodia open hummock grassland	CcAstipTeAhh	*Corymbia chippendalei* scattered low trees over *Acacia stipuligera* scattered tall shrubs over *Triodia epactia* open hummock grassland with *Aristida holathera* var. *holathera* scattered tussock grasses. Associated species: *Acacia acradenia*, *Acacia ?sericophylla*, *Dicrastylis doranii*, *Eriachne obtusa* , *Hakea lorea*, *Indigofera monophylla* and *Yakirra australiensis* var. *?intermedia*.	Excellent to Very Good	391.77	0.09	391.77	100.00	11.20	2.86
Triodia open hummock grassland	CcAlALMAmNsDdTsTp	*Corymbia chippendalei* low open woodland over *Acacia* (*Acacia ligulata*, *Acacia* sp. Lake Mackay (P.K. Latz 12836) or *Acacia melleodora*) open shrubland over *Newcastelia spodiotricha* and *Dicrastylis doranii* low open shrubland over *Triodia schinzii* and/or *Triodia pungens* open hummock grassland. Associated species: *Aristida holathera* var. *holathera*, *Crotalaria cunninghamii* and *Eriachne aristidea*.	Excellent	16,060.89	3.62	1695.98	10.56	10.78	0.07
Triodia open hummock grassland	(Eb)AacTi	(±*Eucalyptus brevifolia* scattered mallee) *Acacia acradenia* open shrubland over *Triodia intermedia* open hummock grassland. Associated species: *Acacia adoxa* var. *adoxa*, *Acacia elachantha*, *Acacia eriopoda*, *Acacia tenuissima*, *Acacia hilliana*, *Dodonaea coriacea*, *Enneapogon polyphyllus*, *Grevillea wickhamii* subsp. *aprica*, *Ptilotus astrolasius* and *Ptilotus calostachyus*.	Excellent	785.60	0.18	785.60	100.00	10.11	1.29
Triodia open hummock grassland	AlSaoTbTp	*Acacia ligulata* and *Senna artemisioides* subsp. *oligophylla* open shrubland over *Triodia basedowii* and/or *Triodia pungens* open hummock grassland. Associated species: *Eucalyptus pachyphylla*, *Ptilotus obovatus*, *Senna artemisioides* subsp. *helmsii* and *Streptoglossa macrocephala*.	Excellent	208.91	0.05	208.91	100.00	9.25	4.43
Triodia open hummock grassland	AccSaoTp	*Acacia cuthbertsonii* subsp. *cuthbertsonii* high open shrubland over *Senna artemisioides* subsp. *oligophylla* scattered shrubs over *Triodia pungens* open hummock grassland.	Excellent	378.43	0.09	315.01	83.24	9.11	2.41

Broad Floristic Formation	Vegetation Type Code	Vegetation Type Description and Associated Species	Vegetation Condition	Extent in Study Area		Extent in Proposal Area		Extent in Indicative Footprint	
				(ha)	(%)	(ha)	(%)	(ha)	(%)
		<u>Associated species:</u> *Aristida contorta, Arivela viscosa, Enneapogon polyphyllus, Eragrostis xerophila* and *Eucalyptus victrix.*							
Acacia open woodland	AaAccSao	*Acacia ?aneura* low open woodland over *Acacia cuthbertsonii* subsp. *cuthbertsonii* and *Senna artemisioides* subsp. *oligophylla* open shrubland. <u>Associated species:</u> *Capparis umbonata, Enteropogon ramosus, Eragrostis xerophila, Ptilotus obovatus* and *Triodia* sp.	Excellent	273.81	0.06	240.94	88.00	8.84	3.23
Triodia hummock grassland	AeDdTeAhh	*Acacia eriopoda* scattered tall shrubs over *Dicrastylis doranii* scattered low shrubs over *Triodia epactia* hummock grassland with *Aristida holathera* var. *holathera* scattered tussock grasses. <u>Associated species:</u> *Acacia melleodora, Calytrix carinata, Cassytha capillaris, Eragrostis eriopoda, Fimbristylis oxystachya, Grevillea stenobotrya* and *Paraneurachne muelleri.*	Excellent	329.65	0.07	329.65	100.00	7.88	2.39
Triodia hummock grassland	MgTbTsaTs	*Melaleuca glomerata* open shrubland over *Triodia basedowii, Triodia salina,* and/or *Triodia schinzii* hummock grassland. <u>Associated species:</u> *Aristida holathera, Dicrastylis doranii, Eriachne aristidea, Eragrostis falcata* and *Senna artemisioides* subsp. *oligophylla.*	Excellent	5,833.57	1.31	153.74	2.64	5.64	0.10
Grevillea tall shrubland	GsAtAlNsTsTp	*Grevillea stenobotrya* tall shrubland over *Acacia trachycarpa* and *Acacia ligulata* shrubland over *Newcastelia spodiotricha* low open shrubland over *Triodia ?schinzii* and/or *Triodia pungens* very open hummock grassland. <u>Associated species:</u> *Aristida holathera* var *holathera, Acacia ?melleodora, Corymbia ?chippendalei, Eucalyptus gamophylla* and *Stylobasium spathulatum.*	Very Good	458.73	0.10	458.73	100.00	4.60	1.00
Corymbia low open woodland	CcDdTpAhh	*Corymbia chippendalei* low open woodland over *Dicrastylis doranii* low scattered shrubs over *Triodia pungens* open hummock grassland with *Aristida holathera* var. *holathera* scattered tussock grasses. <u>Associated species:</u> *Acacia eriopoda, Acacia melleodora, Eremophila forrestii* subsp. *?forrestii, Grevillea stenobotrya, Hakea macrocarpa, Melaleuca lasiandra, Newcastelia spodiotricha* and *Setaria surgens.*	Excellent	119.54	0.03	118.59	99.20	3.09	2.59
Triodia hummock grassland	EvAvSaoTlTe	*Eucalyptus victrix* low open woodland over *Acacia ?victoriae* and *Senna artemisioides* subsp. *oligophylla* open shrubland over *Triodia longiceps* and/or *Triodia epactia* open hummock grassland. <u>Associated species:</u> *Atalaya hemiglauca, Acacia adsurgens, Acacia cuthbertsonii subsp. cuthbertsonii, Aristida holathera* var. *holathera, Arivela viscosa, Eragrostis lanicaulis* and *Evolvulus alsinoides* var. *villosicalyx.*	Excellent to Very Good	81.81	0.02	81.81	100.00	2.05	2.50
Corymbia low woodland	CoTe	*Corymbia opaca* low woodland over *Triodia epactia* open hummock grassland. <u>Associated species:</u> *Acacia melleodora, Androcalva loxophylla, Clerodendrum floribundum* var. *coriaceum, Corchorus sidoides* subsp. *vermicularis, Hakea lorea* subsp. *lorea, Hakea macrocarpa, Polycarpaea corymbosa, Sida* ?sp. Rabbit Flat (B.J. Carter 626), *Sida* ?sp. Western Sand Dunes (P.K. Latz 11980), *Solanum diversiflorum and Trichodesma zeylanicum* var. *zeylanicum.*	Excellent	36.99	0.01	36.99	100.00	0.85	2.30
Triodia hummock grassland	EvTb(TsaTs)	*Eucalyptus victrix* low open woodland over *Triodia basedowii* (±*Triodia salina* or *Triodia schinzii*) hummock grassland. <u>Associated species:</u> *Carissa lanceolata, Melaleuca glomerata* and *Pluchea ferdinandi-muelleri*	Excellent	544.14	0.12	28.19	5.18	0.84	0.15
Tecticornia low open shrubland	TsppEf	*Tecticornia* spp. low open shrubland over *Eragrostis falcata* scattered tussock grasses. <u>Associated species:</u> *Frankenia cordata, Maireana luehmannii, Lawrencia viridigrisea* and *Surreya diandra.*	Excellent	7,871.48	1.77	698.04	8.87	0.25	0.00
Senna low open shrubland	SaoFcTsa(Tb)	*Senna artemisioides* subsp. *oligophylla* and *Frankenia cordata* low open shrubland over *Triodia* (*Triodia basedowii* or *Triodia salina*) very open hummock grassland. <u>Associated species:</u> *Acacia ligulata, Aristida holathera, Euphorbia tannensis* subsp. *eremophila, Scaevola spinescens* and *Sclerolaena crenata.*	Excellent	5,972.17	1.35	70.51	1.18	0.20	0.00
Corymbia low woodland	CcdCaDpTiPa	*Corymbia candida* subsp. *dipsodes* and/or *Corymbia aspera* low woodland over *Dodonaea polyzyga* tall open shrubland over *Triodia intermedia* scattered hummock grasses and *Pseudochaetochloa australiensis* very open tussock grassland. <u>Associated species:</u> *Acacia monticola, Amaranthus undulatus, Boerhavia coccinea, Arivela viscosa, Cymbopogon obtectus* and *Eriachne mucronata.*	Excellent	46.38	0.01	46.38	100.00	0.09	0.20
Acacia low woodland	AaptAparSaoAhh	*Acacia aptaneura* and/or *Acacia paraneura* low woodland over *Senna artemisioides* subsp. *oligophylla* low open shrubland over *Aristida. holathera* var. *holathera* very open tussock grassland.	Very Good to Excellent	195.84	0.04	0.00	0.00	0.00	0.00

Broad Floristic Formation	Vegetation Type Code	Vegetation Type Description and Associated Species	Vegetation Condition	Extent in Study Area		Extent in Proposal Area		Extent in Indicative Footprint	
				(ha)	(%)	(ha)	(%)	(ha)	(%)
		Associated species: *Aristida contorta*, *Carissa lanceolata*, *Enchylaena tomentosa*, *Eucalyptus victrix*, *Rhagodia eremaea* and *Sida fibulifera*.							
Acacia open shrubland	ALMNsTp	*Acacia* sp. Lake Mackay (P.K. Latz 12836) open shrubland over *Newcastelia spodiotricha* low open shrubland over *Triodia pungens* hummock grassland. Associated species: *Anthobolus leptomerioides, Aristida holathera* var. *holathera, Corynotheca micrantha, Grevillea stenobotrya, Leiocarpa semicalva, Paractaenum refractum, Ptilotus latifolius, Ptilotus polystachyus Sida* sp. sand dunes (A.A. Mitchell PRP1208), *Stylobasium spathulatum* and *Triumfetta winneckeana.*	Excellent	2,626.07	0.59	20.18	0.77	0.00	0.00
Chrysopogon open tussock grassland	EssDpAsyCencCfAv	*Ehretia saligna* var. *saligna* and/or *Dodonaea polyzyga* tall open shrubland over *Chrysopogon fallax* and **Cenchrus ciliaris* open tussock grassland with *Arivela viscosa* open herbland. Associated species: *Abutilon hannii, Acacia ?synchronicia, Amaranthus induratus, Atalaya hemiglauca, Boerhavia coccinea, Crotalaria medicaginea* var. *neglecta, Evolvulus alsinoides* var. *villosicalyx, Indigofera colutea* and *Triodia intermedia.*	Good to Very Good	6.95	<0.01	6.95	100.00	0.00	0.00
Triodia hummock grassland	MgAl(Fc)TpEf	*Melaleuca glomerata* and/or *Acacia ligulata* open shrubland (± *Frankenia cordata)* over *Triodia pungens* hummock grassland with *Eragrostis falcata* scattered tussock grasses. Associated species: *Aristida holathera* var. *holathera, Arivela viscosa* and *Euphorbia tannensis* subsp. *eremophila.*	Excellent	13,433.11	3.03	86.83	0.65	0.00	0.00
Triodia open hummock grassland	SggTbr	*Senna glutinosa* subsp. *glutinosa* scattered shrubs over *Triodia brizoides* open hummock grassland. Associated species: *Acacia ?ancistrocarpa*, *Indigofera monophylla* and *Tephrosia* sp. Northern (K.F. Kenneally 11950).	Excellent	27.21	0.01	27.21	100.00	0.00	0.00

Note: ± denotes intermittent dominance of species across the overall vegetation type.

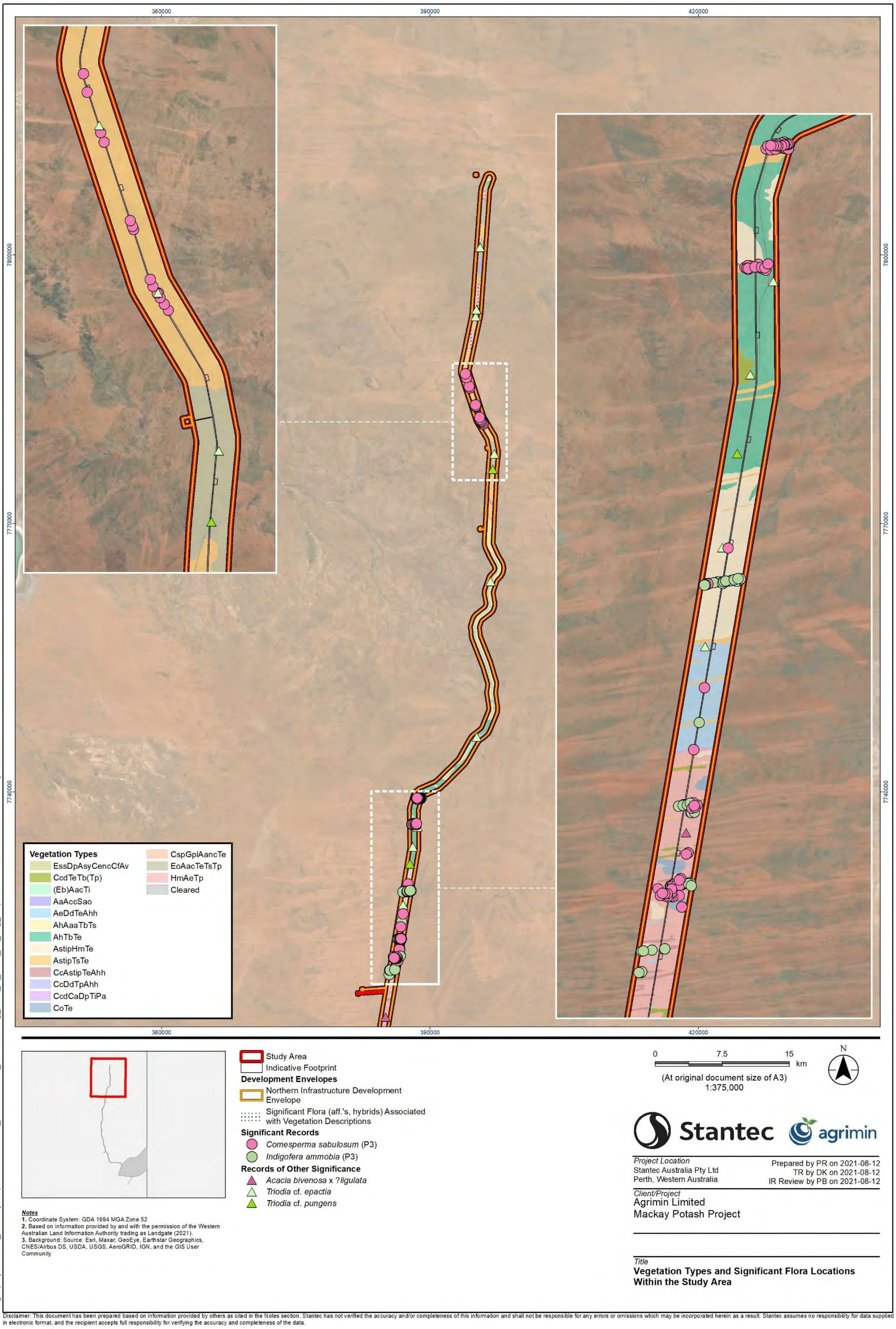

Figure 6-4: Vegetation types and significant flora within the Proposal area (NIDE - north)

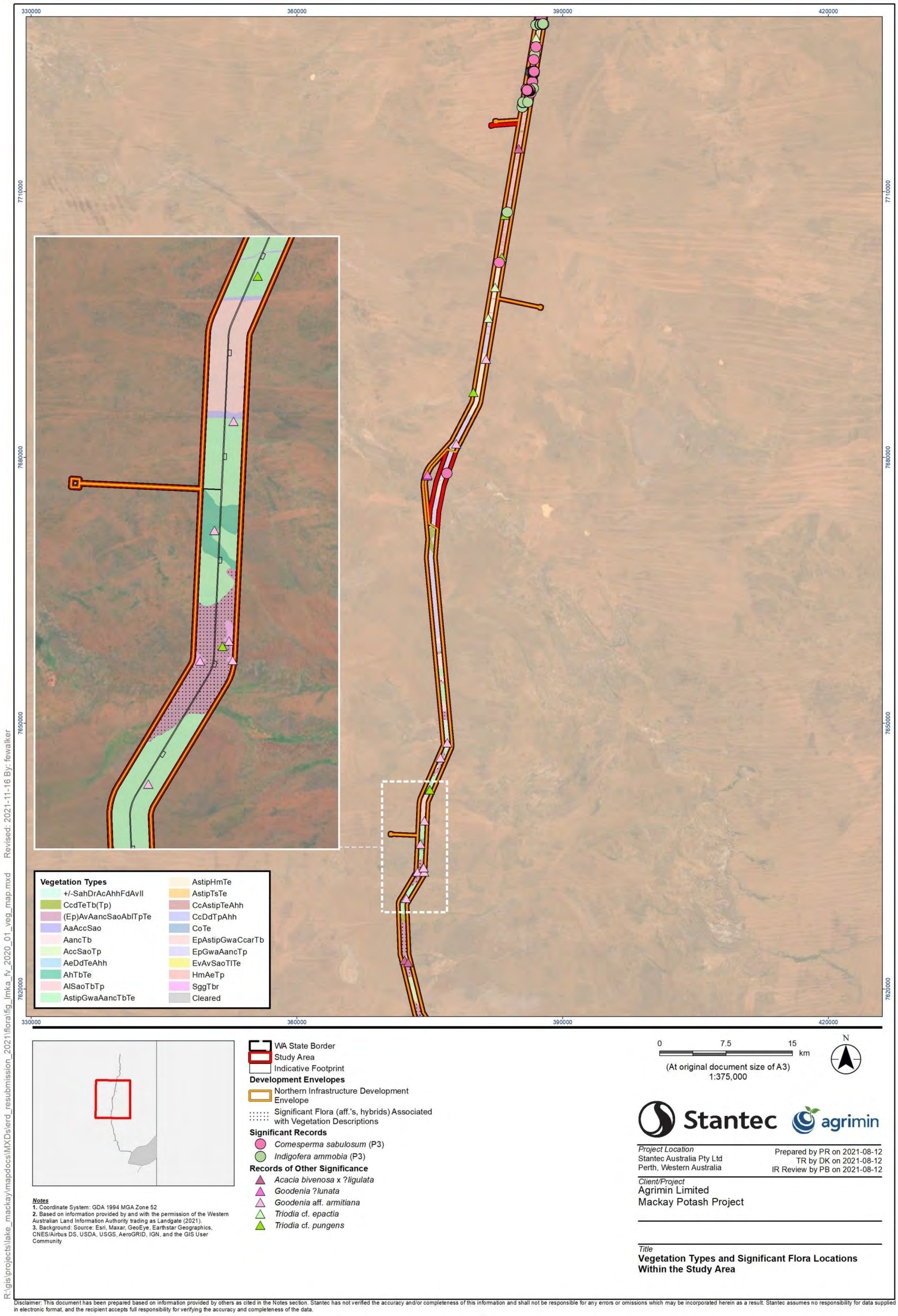

Figure 6-5: Vegetation types and significant flora within the Proposal area (NIDE - centre)

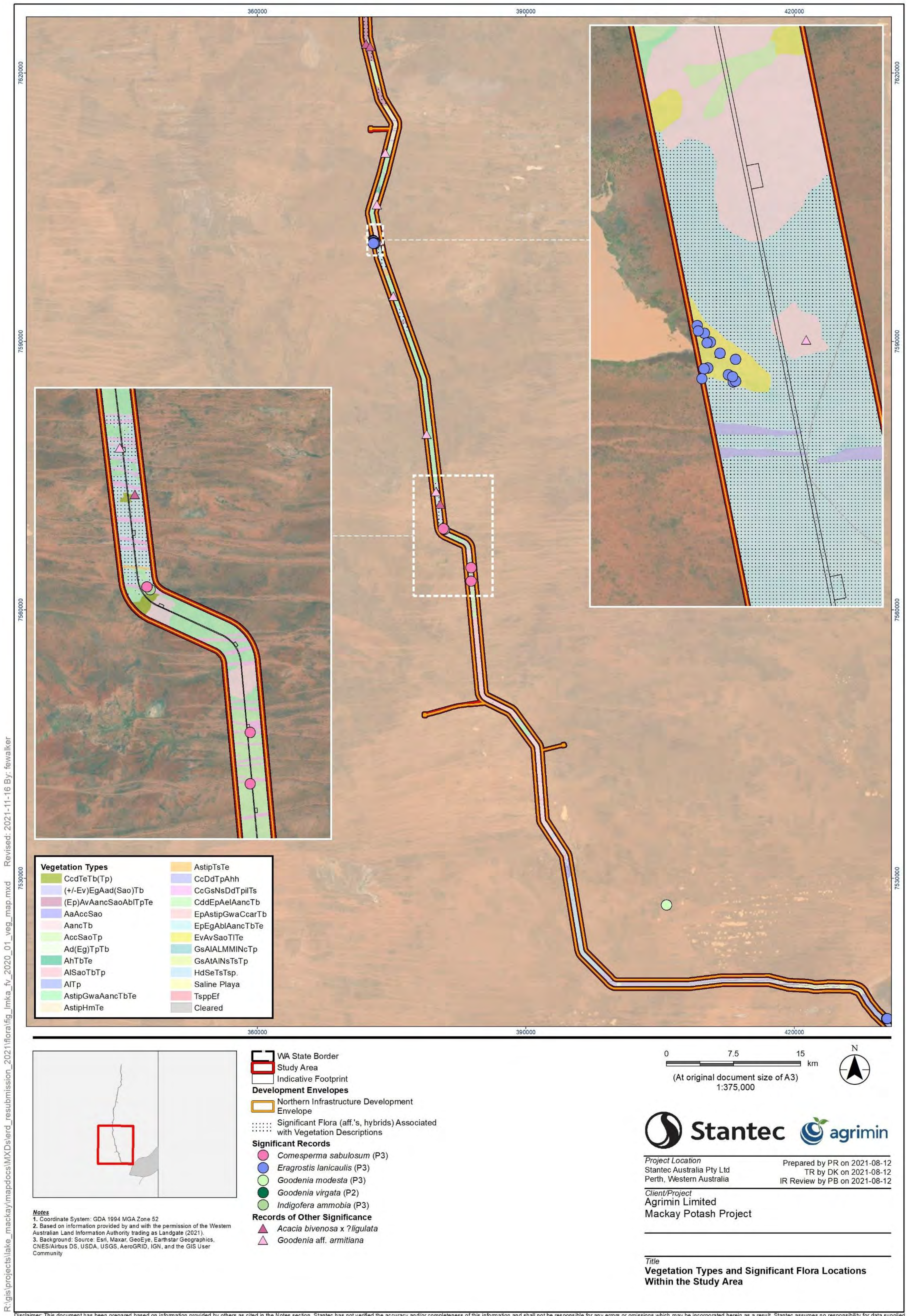

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Figure 6-6: Vegetation types and significant flora within the Proposal area (NIDE - south)

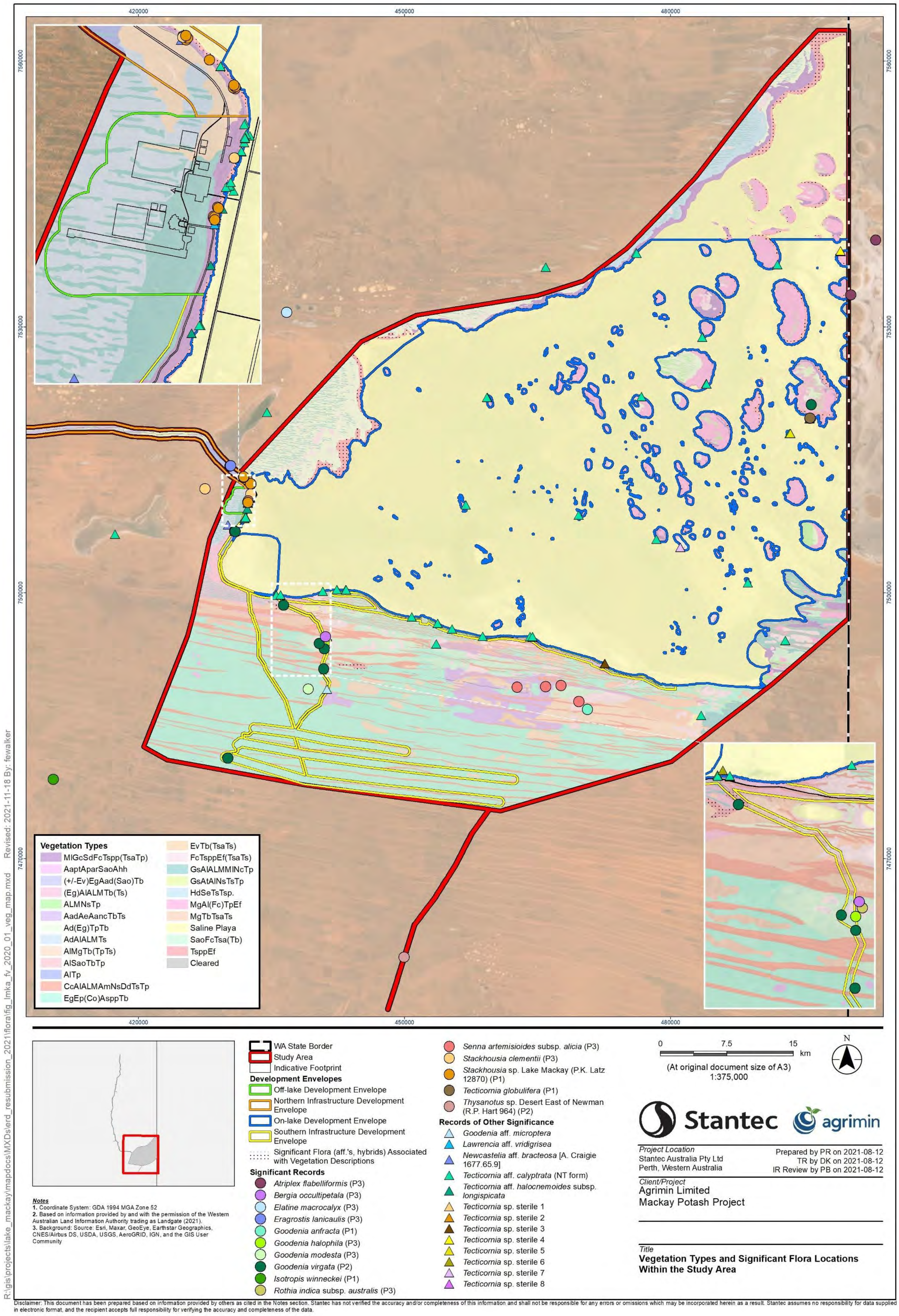


Figure 6-7: Vegetation types and significant flora within the Proposal area (SIDE, On-LDE and Off-LDE)

Table 6-7: Vegetation types supporting Priority flora located within the Proposal area

Locally Significant Vegetation Type	Priority Flora	Habitat (ha)	Extent within Study Area		Extent within Proposal area		Extent in Indicative Footprint	
			(%)	(ha)	(%)	(ha)	(5)	(ha)
EgEp(Co)AsppTb	*Goodenia virgata* (P2) *Goodenia modesta* (P3)	Plains	243,461.0	54.84	8,253.63	3.13	143.47	0.23
EpGwaAancTp	*Comesperma sabulosum* (P3)	Sand dunes, swales	2,830.39	0.64	2,204.46	0.84	72.16	2.55
AstipHmTe	*Comesperma sabulosum* (P3) *Indigofera ammobia* (P3)	Sand dunes, swales	2,319.05	0.52	2,262.76	0.86	65.84	2.84
AstipTsTe	*Comesperma sabulosum* (P3) *Indigofera ammobia* (P3)	Sand dunes, swales	2,176.92	0.49	2,176.92	0.83	61.25	2.81
HmAeTp	*Comesperma sabulosum* (P3) *Indigofera ammobia* (P3)	Sand plains on swales	1,818.27	0.41	1,808.83	0.69	54.98	3.02
AhTbTe	*Comesperma sabulosum* (P3)	Stoney plains	1,601.37	0.36	1,600.25	0.61	46.95	2.93
EpEgAblAancTbTe	*Comesperma sabulosum* (P3)	Sand dunes, swales	1,009.37	0.23	1,009.37	0.38	27.15	2.69
MlGcSdFcTspp(TsaTp)	*Stackhousia* sp. Lake Mackay (P.K. Latz 12870) (P1) *Eragrostis lanicaulis* (P3) *Stackhousia clementii* (P3)	Semi-saline lake margin or island habitat; dominated by chenopods	7,673.33	1.73	678.34	0.26	21.68	0.28
CcGsNsDdTpilTs	*Comesperma sabulosum* (P3) *Indigofera ammobia* (P3)	Sand dune crest and slope	563.46	0.13	562.26	99.79	15.59	2.77
CddEpAelAancTb	*Comesperma sabulosum* (P3)	Sand dunes, swales	545.77	0.12	545.77	100.00	15.26	2.8
AlTp	*Goodenia virgata* (P2)	Sand plains	377.95	0.09	377.95	100.00	14.46	3.83
CcdTeTb(Tp)	*Comesperma sabulosum* (P3) *Indigofera ammobia* (P3)	Sand plains, broad swales	393.58	0.09	393.58	0.15	12.17	3.09
CcAstipTeAhh	*Comesperma sabulosum* (P3) *Indigofera ammobia* (P3)	Sand dunes, swales	391.77	0.09	391.77	0.15	11.2	2.86
AeDdTeAhh	*Indigofera ammobia* (P3)	Sand dunes, swales	329.65	0.07	329.65	0.13	7.88	2.39
CcDdTpAhh	*Comesperma sabulosum* (P3)	Sand dune crest and slope	119.54	0.03	118.59	0.04	3.09	2.59
EvAvSaoTlTe	*Eragrostis lanicaulis* (P3)	Banks of freshwater claypan	81.81	0.02	81.81	0.03	2.05	2.50
CoTe	*Comesperma sabulosum* (P3)	Sand plains on swales	36.99	0.01	36.99	0.01	0.85	2.3
TsppEf	*Stackhousia* sp. Lake Mackay (P.K. Latz 12870) (P1) *Goodenia virgata* (P2)	Semi-saline lake margin or island habitat; dominated by chenopods	7,871.48	1.77	698.04	0.26	0.25	<0.01
SaoFcTsa(Tb)	*Goodenia virgata* (P2) *Goodenia halophila* (P3)	Plains Clay plain/clay depression	5,972.17	1.35	70.51	0.03	0.20	<0.01

6.4.2.3 Riparian Vegetation (*Tecticornia*-dominated habitat)

The *Tecticornia* genus (samphires) are members of the Chenopodiaceae family and are renowned for being drought and salt tolerant. *Tecticornia* species are known to dominate the vegetation adjacent to salt lake margins; however, they require freshwater to germinate, and have varying requirements in regards to salinity (Datson 2005). Samphire shrublands adjacent to the saline playa of Lake Mackay can be temporarily submerged following infrequent major flooding events. Zonation of *Tecticornia* spp. is common within riparian vegetation which may relate to differing submergence tolerances; some species are more susceptible to prolonged waterlogging than others (Konnerup *et al.* 2015).

The samphire dominated vegetation types listed in Table 6-8 are considered to be representative of vegetation in association with the riparian zone and were recorded in the following habitats:

- hypersaline lake margins and smaller islands of Lake Mackay, dominated by halophytic taxa such as *Tecticornia*, *Frankenia*, *Eragrostis falcata* and *Triodia salina*; and
- saline flats and small depressions consisting of similar species to the lake margins.

Table 6-8: Riparian zone vegetation types dominated by *Tecticornia* species within the Proposal area

Vegetation Type	Habitat	Study Area		Proposal area		Proposal area extent as a proportion of representation in the Study Area (%)
		Extent (ha)	Proportion (%)	Extent (ha)	Proportion (%)	
TsppEf	Riparian zone (lake margin)	7,871.48	1.77	698.04	0.26	8.87
MlGcSdFcTspp(TsaTp)	Riparian zone (lake margin)	7,673.33	1.73	678.34	0.26	8.84
FcTsppEf(TsaTs)	Saline clay pans	6,090.96	1.37	146.99	0.06	2.41
	Total	21,635.77	4.87	1,523.37	0.58	n/a

6.4.2.4 Potential Groundwater-dependent Vegetation

There were no groundwater-dependent vegetation types recorded within the Proposal area. No permanent or semi-permanent surface water features such as rivers or major creeks occur within the Proposal area. Claypans that temporarily hold freshwater following significant rainfall events are distributed within the southern and central portions of the Study Area.

Four species recorded within the Proposal area represent potential groundwater-dependent species: *Allocasuarina decaisneana, Eucalyptus victrix, Melaleuca glomerata* and *Corymbia candida*. Other dominant and associated species in the vegetation types supporting the potential groundwater-dependent species are not dependent on groundwater.

Eucalyptus victrix, Melaleuca glomerata and potentially *Corymbia candida*, are generally considered to be examples of vadophytes; species which have a lower reliance on groundwater and primarily use water held in the unsaturated zone above the watertable (Sommer and Froend 2010). *Eucalyptus victrix* can access groundwater in proximity to the surface (O'Grady 2009), and while they are relatively drought tolerant, individuals can decline in condition when groundwater is limited. Furthermore, *Allocasuarina decaisneana* is known to develop a fast growing tap-root that can reach a depth of over 10 m, and can reach any sub-surface water source (ALA 2021). Vegetation types dominated by *Allocasuarina decaisneana, Eucalyptus victrix* or *Melaleuca glomerata* within the Proposal area are listed in Table 6-9.

Table 6-9: Vegetation types supporting species potentially accessing groundwater within the Proposal area

Vegetation Type	Species potentially accessing groundwater	Habitat	Study Area		Proposal area		Proposal area extent as a proportion of representation in the Study Area (%)
			Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	
MgAl(Fc)TpEf	*Melaleuca glomerata*	Clay plains	13,433.11	3.03	86.83	0.03	0.65
Ad(Eg)TpTb	*Allocasuarina decaisneana*	Sand plains on swales	12,625.80	2.84	472.43	3.74	0.03
MgTbTsaTs	*Melaleuca glomerata*	Clay pans and plains	5,833.57	1.31	153.74	0.06	2.64
AdAlALMTs	*Allocasuarina decaisneana*	Smaller lakeside dunes	941.66	0.21	331.48	35.20	35.20
EvTb(TsaTs)	*Eucalyptus victrix*	Clay pans, clay plains	544.14	0.12	28.19	0.01	5.18
EvAvSaoTlTe	*Eucalyptus victrix*	Clay pans, clay plains	81.81	0.02	81.81	0.03	100.00
		Total	19,892.63	4.48	350.57	0.13	n/a

6.4.2.5 Vegetation Condition

Vegetation condition within the Proposal area ranged from Excellent to Completely Degraded (Table 6-10). The majority of the vegetated portions of the Proposal area were considered to be in Excellent condition, with the saline playa disregarded from condition assessment due to being largely devoid of vegetation.

Fire has impacted large areas of the region, including within the Study Area and the Proposal area. The Darwin Centre for Bushfire Research mapped the extent of fires occurring within the Study Area between 2016 and 2019, as approximately 19,795 ha (Firenorth 2020). Apart from burnt vegetation, relatively low levels of disturbance were noted within the Study Area. Given the Study Area represents an extremely remote region of WA, with relatively minimal vegetation disturbance associated with humans of European descent, fire (from lightning strikes or Traditional Owner land management), was not considered to be an appropriate justification to assign a decline in vegetation condition. There are existing tracks and roads in the Study Area, particularly in the NIDE where approximately 30% of the haulage corridor will be situated on an existing cleared track. Figure 6-8, Figure 6-9, Figure 6-10 and Figure 6-11 display vegetation condition mapping within the Proposal area.

Table 6-10: Summary of vegetation condition within the Proposal area

Vegetation Condition	Extent in Study Area		Extent within Proposal area		Proposal area extent as a proportion of total extent within Study Area (%)
	(ha)	(%)	(ha)	(%)	
Excellent	198,562.11	44.72	45,550.97	17.28	22.94
Very Good	1,408.16	0.32	1,280.20	0.49	90.91
Good	437.75	0.10	437.75	0.17	100.00
Poor	0	0	0	0	0
Degraded	0	0	0	0	0
Completely Degraded	116.28	0.03	93.28	0.04	80.22
n/a (Saline Playa)	243,461.00	100	216,321.91	82.04	88.85

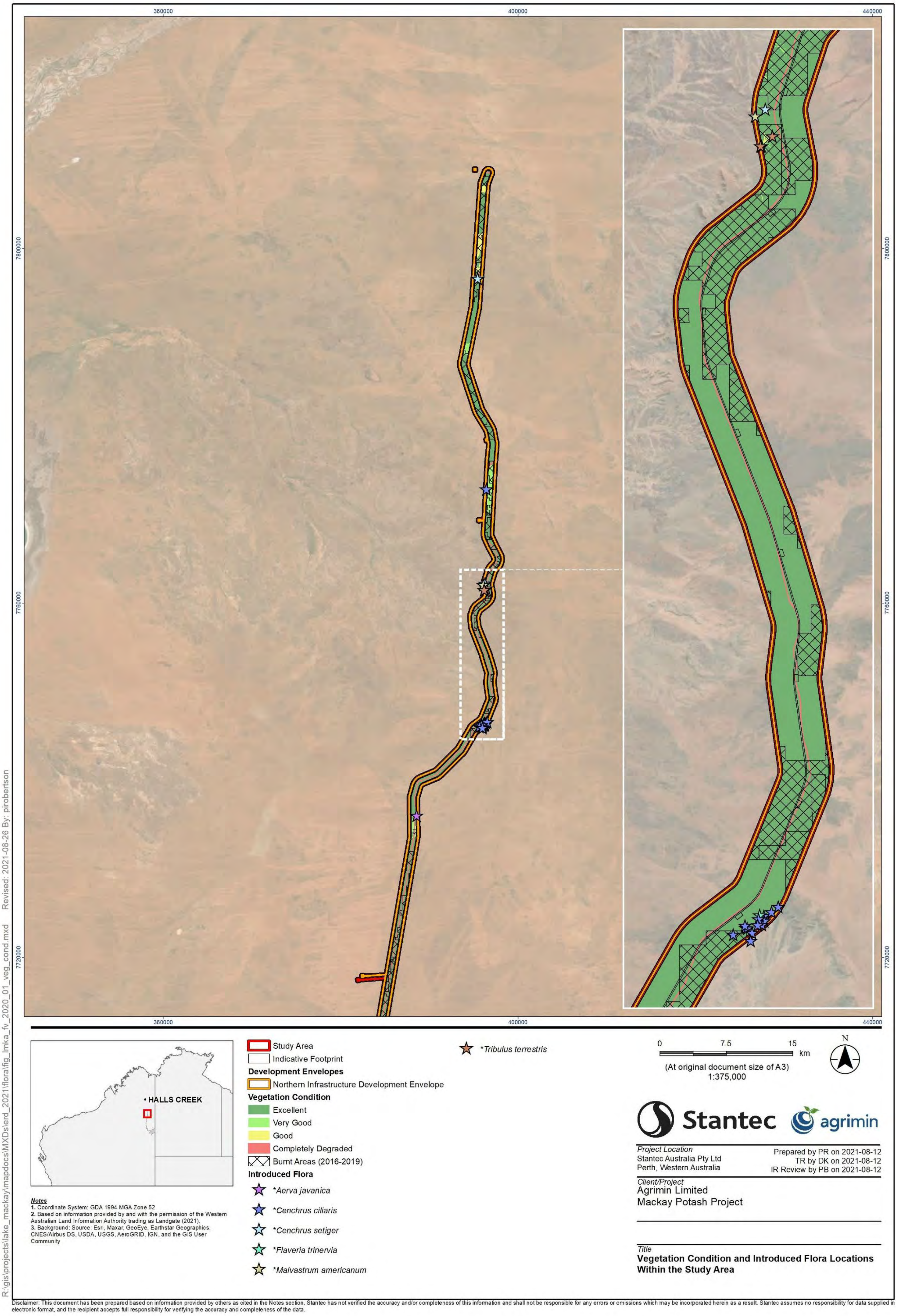


Figure 6-8: Vegetation condition and introduced flora within the Proposal area (NIDE - north)

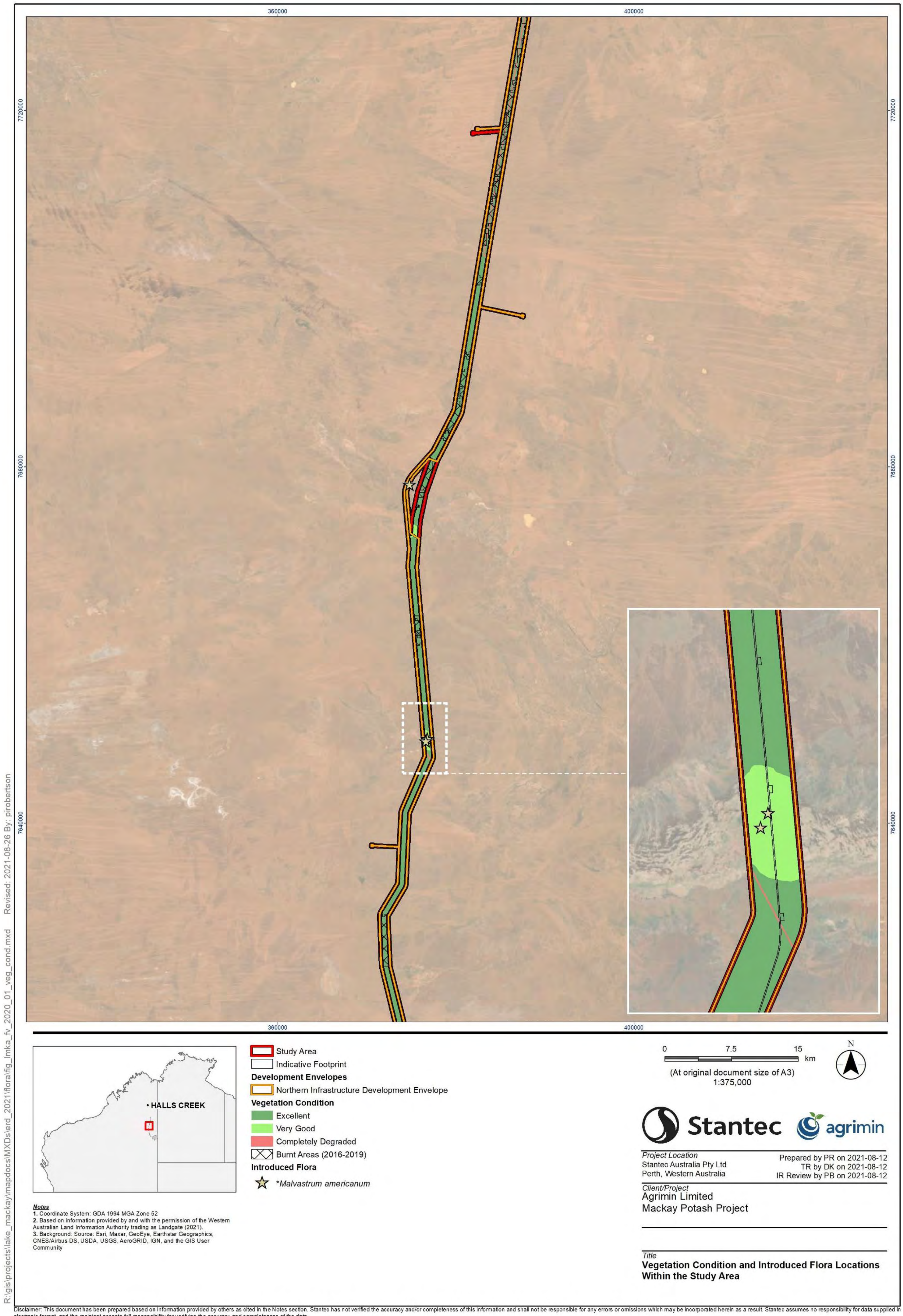


Figure 6-9: Vegetation condition and introduced flora within the Proposal area (NIDE - centre)

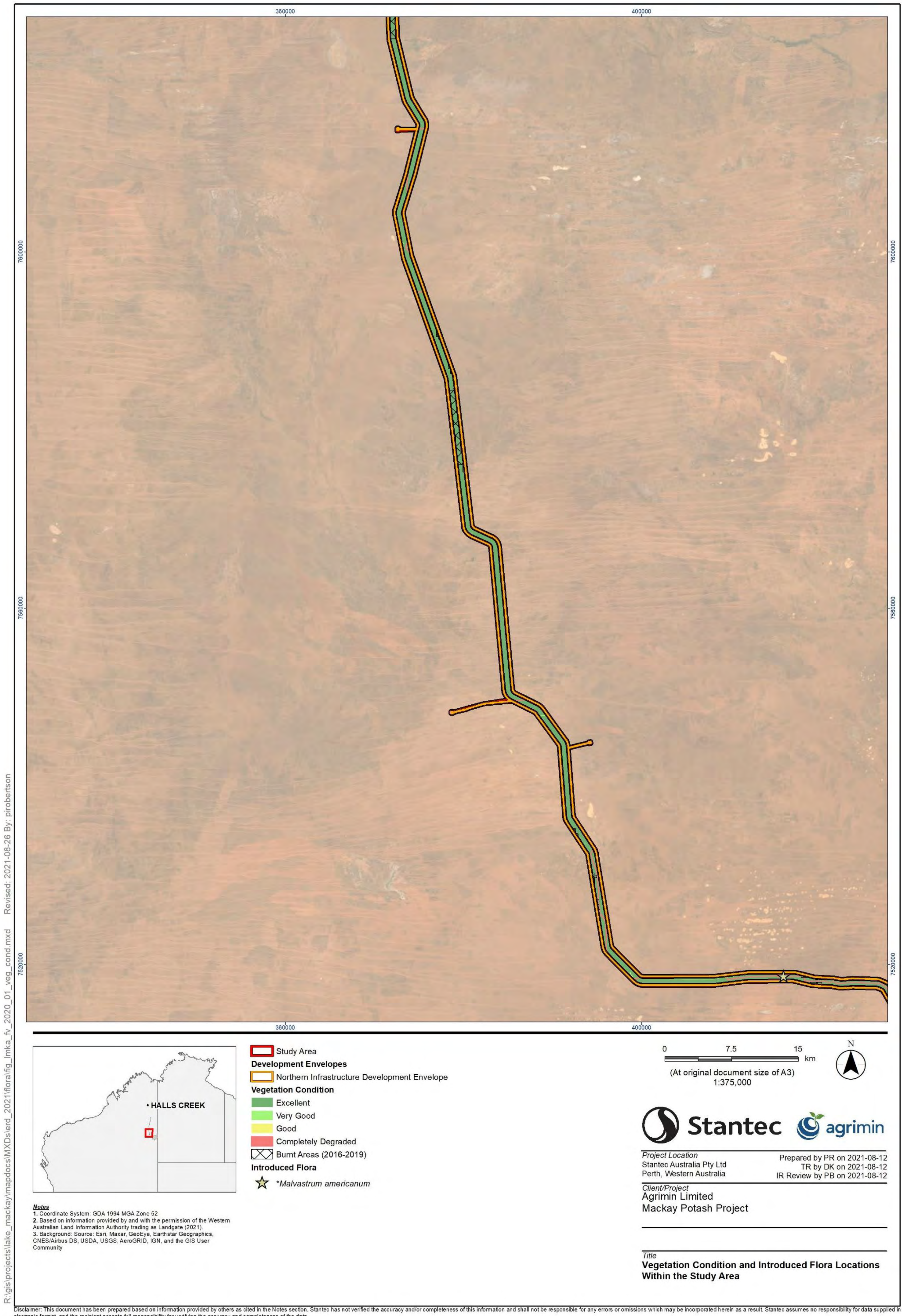


Figure 6-10: Vegetation condition and introduced flora within the Proposal area (NIDE – south)

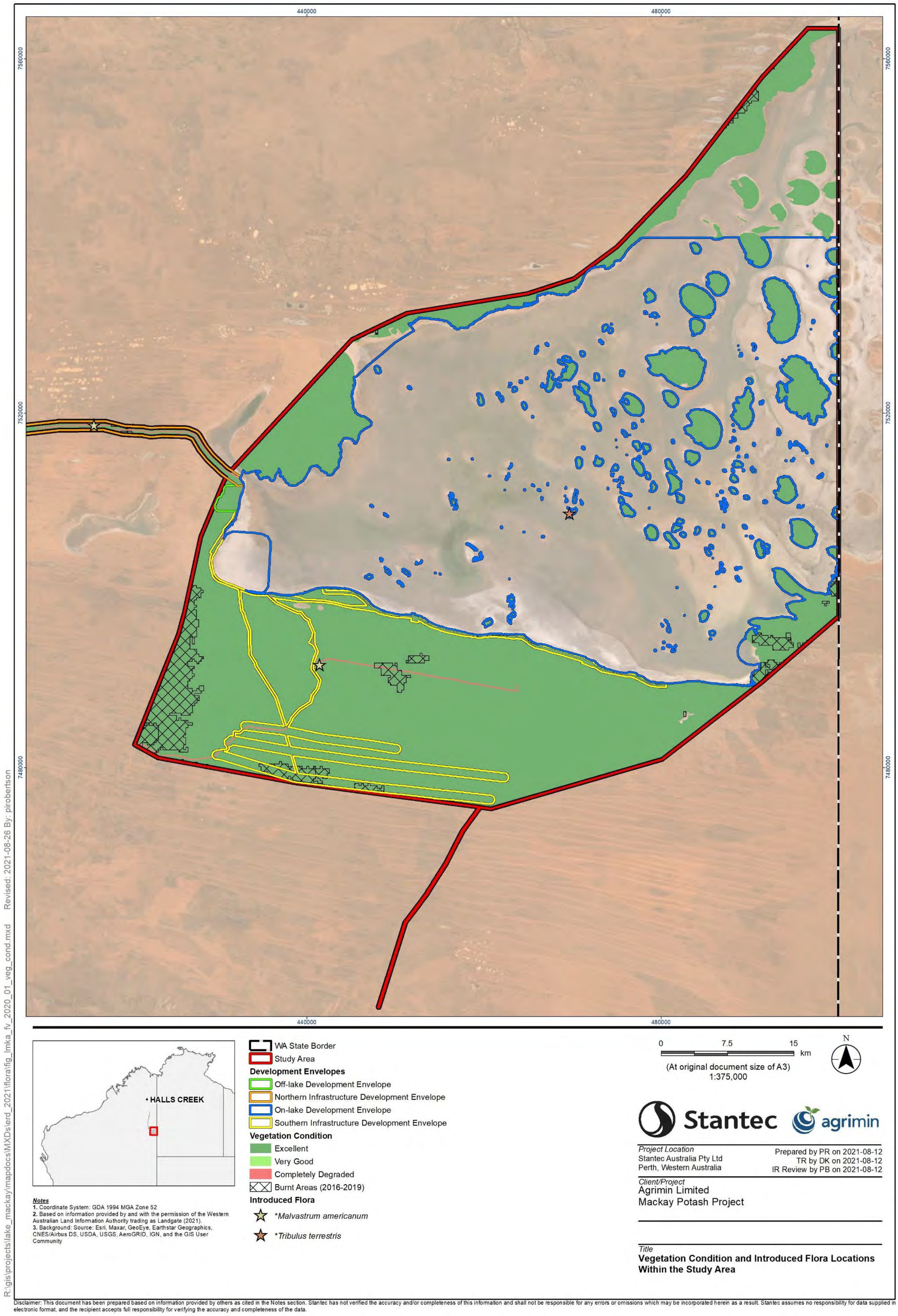


Figure 6-11: Vegetation condition and introduced flora within the Proposal area (SIDE, On-LDE and Off-LDE)

6.4.3 Flora

6.4.3.1 Significant Flora

No flora listed as Threatened under the EPBC Act have been recorded within the Study Area. Of the 14 Priority flora species recorded in the Study Area, seven have been recorded within the Proposal area and no Priority flora occurred within the On-LDE. The remaining seven Priority flora have been recorded within the Study Area but not the Proposal area, and these have been rated as Likely to occur in the likelihood of occurrence assessment for the Proposal. Additionally, eight sterile *Tecticornia* taxa were collected during the *Lake Mackay Potash Project: Baseline Aquatic Ecology Study* (Appendix J). However, based on their locations in proximity to common and widespread *Tecticornia* taxa from riparian vegetation sampling transects, these were assessed as unlikely to represent flora of significance. Figure 6-4 to Figure 6-7 show the location of significant flora species within their respective vegetation types within the Proposal area. Table 6-7 presents the extent of the vegetation types which support Priority flora within the Proposal area.

6.4.3.2 Affinity species, potential hybrids, and anomalous records

A number of flora records from the surveys which were recorded within the Proposal area are particularly noteworthy, as listed below and detailed in (Table 6-12). This includes where specimens displayed an affinity ('aff.') to a recognised species; however, also had characteristics that separate it from the known species. In each instance, the species it most closely resembles has been applied with the application of 'aff.'. Further taxonomic work would be required to determine these as distinct taxa, and until resolved, these should be considered as flora of significance:

- specimens tentatively identified as *Acacia bivenosa ?x ligulata* (NIDE);
- one specimen tentatively identified as *Goodenia ?lunata* (P1)(NIDE);
- specimens identified as *Goodenia* aff. *armitiana* (NIDE);
- one specimen identified as *Goodenia* aff. *microptera* (SIDE);
- one specimen identified as *Lawrencia* aff *viridigrisea*; (Off-LDE)
- one specimen identified as *Newcastelia* aff. *bracteosa* (NIDE);
- one unknown and potentially new taxa, *Tecticornia* aff. *calyptrata* (N.T. form) (On-LDE, Off-LDE NIDE & SIDE);
- specimens identified as *Tecticornia* aff. *halocnemoides subsp. longispicata* (On-LDE, Off-LDE & SIDE); and
- a potential hybrid or presently undescribed *Triodia* species (NIDE).

Additionally, eight sterile *Tecticornia* specimens were collected during the *Lake Mackay Potash Project: Baseline Aquatic Ecology Study* (Appendix J). However, based on their locations in proximity to common and widespread *Tecticornia* taxa from riparian vegetation sampling transects, these were assessed as unlikely to represent flora of significance.

Table 6-11: Priority flora locations with respect to the Study Area and Proposal area

Taxon (status)	Number of Records Within Study Area	Number of Records Within Proposal Area	Number of Vouchered Records (FloraBase) (WAH 2020)		Number of Records as listed by the Atlas of Living Australia	Number of records within Development Envelopes				Vegetation types supporting the species within the Proposal Area	
			Total	Within Study Area		NIDE	SIDE	On-LDE	Off-LDE	Vegetation type code	Extent within the Proposal Area
Stackhousia sp. Lake Mackay (P.K. Latz 12870) (P1)	16	16	5	2#	8	9		-	7	TsppEf MlGcSdFcTspp(TsaTp)	1376.38
Goodenia virgata (P2)	9	6	7	1	49	2	4	-	-	AlTp, EgEp(Co)AsppTb MgAl(Fc)TpEf, SaoFcTsa(Tb), TsppEf	9,486.96
Comesperma sabulosum (P3)	106	105	14	0	30	105	-	-	-	AhTbTe, AstipHmTe, AstipTsTe, CcAstipTeAhh, CcDdTpAhh, CcdTeTb(Tp), CcGsNsDdTpilTs, CddEpAelAancTb, CoTe, EpEgAblAancTbTe, HmAeTp	10,907.09
Eragrostis lanicaulis (P3)	16	15	12	0	91	14	-	-	1	EvAvSaoTlTe, MlGcSdFcTspp(TsaTp), TsppEf	1,458.19
Goodenia modesta (P3)			27	2	30	44	-	-	-	EgEp(Co)AsppTb	8,253.63
Indigofera ammobia (P3)	2	1	15	0	220	2	2	-	1	AeDdTeAhh, AstipHmTe, CcAstipTeAhh, CcdTeTb(Tp), CcGsNsDdTpilTs, HmAeTp	5,748.85
Stackhousia clementii (P3)	44	44	21	1						TsppEf	698.04

Note: # indicates one record from an island of the Lake Mackay playa.

Table 6-12: Flora of other significance locations with respect to the Study Area and the Proposal area

Taxon (status)	Number of Records Within Study Area	Number of Records Within Proposal Area	Number of Vouchered Records (formally described taxa) (FloraBase)(WAH 2020)	Number of Records as Listed by the Atlas of Living Australia (formally described taxa)	Number of records within Development Envelopes				Vegetation types supporting the species within the Proposal Area	
					NIDE	SIDE	On-LDE	Off-LDE	Vegetation type code	Extent within the Proposal Area
Acacia bivenosa ?x ligulata	8	8	A. bivenosa: 424 A. ligulata: 374	A. bivenosa: 1,081 A. ligulata: 9,093	8	-	-	-	(Ep)AvAancSaoAblTpTe, CspGplAancTe, EpEgAblAancTbTe, AstipHmTe, CcdTeTb(Tp), HmAeTp	7,572.06
Goodenia aff. *armitiana*	22	22	105	835	22	-	-	-	(Ep)AvAancSaoAblTpTe, EvAvSaoTlTe, AancTb, AhTbTe, AstipGwaAancTbTe, AstipHmTe, EpEgAblAancTbTe, SggTbr	13,080.43
Goodenia ?lunata (P1)	2	2	5	1,128	2	-	-	-	+/-SahDrAcAhhFdAvll	382.92
Goodenia aff. *microptera*	1	1	151	202	-	1	-	-	EgEp(Co)AsppTb	8,253.63
Lawrencia aff *viridigrisea*	3	2	61	135	-	-	-	2	TsppEf	698.04
Newcastelia aff. *bracteosa*	2	1	24	119	1	-	-	-	AlMgTb(TpTs)	340.64
Tecticornia aff. *calyptrata* (N.T. form)	75	46	33	46	5	10	16	15	MlGcSdFcTspp(TsaTp), TsppEf, Saline Playa	217,689.29
Tecticornia aff. *halocnemoides* subsp. *longispicata*	6	3	19	198	-	1	2	3	MlGcSdFcTspp(TsaTp), TsppEf, Saline Playa	217,689.29
Triodia cf *epactia*	15	15	252	367	15	-	-	-	(Eb)AacTi, AeDdTeAhh, AhTbTe, AstipHmTe, AstipTsTe, CcAstipTeAhh, CcdTeTb(Tp), CspGplAancTe, EoAacTeTsTp	9,706.41
Triodia cf *pungens*	7	7	115	2,509	7	-	-	-	(Ep)AvAancSaoAblTpTe, AhTbTe, AstipGwaAancTbTe, AstipHmTe, EoAacTeTsTp, HmAeTp	12,845.14

Table 6-13: Likelihood of occurrence of additional Priority within the Proposal area

Taxon	WA (Rank)	EPBC (Rank)	Habitat	Nearest Location (km) to the Proposal area	Database	Stantec Likelihood Assessment	Justification
Eriachne armitii	P1	-	Lateritic soils and plains.	128	WA Herbarium	Unlikely	Nearest previous record a substantial distance from the Proposal area
Goodenia anfracta	P1	-	Semi-saline flats dominated by *Tecticornia* spp. and *Melaleuca glomerata*	Within the Study Area, outside DE	Outback Ecology (2012c)	Likely	Previous record in close proximity and suitable habitat occurs within the Proposal area
Goodenia grandiflora	P1	-	Sandy, gravelly soils. Rocky slopes and breakaways.	143	TPFL	Unlikely	Nearest previous record a substantial distance from Proposal area
Goodenia lunata	P1	-	Small salt lake with narrow fringe. Salt lake margin. Mitchell Grass alluvial plain pasture.	165	WA Herbarium	Likely	Suitable habitat occurs within Study Area. Nearest previous record a substantial distance from the Proposal area
Goodenia strangfordii	P1	-	Heavy and seasonally wet soils.	45	WA Herbarium, TPFL	Possible	Previous record a moderate distance away; marginal suitable habitat occurs within Proposal area
Goodenia suffrutescens	P1	-	Lateritic pavement, rocky outcrop, shrub steppe.	2	WA Herbarium, TPFL	Likely	Previous record in close proximity and suitable habitat occurs within the Proposal area
Isotropis winneckei	P1	-	Perennial, herb.	Geospatial co-ordinates unavailable	Previous survey BushBlitz (2015)	Likely	Previous record in close proximity and suitable habitat occurs within the Proposal area
Rorippa eustylis	P1	-	Clay. Around pools or along water courses.	140	WA Herbarium	Unlikely	Nearest previous record a substantial distance from the Proposal area
Tecticornia globulifera	P1	-	Variable-drained, red, saline clay loam. Extensive salt flat, Undulating saline flat on edge of salt lake. Flat floodway. Clayey sand.	Within the Study Area, outside DE	360 Environmental (2017a) ecologia Environment (2017a)	Likely	Previous record in close proximity and suitable habitat occurs within the Proposal area
Teucrium sp. Sturt Creek (A.A. Mitchell 5536)	P1	-	Large crab holes in black soil. Tussock grassland of *Eragrostis xerophila* with an overstorey of *Acacia victoriae*.	72	WA Herbarium, TPFL	Unlikely	Nearest previous record a moderate distance away; no black soil crab hole habitat occurs within Proposal area
Trachymene villosa	P1	-	Skeletal soils over quartzite. Red skeletal soil, quartz.	88	WA Herbarium, TPFL	Possible	Previous record a moderate distance away; marginal suitable habitat occurs within the Proposal area
Eremophila pallida	P2	-	Rangeland. Plain, red brown loam. Plain. Red sand. Plain in rangeland with dry red loam / ironstone gravel. Damp hilltop. Recent rains. Red sand-laterite over sandstone	Geospatial co-ordinates unavailable	Previous survey BushBlitz (2015)	Likely	Previous record in close proximity and suitable habitat occurs within Proposal area
Isotropis parviflora	P2	-	Valley slope of ironstone plateau. Upper hill spur/gentle slopes on top of spur with brown sandy loam soil. Hill crest. Hillslope. Red soil over ironstone.	17	WA Herbarium	Possible	Previous record in close proximity and marginal habitat occurs within Proposal area
Kohautia australiensis	P2	-	On low stony calcrete hills and rises; slightly raised calcrete platform, dominated by calcrete outcropping surrounded by minor flowlines.	74	WA Herbarium, TPFL	Possible	Previous record a moderate distance away; marginal suitable habitat occurs within Proposal area
Peplidium sp. Tanami (P.K. Latz 11904)	P2	-	Flats around salt lake. Edge of semi-saline lake, brown, sandy clay.	Within the Study Area, outside DE	WA Herbarium, Naturemap	Likely	Previous record in close proximity and suitable habitat occurs within Proposal area
Ptilotus marduguru	P2	-	Rocky slopes of sandstone hills & gorge.	142	WA Herbarium, Naturemap	Possible	Marginal suitable habitat occurs within Proposal area
Thysanotus sp. Desert East of Newman (R.P. Hart 964)	P2	-	Red-brown loamy sand or red sand, sometimes silty. Sand plain, pisolitic buckshot plain.	Within the Study Area, Outside DE	ecologia Environment (2017a)	Likely	Previous record in close proximity and suitable habitat occurs within the Proposal area
Atriplex flabelliformis	P3	-	Clay loam, loam. Saline flats or marshes.	130	WA Herbarium	Likely	Previous record in close proximity and suitable habitat occurs within Proposal area
Bergia occultipetala	P3	-	Margin of semi-saline lake; silty sand, subsaline.	Within the Study Area, outside DE	BushBlitz (2015)	Likely	Previous record in close proximity and suitable habitat occurs within the Proposal area
Chrysocephalum apiculatum subsp. *racemosum*	P3	-	On sand dune. Palgrave volcanics	135	WA Herbarium	Possible	Suitable habitat occurs within Proposal area; however, nearest previous record a substantial distance from Proposal area
Crotalaria smithiana	P3	-	Floodplains and banks of small creek.	73	WA Herbarium	Unlikely	Nearest previous record a substantial distance from Proposal area; no creek habitat occurs within Proposal area

Taxon	WA (Rank)	EPBC (Rank)	Habitat	Nearest Location (km) to the Proposal area	Database	Stantec Likelihood Assessment	Justification
Dampiera atriplicina	P3	-	Red sand. Sand ridges. Lower slopes of sand dune.	104	WA Herbarium	Likely	Recorded outside Proposal area by Bush Blitz survey (BushBlitz 2015) and suitable habitat occurs within Proposal area
Daviesia arthropoda	P3	-	Dunes.	104	WA Herbarium	Unlikely	Nearest previous record a substantial distance from Proposal area
Elatine macrocalyx	P3	-	Shallow sands over clay. Margins of playa lakes and clay pans.	Geospatial co-ordinates unavailable	Previous survey BushBlitz (2015)	Likely	Previous record in close proximity and suitable habitat occurs within Proposal area
Eleocharis papillosa	P3	Vu	Red clay over granite, open clay flats. Claypans.	36	WA Herbarium	Possible	Previous record a moderate distance away; marginal suitable habitat occurs within Proposal area
Eragrostis confertiflora	P3	-	Black cracking clay. Edges of waterholes.	140	WA Herbarium	Unlikely	Nearest previous record a substantial distance from Proposal area
Eragrostis crateriformis	P3	-	Clayey loam or clay. Creek banks, depressions. Red sandy loam.	23	WA Herbarium, Naturemap	Possible	Previous record in close proximity and suitable habitat occurs within Study Area
Eragrostis sp. Erect spikelets (P.K. Latz 2122)	P3	-	Calcrete, interzone between sandy gypsum rise and semi saline samphire dominated lake.	165	WA Herbarium	Unlikely	Nearest previous record a substantial distance from Proposal area
Eragrostis sp. Limestone (P.K. Latz 5921)	P3	-	Undulating, low rise. Deep red sand	182	WA Herbarium	Possible	Suitable habitat occurs within Proposal area Nearest previous record a substantial distance from Proposal area
Goodenia crenata	P3	-	Fine red earth, red clay. Flat sandplains, sandstone outcrops.	96	WA Herbarium	Possible	Suitable habitat occurs within Proposal area Nearest previous record a substantial distance from Proposal area
Goodenia gibbosa	P3	-	Sandy soils and creek lines.	131	WA Herbarium, Threatened and Priority Flora Database (TPFL)	Unlikely	Nearest previous record a substantial distance from Proposal area
Goodenia lyrata	P3	-	Red sandy loam. Near claypan.	90	WA Herbarium	Unlikely	Nearest previous record a substantial distance from Proposal area
Indigofera gilesii	P3	-	Amongst boulders & outcrops, hills.	86	WA Herbarium	Possible	Suitable habitat occurs within Proposal area Nearest previous record a substantial distance from Proposal area
Iotasperma sessilifolium	P3	-	Cracking clay, black loam. Edges of waterholes, plains.	140	WA Herbarium	Unlikely	Nearest previous record a substantial distance from Proposal area; preferred habitat does not occur within Proposal area
Rothia indica subsp. *australis*	P3	-	Prostrate annual, herb, to 0.3 m high, densely covered in spreading hairs.	Within the Study Area, outside DE	BushBlitz (2015)	Likely	Previous record in close proximity and suitable habitat occurs within the Proposal area
Senna artemisioides subsp. *alicia*	P3	-	Compact shrub, 1.2 m high x 1 m wide.	Within the Study Area, outside DE	Outback Ecology (2012c)	Likely	Previous record in close proximity and suitable habitat occurs within the Proposal area
Sauropus arenosus	P3	-	Red sand dunes.	38	WA Herbarium	Possible	Previous record in close proximity and suitable habitat occurs within the Proposal area
Tephrosia sp. Central (P.K. Latz 17037)	P3	-	Rocky slope/outcrop.	52	WA Herbarium	Possible	Previous record a moderate distance away; marginal suitable habitat occurs within Proposal area
Trachymene dusenii	P3	-	On coarse textured skeletal soil on hill. Rocky ridge.	103	WA Herbarium	Unlikely	Nearest previous record a substantial distance from Proposal area
Triodia latzii	P3	-	Confined to edge of cliffs.	140	WA Herbarium	Unlikely	Nearest previous record a substantial distance from Proposal area

6.4.3.3 Range extensions

Of the 541 species recorded within the Study Area, 137 (135 native flora species and two introduced flora species) represent range extensions. Although the total number of range extensions represents a high proportion (approximately 25%) of the total flora inventory, it is reflective of the absence of detailed flora surveys conducted in the Great Sandy Desert bioregion and Tanami bioregion, as well as lack of vouchering of these species in general. Of the 137 species:

- 52 species are considered to be bioregional extensions, with no specimen records previously lodged for either the Great Sandy Desert or Tanami bioregions;
- 60 species are considered to be range extensions, with the closest lodged record at least 100 km from the Study Area;
- 23 species are considered to be bridging records, indicating that they are a record which occurs between two populations that are otherwise widely separated; and
- 50 of the above species are considered to be associated with more than one range extension category. Of these 50 species:
  - 39 species are regarded as both new to a bioregion and as range extensions; and
  - 11 species are regarded as both new to a bioregion and as bridging records.

The record of *Euphorbia papillata* var. *laevicaulis* within the NIDE not only represents a bioregional extension and range extension but is also a new flora species record for WA. Of the species within the Study Area representing bioregional extensions (including the new records for WA), 30 species were identified as new records for the Great Sandy Desert bioregion and 16 species were new records for the Tanami bioregion. Six of these species represent new records for both bioregions (Table 6-14). A complete list of flora records collected during surveys and determined to be range extensions is presented in (Stantec 2021c).

Bioregional range extensions recorded within the Proposal area are presented in Table 6-14, with location records of vouchered specimens held within the Western Australian Herbarium (WAH) database and Atlas of Living Australia database shown to contextualise the known distribution of each species.

Table 6-14 Bioregional range extensions identified within the Proposal area and Indicative Footprint

Species	Location records from within WA (WAH 2021a)	Atlas of Living Australia location records (ALA 2021)	Number of records		New bioregional distribution within WA	Vegetation types supporting the species within the Proposal Area	
			Proposal Area	Indicative Footprint		Vegetation type code	Extent within the Proposal Area
Abutilon hannii	81	989	3	0	Great Sandy Desert	EssDpAsyCencCfAv	6.95
Atalaya hemiglauca	91	4,795	5	0	Great Sandy Desert	(Ep)AvAancSaoAblTpTe, AeDdTeAhh, EssDpAsyCencCfAv, EvAvSaoTlTe	1,882.86
Boerhavia gardneri	67	166	3	0	Great Sandy Desert & Tanami	AstipTsTe, CcGsNsDdTpilTs, CspGplAancTe	3,372.25
Corchorus tridens	83	323	2	0	Great Sandy Desert & Tanami	EssDpAsyCencCfAv	6.95
Cucumis melo	112	1,364	5	0	Great Sandy Desert & Tanami	(Eb)AacTi, CcdCaDpTiPa, EssDpAsyCencCfAv	838.93
Dichrostachys spicata	55	293	1	0	Great Sandy Desert & Tanami	EssDpAsyCencCfAv	6.95
Dodonaea polyzyga	48	156	7	0	Great Sandy Desert	CcdCaDpTiPa, EssDpAsyCencCfAv	53.33
Ehretia saligna var. *saligna*	57	57	3	0	Great Sandy Desert & Tanami	EssDpAsyCencCfAv	6.95
Eremophila latrobei subsp. *filiformis*	77	81	4	1	Great Sandy Desert	(+/-Ev)EgAad(Sao)Tb, AaAccSao, AstipGwaAancTbTe, EpEgAblAancTbTe	7,930.6
Eremophila longifolia	272	6,936	2	0	Great Sandy Desert	CcDdTpAhh, HmAeTp	1,927.42
Euphorbia papillata var. *laevicaulis*	0	29	1	0	Tanami	+/-SahDrAcAhhFdAvll	382.92
Euphorbia psilosperma	8	13	5	0	Tanami	AstipHmTe, AstipTsTe, CcAstipTeAhh, CspGplAancTe, EoAacTeTsTp	6,597.33
**Flaveria trinervia*	172	859	1	0	Tanami	(Eb)AacTi	785.60
Goodenia stobbsiana	98	131	1	0	Tanami	AhAaaTbTs	2,081.61
Grevillea pyramidalis subsp. *leucadendron*	132	266	2	0	Tanami	CspGplAancTe	633.07
Heliotropium sphaericum	1	26	5	0	Great Sandy Desert	(Ep)AvAancSaoAblTpTe, CcAstipTeAhh, EvAvSaoTlTe	1,938.03

Species	Location records from within WA (WAH 2021a)	Atlas of Living Australia location records (ALA 2021)	Number of records		New bioregional distribution within WA	Vegetation types supporting the species within the Proposal Area	
			Proposal Area	Indicative Footprint		Vegetation type code	Extent within the Proposal Area
Hibiscus sturtii var. *truncatus*	61	171	3	0	Tanami	(Eb)AacTi, AccSaoTp, SggTbr	1,127.82
Indigastrum parviflorum	47	402	1	0	Great Sandy Desert & Tanami	EssDpAsyCencCfAv	6.95
Indigofera georgei	139	555	1	0	Great Sandy Desert	AstipGwaAancTbTe	4,576.04
Ipomoea coptica	74	533	4	0	Great Sandy Desert	+/-SahDrAcAhhFdAvll, (Ep)AvAancSaoAblTpTe, EvAvSaoTlTe	1,929.18
Jasminum didymum	223 (187 represent the two subspecies of the taxa)	347	1	0	Great Sandy Desert	CoTe	36.99
Josephinia eugeniae	36	264	2	1	Great Sandy Desert	(Ep)AvAancSaoAblTpTe	1,464.45
Neptunia dimorphantha	122	1341	6	0	Great Sandy Desert	+/-SahDrAcAhhFdAvll, (Ep)AvAancSaoAblTpTe, AccSaoTp, EvAvSaoTlTe	2,244.19
Polygala glaucifolia	82	111	9	0	Tanami	AeDdTeAhh, AstipGwaAancTbTe, AstipHmTe, AstipTsTe, CspGplAancTe, EoAacTeTsTp, EpGwaAancTp, HmAeTp	15,124.54
Polygala isingii	43	173	15	2	Tanami	AancTb, AeDdTeAhh, AhTbTe, AstipGwaAancTbTe, AstipHmTe, CcdTeTb(Tp), EgEp(Co)AsppTb	19,431.15
Pseudochaetochloa australiensis	58	130	4	0	Tanami	CcdCaDpTiPa	46.38
Ptilotus gomphrenoides	156	189	1	1	Tanami	(Eb)AacTi	785.60
Senna glaucifolia	111	224	8	0	Tanami	CcAstipTeAhh, (Eb)AacTi, AhAaaTbTs, Cleared, CspGplAancTe, EoAacTeTsTp	5,118.14
Spermacoce hillii	15	180	8	2	Tanami	AeDdTeAhh, AhAaaTbTs, CcAstipTeAhh, CcDdTpAhh, CcdTeTb(Tp), HmAeTp	5,124.03

Species	Location records from within WA (WAH 2021a)	Atlas of Living Australia location records (ALA 2021)	Number of records		New bioregional distribution within WA	Vegetation types supporting the species within the Proposal Area	
			Proposal Area	Indicative Footprint		Vegetation type code	Extent within the Proposal Area
Stackhousia clementii	21	220	5	0	Great Sandy Desert	MlGcSdFcTspp(TsaTp)	678.34
Tephrosia virens	123	381	1	1	Tanami	EoAacTeTsTp	1,132.81
Tribulopis angustifolia	92	467	39	4	Great Sandy Desert	CcAstipTeAhh, CspGplAancTe, EvAvSaoTlTe, (Eb)AacTi, (Ep)AvAancSaoAblTpTe, AancTb, AccSaoTp, AeDdTeAhh, AstipGwaAancTbTe, AstipHmTe, AstipTsTe, CcdTeTb(Tp), CoTe, EoAacTeTsTp, EssDpAsyCencCfAv, HmAeTp	16,602.65
Tribulus astrocarpus	73	259	1	0	Great Sandy Desert	AccSaoTp	315.01
Triodia spicata	10	328	2	0	Great Sandy Desert	AhAaaTbTs	2,081.61
Triumfetta deserticola	24	40	11	0	Tanami	AhAaaTbTs, AhTbTe, AstipGwaAancTbTe, CddEpAelAancTb, EpAstipGwaCcarTb	10,213.26
Yakirra australiensis var. *australiensis*	29	259	15	2	Tanami	CcAstipTeAhh, (Eb)AacTi, AhAaaTbTs, AhTbTe, AstipTsTe, Cleared, CspGplAancTe, EoAacTeTsTp, EssDpAsyCencCfAv	8,902.26

6.4.3.4 Introduced Flora

Six introduced flora species have been recorded within the Proposal area, all of which occur within the NIDE. One of these weed species, **Tribulus terrestris*, has also been recorded on an island, in close proximity to the On-LDE. The fruits of **Tribulus terrestris* comprise spiny burs which can attach to vectors such as people, animals and vehicles. The transport of this weed to an island is potentially associated with either movement of birds across the region or exploration activity.

None of the introduced flora species represent Weeds of National Significance (WoNS) or are listed under the *Biosecurity and Agriculture Management Act 2007* as declared pests for either the Tanami or Great Sandy Desert bioregions. However, **Cenchrus* spp. and **Aerva javanica* are generally considered to be serious environmental weeds with the potential to proliferate and become dominant in their preferred habitats. The record of **Flaveria trinervia* within the NIDE also represented a bioregional range extension.

The ecological impact and invasiveness classifications (DPaW 2013;2014) for weed species recorded within the Proposal area are provided in Table 6-15. The locations of recorded introduced flora are presented in conjunction with vegetation condition mapping (Figure 6-8, Figure 6-10 and Figure 6-11).

Table 6-15: Introduced flora recorded within the Proposal area and the DPaW Weed Prioirtisation Process

Weed species (Common Name)	Location	Number of Records	DPaW Classification^	
			Ecological Impact	Invasiveness
**Aerva javanica* (Kapok Bush)	NIDE	1	High	Rapid
**Cenchrus ciliaris* (Buffel Grass)	NIDE	19	High	Rapid
**Cenchrus setiger* (Birdwood Grass)	NIDE	3	High	Rapid
**Flaveria trinervia* (Speedy Weed)	NIDE	1	n/a	n/a
**Malvastrum americanum* (Spiked Malvastrum)	NIDE	6	High	Rapid
**Tribulus terrestris* (Caltrop)	NIDE	2	Unknown	Moderate
	Lake Mackay island	1		

*Note: ^ indicates that in the absence of DPaW classifications for the Tanami and Great Sandy Desert bioregions, the Pilbara classifications are presented; No classification information is available for *Flaveria trinervia.*

6.5 Potential Impacts and Mitigation Measures

The potential exists for direct and indirect impacts from the Proposal to the flora and vegetation values of all four Development Envelopes. The key risks of activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of the environmental risk assessment completed by the Proponent. A summary of potential impacts and mitigation measures that were identified in the risk assessment are provided in Table 6-16. The key impacts on flora and vegetation from Proposal activities are discussed in detail in Section 6.6.1 to Section 6.6.5 and provides local and regional ecological context for the impact assessment, and include:

- clearing and fragmentation of native vegetation – flora and vegetation;
- clearing and fragmentation of native vegetation – loss of significant flora, significant vegetation, and riparian vegetation;
- weed introduction and proliferation resulting in decline in vegetation health;
- drawdown from groundwater abstraction resulting in decline in vegetation health (including riparian vegetation and flora with the ability to use groundwater);
- changes to surface hydrology and water flows during flooding events, causing changes to periods of inundation, resulting in disturbance and decline in flora and vegetation health; and
- altered fire regimes resulting in disturbance and decline in vegetation health.

Additional potential impacts were identified during the risk assessment which were ranked as lower risk (Table 6-16). These impacts were considered as having a risk level that can be managed appropriately and are not discussed in detail in the following sections; however, these risks will be addressed via management measures in the relevant EMP. These additional potential impacts to flora and vegetation include:

- discharge or seepage of untreated wastewater resulting disturbance and decline in vegetation health;
- chemical, oil or hydrocarbon spill resulting in disturbance and decline in vegetation health;
- increased soil salinity resulting in disturbance and decline in vegetation health; and
- fugitive dust emissions resulting in disturbance and decline in vegetation health.

The mitigation hierarchy has been considered and applied to potential Proposal impacts 'to protect flora and vegetation so that biological diversity and ecological integrity are maintained', aligning with the EPA objective for the Flora and Vegetation Factor (EPA 2016b).

Mitigation measures are summarised in Table 6-16 which largely avoid, mitigate, manage, monitor and rehabilitate significant impacts to flora and vegetation receptors to reduce the environmental risk.

The mitigation measures are discussed in more detail in subsequent sections and will ensure the EPA objective for Flora and Vegetation will be met.

Table 6-16: Mitigation hierarchy applied to mitigate impacts from the Proposal on Flora and Vegetation

Key Proposal Impacts (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
Clearing and fragmentation of native vegetation (including loss of priority flora, significant, and riparian vegetation) *Direct impact*	• Processing plant and associated infrastructure constructed outside of the riparian vegetation • No clearing of vegetation on lake islands • 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas	• Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing	• Comply with FVEMP • Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure • Develop a Topsoil Stripping and Storage Procedure • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process	• Rehabilitation of temporarily cleared areas	✓	No
Drawdown from groundwater abstraction resulting in decline in vegetation health (including riparian vegetation and flora with the ability to use groundwater) *Indirect impact*	• Trench network will be outside a suitable buffer zone from island formations (buffer dependent on island size Appendix I.10) and riparian vegetation to prevent groundwater drawdown impacts • Significant communities in vicinity of borefield are not true GDEs and considered vadophytes, therefore will not be impacted by drawdown	• Large rainfall events (300 mm within one month) will recharge groundwater level and reset to within 0.5 m of the surface (baseline conditions) • Cohesive salt crust to assist in retention of sediment/soil moisture limiting sediment/soil mobilisation • Borefield pumping is managed to limit groundwater drawdown	• Comply with FVEMP • Comply with CEMP • Comply with IWEMP • Comply with Groundwater Monitoring Procedure (outlined in the IWEMP)	• Monitor riparian vegetation health in accordance with guidance and industry best practise • Routine groundwater monitoring will be conducted to monitor groundwater drawdown • Regular borefield equipment inspections and maintenance	• NA	✓	No
Weed introduction and proliferation resulting in disturbance and decline in vegetation health *Indirect impact*	• Avoid facilitating the introduction of new weed species or the spread of existing weed species in the Proposal area as a result of the Proposal	• Include hygiene obligations into contracts with any contractor entering the site • Timely response for management of any declared weed occurrences • Limit vehicle and personnel movements outside of approved areas • Training for personnel to identify weed species and process for reporting weed locations. • Incident reporting of new weed species and new locations	• Comply with FVEMP • Comply with CEMP • Comply with MCP • Develop a Weed Management Procedure • Develop a Ground Disturbance Permit System and Procedure • Develop a Topsoil Stripping and Storage Procedure. • Develop a Waste Management Procedure • Develop an Incident Reporting Procedure	• Inspections of cleared and rehabilitated areas to detect presence of new weed species and to determine success of weed mitigation measures • Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas	✓	No
Changes to surface hydrology and water flows during inundation, resulting in disturbance and decline in flora and vegetation health *Indirect impact*	• Limit disturbance On-LDE (<5%; 15,000 ha) • The location and layout of the On-LDE infrastructure has been designed to exclude impacts to the Lake Islands and minimise impacts to the lake fringe riparian zone, including avoidance buffers ranging from 250 to 500 m (Appendix I.10) • Avoid clearing within drainage features and drainage lines where possible	• Detailed hydrological modelling of surface water flows, simulation 1:100-year events to determine impacts • Staged development of trenches via BMUs and engineering design (1 km spacing, install crossovers) to allow natural surface water flows and flooding in natural depressions of the lake. The staged development will allow for adaptive management and mitigation. • Haul road constructed to avoid impediments to surface water flows/sheet drainage during flooding events	• Comply with FVEMP • Comply with CEMP • Develop a Ground Disturbance Permit System and Procedure • Comply with IWEMP • Comply with MCP • Develop an Incident Reporting Procedure	• Monitor riparian vegetation health in accordance with guidance and industry best practice.	• at closure, strategic breaching of the southern feeder of trench bunding canal to maintain hydrology, based on hydrological modelling results; and • at closure, trenches to infill naturally, a process likely to occur within approximately 10 years (based on field observations of test trenches), aided by flooding, which will	✓	No

Key Proposal Impacts (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
					increase sedimentation into trenches.		
Altered fire regimes resulting in disturbance and decline in vegetation health *Indirect impact*	• Avoid hot works in fire sensitive vegetation	• Liaise with Traditional Owners about the management of local fire regimes and fire management practices Establish Emergency Response Plan and Emergency Response Team (ERT) • Fire response equipment maintained at site and in vehicles and machinery and Haul Trucks • Water trucks fitted with high pressure monitors and pumps for fire management • Implement a hot works permit system for high ignition risk work activities high ignition risk work activities • Develop education programs for haul road users (including Traditional Owners)	• Comply with FVEMP • Comply with CEMP • Develop a Fire Management Procedure • Develop an Emergency Response Plan • Develop a Hot Works Permit System • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process	• NA	✓	No
Hydrocarbon and chemicals spills resulting in disturbance and decline in vegetation health *Indirect impact*	• Power generation by using LNG, solar and wind operation reduces field usage required for the Proposal • Avoid fuel/chemical storage and transfer from occurring outside of designated area • Avoid off-road driving and stay on approved access ways	• Spill response equipment available • Spill response training for all personnel and contractors • Dedicated workshop for maintenance • Maintain high standard of housekeeping	• Comply with FVEMP • Comply with CEMP • Bioremediation facility for the treatment of contaminated fill, soils, or sediment • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process	• If required, contaminated site rehabilitation	✓	No
Discharge or seepage of untreated wastewater resulting disturbance and decline in vegetation health *Indirect impact*	• Uncontrolled discharge or seepage	• WWTP and irrigation infrastructure to be operated and maintained in accordance with design specifications • Obtain all required environmental approvals for construction and operation of the WWTP (Part 5 and local council/ DoH approvals) • Maintain high standard of housekeeping around processing plant and associated infrastructure • Adhere to wastewater best practice health and environmental legislation and guidelines for irrigation of treated wastewater	• Comply with FVEMP • Comply with CEMP • Develop an Emergency Response Plan • Develop a Controlled Waste Management Procedure • Develop an Incident reporting Procedure	• Routine testing of treated wastewater to ensure discharged wastewater meets minimum compliance discharge criteria • Internal incident reporting and investigation process	• NA	✓	No
Increased soil salinity resulting in disturbance and decline in vegetation health *Indirect impact*	• Avoid uncontrolled discharge of brackish/saline water	• Pipelines to be installed in earthen bunded culverts to prevent spills from discharging into the surrounding environment	• Comply with FVEMP • Comply with CEMP • Comply with an Emergency Response Plan • Comply with IWEMP • Develop an Incident reporting Procedure	• Regular pipeline inspections and maintenance • Internal incident reporting and investigation process	• NA	✓	No
Fugitive dust emissions resulting in disturbance and decline in vegetation health *Indirect impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Haul road will be sealed in the early stages of the Proposal, limiting dust emissions that would otherwise be likely from an unsealed haul road	• Use of dust suppression (water carts) during clearing activities and operations • Vehicle speeds on construction roads will be reduced where necessary to minimise dust emissions	• Comply with FVEMP • Comply with CEMP • Develop a Dust Management Plan (DMP) • Develop a Traffic Management Plan (TMP) • Develop a Complaints Procedure and Register	• Monitor daily wind conditions will be taken into consideration when clearing activities are proposed • Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas	✓	No

6.6 Assessment of Impacts

6.6.1 Clearing and fragmentation of native vegetation

The Proposal will directly and indirectly impact on flora and vegetation within the Indicative Footprint and relevant Development Envelopes. Direct impacts as a result of vegetation clearance will be primarily limited to the construction phase of the Proposal; however, any future road maintenance activities may also require minor, localised clearing. Most vegetation types are considered to be very widespread in the region, and no vegetation types are limited to occurring within the Indicative Footprint. Area calculations of each vegetation type within the Proposal area are listed in Table 6-17, which also provides proportions of each vegetation type within the entire Study Area. Typically, less than 5% of a given vegetation type occurs within the Indicative Footprint when compared to its extent within the Study Area, except for the vegetation type, AdAlALMTs, for which the extent within the Indicative Footprint was 7.43% of its extent within the Study Area. Vegetation condition calculations within the Proposal area and each Indicative Footprint are provided in Table 6-18.

Indirect impacts such as minor fragmentation of vegetation types, and populations of flora may occur. The majority the vegetation was classified as Excellent vegetation condition within the Proposal area and the Study Area which is also representative of the broader region. No TECs, PECs or groundwater-dependent vegetation occur within or near the Proposal area and most vegetation types within the Development Envelopes are considered widespread and occur beyond the Proposal area.

Trenching and construction of infrastructure on the surface of Lake Mackay will cause direct impacts to a maximum of 15,000 ha of the non-vegetated playa (On-LDE). There has been 0.38 ha of vegetation mapped within the On-LDE Indicative Footprint. Earthworks within the On-LDE for the Proposal is likely to impact vegetation; however, in relatively minimal proportions. Of the two vegetation types mapped within the Indicative Footprint, less than 0.1% of the total representation of the vegetation mapped across the Study Area occurs.

Clearing of vegetation for processing infrastructure and associated requirements will result in direct impact due to a loss of up to 200 ha of vegetation within the 688 ha Off-LDE. AdAlALMTs comprises 303 ha of the Off-LDE; this represents 32% of the vegetation type within the Study Area. Five vegetation types are mapped within the Off-LDE. Approximately 70 ha of AdAlALMTs occurs within the Indicative Footprint; less than 8% of its representation in the Study Area. The majority of the dominant species comprising this vegetation type have a widespread distribution across arid and semi-arid regions of WA.

Clearing of vegetation will result in a direct impact due to the loss of up to 1,000 ha of vegetation within the 33,928 ha NIDE. Construction of the haul road requires removal of vegetation generally within a 24 m wide corridor (of which 30% is on an existing cleared track). Of the 39 vegetation types mapped within the NIDE, the most dominant is AstipGwaAancTbTe which comprises 4,576 ha (13.5 %) of the Development Envelope and represents the full extent of the vegetation type within the Study Area. However, 132 ha of AstipGwaAancTbTe occurs within the Indicative Footprint; less than 3% of the representation in the Study Area. This vegetation type is dominated by very common species and is considered to occur extensively across the Great Sandy Desert.

Clearing of vegetation for borefield, water pipelines and access tracks will result in a direct impact of up to 300 ha of vegetation within the 11,799 ha SIDE. Of the 16 vegetation types mapped within the SIDE, EgEp (Co)AsppTb comprises 8,254 ha (70%) of the Development Envelope; however, this represents only 13% of the vegetation type within the Study Area. Approximately 144 ha of EgEp (Co)AsppTb occurs within the Indicative Footprint; less than 1% of the representation in the Study Area. This vegetation type is dominated by very common species and is considered to occur extensively across the Great Sandy Desert.

Based on the implementation of mitigation measures to limit the impact of clearing and fragmentation of native vegetation, the EPA objective for Flora and Vegetation will be met.

Table 6-17: Extent of vegetation type within the Study Area, Development Envelopes and Indicative Footprint

Vegetation Type	Significance	Extent within the Study Area (ha)	Extent within the Proposal area										Extent within the Indicative Footprint									
			On-LDE		Off-LDE		SIDE		NIDE		Total Proposal area		On-LDE		Off-LDE		SIDE		NIDE		Total Disturbance within the Indicative Footprint	Total Disturbance as a proportion of the Study Area
			ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Saline Playa	-	243,461.00	216,238.63	88.82	0.08	<0.01	0.24	<0.01	73.96	0.03	216,312.91	88.85	13,363.12	5.49	-	-	-	-	-	-	13363.12	5.49
EgEp(Co)AsppTb	Priority flora	6,3076.43	0.01	<0.01	-	-	8,253.62	13.09	-	-	8,253.63	13.09	-	-	-	-	143.47	0.23	-	-	143.47	0.23
AstipGwaAancTbTe	-	4,576.04	-	-	-	-	-	-	4,576.04	100.00	4576.04	100.00	-	-	-	-	-	-	132.30	2.89	132.30	2.89
AhAaaTbTs	-	2,083.11	-	-	-	-	-	-	2,081.61	99.93	2,081.61	99.93	-	-	-	-	-	-	73.65	3.54	73.65	3.54
EpGwaAancTp	Priority flora	2,830.39	-	-	-	-	-	-	2,204.46	77.89	2,204.46	77.89	-	-	-	-	-	-	72.16	2.55	72.16	2.55
AdAlALMTs	-	941.66	-	-	302.76	32.15	0.20	0.02	28.52	3.03	331.48	35.20	-	-	69.09	7.34	-	-	0.85	0.09	69.94	7.43
AstipHmTe	Priority flora	2,319.05	-	-	-	-	-	-	2,262.76	97.57	2,262.76	97.57	-	-	-	-	-	-	65.84	2.84	65.84	2.84
GsAlALMMlNcTp	-	6,413.68	0.11	<0.01	276.66	4.31	101.13	1.58	26.70	0.42	404.61	6.31	-	-	61.38	0.96	1.56	0.02	<0.01	<0.01	62.94	0.98
AancTb	-	2,122.25	-	-	-	-	-	-	2,015.24	94.96	2,015.24	94.96	-	-	-	-	-	-	62.92	2.96	62.92	2.96
AstipTsTe	Priority flora	2,176.92	-	-	-	-	-	-	2,176.92	100.00	2,176.92	100.00	-	-	-	-	-	-	61.25	2.81	61.25	2.81
(+/-Ev)EgAad(Sao)Tb	-	2,104.25	-	-	-	-	-	-	2,104.25	100.00	2,104.25	100.00	-	-	-	-	-	-	57.31	2.72	57.31	2.72
HmAeTp	-	1,818.27	-	-	-	-	-	-	1,808.83	99.48	1,808.83	99.48	-	-	-	-	-	-	54.98	3.02	54.98	3.02
AhTbTe	Priority flora	1,601.37	-	-	-	-	-	-	1,600.25	99.93	1,600.25	99.93	-	-	-	-	-	-	46.95	2.93	46.95	2.93
EpAstipGwaCcarTb	-	1,416.25	-	-	-	-	-	-	1,409.59	99.53	1,409.59	99.53	-	-	-	-	-	-	43.28	3.06	43.28	3.06
HdSeTsTsp.	-	4,423.51	<0.01	<0.01	-	-	-	-	1,308.24	29.57	1,308.24	29.57	-	-	-	-	-	-	39.26	0.89	39.26	0.89
(Ep)AvAancSaoAblTpTe	-	1,468.82	-	-	-	-	-	-	1,464.45	99.70	1,464.45	99.70	-	-	-	-	-	-	39.22	2.67	39.22	2.67
(Eg)AlALMTb(Ts)	-	2,233.67	<0.01	<0.01	-	-	428.27	19.17	-	-	428.27	19.17	-	-	-	-	33.08	1.48	-	-	33.08	1.48
EoAacTeTsTp	-	1,132.87	-	-	-	-	-	-	1,132.81	100.00	1,132.81	100.00	-	-	-	-	-	-	27.94	2.47	27.94	2.47
EpEgAblAancTbTe	Priority flora	1,009.37	-	-	-	-	-	-	1,009.37	100.00	1,009.37	100.00	-	-	-	-	-	-	27.15	2.69	27.15	2.69
AadAeAancTbTs		5,804.73	-	-	-	-	360.15	6.20	-	-	360.15	6.20	-	-	-	-	21.76	0.37	-	-	21.76	0.37
MlGcSdFcTspp(TsaTp)	Riparian zone / Priority flora	7,673.33	345.17	4.50	50.00	0.65	268.67	3.50	14.50	0.19	678.34	8.84	0.31	0.00	3.92	0.05	17.46	0.23	-	-	21.68	0.28
Ad(Eg)TpTb	-	12,625.80	1.72	0.01	-	-	41.66	0.33	429.05	3.40	472.43	3.74	-	-	-	-	1.22	0.01	17.59	0.14	18.81	0.15
Cleared	-	116.28	-	-	1.21	1.04	19.48	16.75	72.60	62.43	93.28	80.22	-	-	0.44	0.38	5.98	5.14	12.01	10.33	18.43	15.85
CspGplAancTe	-	633.07	-	-	-	-	-	-	633.07	100.00	633.07	100.00	-	-	-	-	-	-	17.42	2.75	17.42	2.75
+/-SahDrAcAhhFdAvll	Restricted distribution	382.92	-	-	-	-	-	-	382.92	100.00	382.92	100.00	-	-	-	-	-	-	16.80	4.39	16.80	4.39
CcGsNsDdTpilTs	Priority flora	563.46	-	-	-	-	-	-	562.26	99.79	562.26	99.79	-	-	-	-	-	-	15.59	2.77	15.59	2.77
CddEpAelAancTb	Priority flora	545.77	-	-	-	-	-	-	545.77	100.00	545.77	100.00	-	-	-	-	-	-	15.26	2.80	15.26	2.80
AlTp	Priority flora	377.95	-	-	-	-	-	-	377.95	100.00	377.95	100.00	-	-	-	-	-	-	14.46	3.83	14.46	3.83
AlMgTb(TpTs)	-	5,885.48	0.11	<0.01	40.98	0.70	184.57	3.14	114.98	1.95	340.64	5.79	-	-	9.31	0.16	-	-	4.56	0.08	13.87	0.24
CcdTeTb(Tp)	Priority flora	393.58	-	-	-	-	-	-	393.58	100.00	393.58	100.00	-	-	-	-	-	-	12.17	3.09	12.17	3.09
FcTsppEf(TsaTs)	Riparian zone	6,090.96	9.57	0.16	-	-	137.42	2.26	-	-	146.99	2.41	-	-	-	-	11.20	0.18	-	-	11.20	0.18
CcAstipTeAhh	Priority flora	391.77	-	-	-	-	-	-	391.77	100.00	391.77	100.00	-	-	-	-	-	-	11.20	2.86	11.20	2.86
CcAlALMAmNsDdTsTp	-	16,060.89	-	-	-	-	1,695.98	10.56	-	-	1,695.98	10.56	-	-	-	-	10.78	0.07	-	-	10.78	0.07

Vegetation Type	Significance	Extent within the Study Area (ha)	Extent within the Proposal area										Extent within the Indicative Footprint									
			On-LDE		Off-LDE		SIDE		NIDE		Total Proposal area		On-LDE		Off-LDE		SIDE		NIDE		Total Disturbance within the Indicative Footprint	Total Disturbance as a proportion of the Study Area
			ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
(Eb)AacTi	-	785.60	-	-	-	-	-	-	785.60	100.00	785.60	100.00	-	-	-	-	-	-	10.11	1.29	10.11	1.29
AlSaoTbTp	-	208.91	-	-	-	-	-	-	2,08.91	100.00	208.91	100.00	-	-	-	-	-	-	9.25	4.43	9.25	4.43
AccSaoTp	-	378.43	-	-	-	-	-	-	315.01	83.24	315.01	83.24	-	-	-	-	-	-	9.11	2.41	9.11	2.41
AaAccSao	-	273.81	-	-	-	-	-	-	240.94	88.00	240.94	88.00	-	-	-	-	-	-	8.84	3.23	8.84	3.23
AeDdTeAhh	Priority flora	329.65	-	-	-	-	-	-	329.65	100.00	329.65	100.00	-	-	-	-	-	-	7.88	2.39	7.88	2.39
MgTbTsaTs	Potential GDV	5,833.57	-	-	-	-	153.74	2.64	-	-	153.74	2.64	-	-	-	-	5.64	0.10	-	-	5.64	0.10
GsAtAlNsTsTp	-	458.73	-	-	-	-	-	-	458.73	100.00	458.73	100.00	-	-	-	-	-	-	4.60	1.00	4.60	1.00
CcDdTpAhh	Priority flora	119.54	-	-	-	-	-	-	118.59	99.20	118.59	99.20	-	-	-	-	-	-	3.09	2.59	3.09	2.59
EvAvSaoTlTe	Priority flora Potential GDV	81.81	-	-	-	-	-	-	81.81	100.00	81.81	100.00	-	-	-	-	-	-	2.05	2.50	2.05	2.50
CoTe	Priority flora	36.99	-	-	-	-	-	-	36.99	100.00	36.99	100.00	-	-	-	-	-	-	0.85	2.30	0.85	2.30
EvTb(TsaTs)	Potential GDV	544.14	-	-	-	-	28.19	5.18	-	-	28.19	5.18	-	-	-	-	0.84	0.15	-	-	0.84	0.15
TsppEf	Riparian zone / Priority flora	7,871.48	573.84	7.29	16.03	0.20	39.58	0.50	68.59	0.87	698.04	8.87	0.08	0.00	0.08	<0.01	0.09	<0.01	-	-	0.25	<0.01
SaoFcTsa(Tb)	Priority flora	5,972.17	-	-	-	-	70.51	1.18	-	-	70.51	1.18	-	-	-	-	0.20	<0.01	-	-	0.20	<0.01
CcdCaDpTiPa	Restricted distribution	46.38	-	-	-	-	-	-	46.38	100.00	46.38	100.00	-	-	-	-	-	-	0.09	0.20	0.09	0.20
AaptAparSaoAhh	-	195.84	-	-	-	-	-	-	-	-	0.00	0.00	-	-	-	-	-	-	-	-	-	-
ALMNsTp	-	2,626.07	4.79	0.18	-	-	15.39	0.59	-	-	20.18	0.77	-	-	-	-	-	-	-	-	-	-
EssDpAsyCencCfAv	-	6.95	-	-	-	-	-	-	6.95	100.00	6.95	100.00	-	-	-	-	-	-	-	-	-	-
MgAl(Fc)TpEf	Potential GDV	13,433.11	86.83	0.65	-	-	-	-	-	-	86.83	0.65	-	-	-	-	-	-	-	-	-	-
SggTbr	-	27.21	-	-	-	-	-	-	27.21	100.00	27.21	100.00	-	-	-	-	-	-	-	-	-	-
Total		443,985.32	217,260.78	48.93	687.72	0.15	11,798.79	2.66	33,927.81	7.64	263,675.10	59.39	13,363.51	3.01	144.22	0.03	253.29	0.06	997.96	0.22	14,758.98	3.32

Note: Percentages presented as a proportion of the area of that vegetation type within the entire Study Area; % of extent values are calculated as the area of a particular vegetation type in the Development Envelope, as a proportion of the area of that vegetation type within the Study Area; GDV is groundwater-dependent vegetation.

Table 6-18: Vegetation conditions within the Study Area, Development Envelopes and Indicative Footprint percentages are presented as a proportion of the area of that vegetation condition within the entire Study Area.

Vegetation Condition	Extent within the Study Area (ha)	Extent within the Proposal area										Extent within the Indicative Footprint									
		On-LDE		Off-LDE		SIDE		NIDE		Total Proposal area		On-LDE		Off-LDE		SIDE		NIDE		Total Indicative Footprint	
		ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Excellent	198,562.11	1,022.15	0.51	686.43	0.35	11,779.08	5.93	32,063.31	16.15	45,550.97	22.94	0.38	<0.01	143.77	0.07	247.31	0.12	939.00	0.47	1,330.47	0.67
Very Good	1,408.16	-	-	-	-	-	-	1,280.20	90.91	1,280.20	90.91	-	-	-	-	-	-	37.61	2.67	37.61	2.67
Good	437.75	-	-	-	-	-	-	437.75	100	437.75	100.00	-	-	-	-	-	-	9.34	2.13	9.34	2.13
Poor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Degraded	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Completely Degraded	116.28	-	-	1.21	1.04	19.48	16.75	72.60	62.43	93.28	80.22	-	-	0.44	0.38	5.98	5.12	12.01	10.33	18.43	15.85
Saline Playa	243,461.00	216,238.63	88.82	0.08	<0.01	0.24	<0.01	73.96	0.03	21,6312.91	88.85	13,363.12	5.49	-	-	<0.01	<0.01	-	-	13,363.12	5.49
Total	443,985.32	217,260.78	48.93	687.72	0.15	11,798.79	2.66	33,927.81	7.64	263,675.10	59.39	13,363.51	3.01	144.22	0.03	253.29	0.03	997.96	0.22	14,758.98	3.32

6.6.2 Clearing and fragmentation of significant flora and significant vegetation

No species listed under the EPBC Act and no threatened species listed under the BC Act have been recorded within the Study Area for the Proposal.

A total of 14 Priority Flora species were recorded in the Study Area, of which seven occur within the Proposal area (Table 6-19). Of these, one species, *Comesperma sabulosum* (P3), occurs within the Indicative Footprint. This species was recorded at 106 locations within the Study Area with 10 locations (9%) occurring within the NIDE. No other Priority flora were recorded within the Indicative Footprint.

A total of 11 flora species of 'other significance' have been recorded within the Study Area, of which 10 occur within the Proposal area (Table 6-19). Of these, two species, (*Goodenia* aff. *armitiana* and *Triodia* c.f. *epactia*) occur within the Indicative Footprint. Based on survey work, *Goodenia* aff. *armitiana* has been recorded 15 locations within the Study Area, of which five occur within the Indicative Footprint. *Triodia* c.f. *epactia* has been recorded 22 locations within the Study Area of which one record occurs within the Indicative Footprint. Both species have been recorded extensively outside the Study Area (Table 6-12).

Many of the Priority flora species recorded within the Study Area have relatively few vouchered records within WA, which is likely to be reflective of the paucity of survey work in the region. Additionally, over 130 species (approximately 25% of the species inventory) were classified as range extension records, with most of these species being common in other bioregions. These records further suggest a relative paucity of survey in the vicinity of the Proposal area.

No WoNS or Declared Pest plants have been recorded within the Study Area; however, several environmental weeds rated as having high ecological impact and rapid invasiveness characteristics were recorded in the NIDE (Section 6.6.4).

No vegetation types were considered analogous to any BC Act or EPBC Act listed TECs or PECs. No previously mapped TEC occurs within 150 km of the Study Area and the nearest mapped PEC is the Wolfe Land System (Priority 3), located 55.5 km north-west of the Study Area. No vegetation recorded within the Study Area is considered to be restricted to only occurring within the Study Area.

Based on the implementation of mitigation measures to limit the impact of clearing and fragmentation of significant flora and significant vegetation, the EPA objective for Flora and Vegetation will be met

Table 6-19: Locations of Priority flora, affinity species, potential hybrids and anomalous records with respect to the Study Area, Proposal area and Indicative Footprint

Flora	Study Area records	Proposal area records	Proposal Area				Indicative Footprint			
			NIDE	SIDE	On-LDE	Off-LDE	NIDE	SIDE	On-LDE	Off-LDE
Priority 1										
Stackhousia sp. Lake Mackay (P.K. Latz 12870)	16	16	-	9	-	7	-	-	-	-
Priority 2										
Goodenia virgata	9	6	2	4	-	-	-	-	-	-
Priority 3										
Comesperma sabulosum	106	105	105	-	-	-	10	-	-	-
Eragrostis lanicaulis	16	15	14	-	-	1	-	-	-	-
Goodenia modesta	2	1	-	1	-	-	-	-	-	-
Indigofera ammobia	44	44	44	-	-	-	-	-	-	-
Stackhousia clementii	5	5	2	2	-	1	-	-	-	-
Flora of other significance										
Acacia bivenosa ?xligulata	8	8	8	-	-	-	-	-	-	-
Goodenia ?lunata (P1)	2	2	2	-	-	-	-	-	-	-
Goodenia aff. *armitiana*	22	22	22	-	-	-	1	-	-	-
Goodenia aff. *microptera*	1	1	-	1	-	-	-	-	-	-
Lawrencia aff *viridigrisea*	3	2	-	-	-	2	-	-	-	-
Newcastelia aff. *bracteosa*	2	1	1	-	-	-	-	-	-	-
Tecticornia aff. *calyptrata* (NT form)	75	46	5	10	16	15	-	-	-	-
Tecticornia aff. *halocnemoides* subsp. *longispicata*	6	3	-	1	2	3	-	-	-	-
Triodia c.f. *epactia*	15	15	15	-	-	-	5	-	-	-
Triodia c.f. *pungens*	7	7	7	-	-	-	-	-	-	-

6.6.3 Direct and indirect impact to riparian vegetation

A total of 21,636 ha of riparian vegetation occurs within the Study Area; dominating the margins of Lake Mackay and its islands. Of this, 1,523 ha (7.04%) occurs within the Proposal area, and 33.13 ha occurs within the Indicative Footprint proposed for disturbance which represents only 0.15% of riparian vegetation within the Study Area (Table 6-17). Clearing of riparian vegetation needs to occur for two reasons.

1. Accessing the lake through the lake fringing riparian zone for both equipment and pipelines is an unavoidable impact, but only requires small areas of disturbance
2. Although the southern access track in the SIDE has been sited to avoid as much riparian vegetation associated with drainage features as possible, there are areas of unavoidable impact.

Potential impacts (habitat loss, fragmentation, or modification) to the riparian vegetation are considered minor in relation to the total extent of these vegetation types at Lake Mackay. Mitigation of disturbances to riparian vegetation has already occurred in Proposal planning stages where the location of processing infrastructure was moved to avoid the riparian zone. Further mitigation will primarily involve:

- the exclusion of islands from the Proposal area to avoid direct impacts; and
- the establishment of buffers to mitigate indirect impacts associated with changes in surface hydrology and groundwater drawdown.

The islands on Lake Mackay have been categorised based on size, habitats and geology and subsequent ecological, hydrological and hydrogeological studies were used to develop suitable buffer zones (Appendix I.10). The sizes of the exclusion zones and the number of islands in each category are summarised below and rational provided in Appendix I.10:

- landform islands (3 islands in total) – buffer size will be 500 m;
- intermediate and Large islands (52 islands in total) – buffer size will be 250 m; and
- small islands (216 islands in total) – buffer size will be 100 m.

Riparian vegetation associated with the lake, islands and surrounding peripheral wetlands has been assessed during numerous surveys. This zone is dominated by *Tecticornia* species (including *Tecticornia* aff. *calyptrata* (NT form) and *Tecticornia* aff. *halocnemoides* subsp. *longispicata*, both considered to be of "other significance"), which while affiliated with salt lake margins, requires freshwater to germinate (Datson 2005). A recent study by Botanica Consulting (2017), also found that the root system of *Tecticornia* was restricted to the upper horizon of the soil profile (<30 cm). *Tecticornia* are therefore most likely to opportunistically access stored water within the capillary fringe of the vadose zone. This capillary fringe, which comprises low salinity water within aeolian sands, is recharged by rainfall. Water is subsequently bound and stored in pore spaces, supporting the shallow root systems of samphire vegetation during dry conditions, independent of the lake bed sediments. In addition, the salinity of hypersaline groundwater (>200,000 mg/L) is likely outside the tolerance limits of *Tecticornia*. *Tecticornia* are considered unlikely to represent true groundwater-dependent vegetation (Stantec 2021a) and therefore unlikely to be impacted by groundwater drawdown.

Although groundwater drawdown is unlikely to impact the riparian zone, these is the potential for groundwater drawdown to indirectly impact groundwater-dependent vegetation on the lake islands. Details on the interaction of groundwater drawdown within the lake sediment and the area of influence is provided within the groundwater section of Inland Waters (Section 9). However, a brief summary is provided below to provide context within this section. Groundwater salinity within the lake sediment is hypersaline, typically ~250,000 mg/L. Baseline groundwater levels range from 0.4 to 0.7 mbgl within the lake bed sediments, and from 3.4 to 4.0 mbgl beneath the larger islands. During prolonged dry conditions, a decrease of up to 0.2 mbgl was recorded within the lake bed sediments, while a reduction of up to 0.6 mbgl was observed beneath the larger islands. Potential groundwater-dependent vegetation is not anticipated to be dependent upon the hypersaline groundwater; however, there may be some interaction with lower salinity water that overlies the hypersaline layer (Section 9). Potentially groundwater-dependent vegetation known to occur on the islands includes *Allocasuarina decaisneana* and *Melaleuca glomerata*.

Groundwater drawdown from brine abstraction within the lake bed sediments (up to 100 GL/a) will be progressive over the LoM. The construction of the BMUs will be staged over 17 years and allow for adaptive management of potential impacts. Generally, trench water levels within the BMUs will be drawn down to a sustained level of approximately 3 mbgl within two years after pumping begins, with an associated lowering of groundwater levels occurring laterally away from the trenches. After 10 years of abstraction, drawdown across the BMUs averages 0.52 m to 0.73 m. After 20 years of abstraction, drawdown across the BMUs averages 0.41 m to 0.74 m (Figure 7-24) (see detailed modelling within Section 9.5.4.1, Figure 9-31).

With buffers in place around the islands, maximum drawdown of the lake bed sediments beneath the landform islands is expected to range from 1.25 m on the island fringes to less than 0.25 m in the centre of the islands. Most of the islands are subject to drawdown of less than 0.75 m (Figure 7-24; Section 9.5.4.1, Figure 9-31). Based on this modelling, with buffers in place, drawdown is likely to be minimal at the margins of the islands and negligible beneath the islands (i.e. likely within range of natural variation). Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions. Consequently, based on modelling, potentially groundwater-dependent vegetation should not be impacted by the operation of the Proposal due to groundwater drawdown.

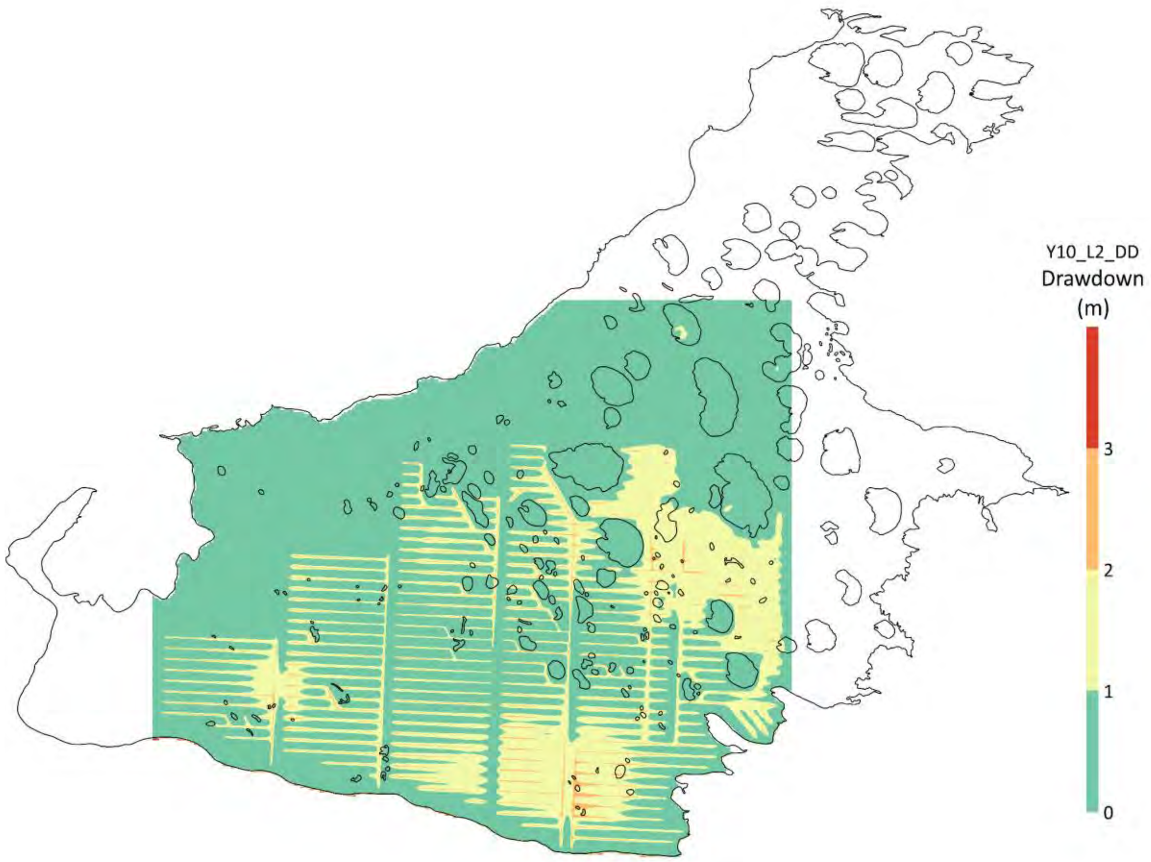
Indirect impacts due to windblown salt has also been identified as a potential indirect impact upon riparian vegetation. However, salts from evaporations ponds and salt piles have cohesive properties that will prevent movement by wind. The implementation of suitable buffers between evaporation ponds and salt piles, and riparian vegetation will further mitigate the risk of adverse effects of windblown particles upon vegetation.

Mitigation of direct impacts to the riparian zone has involved design to minimize disturbance to these vegetation types and exclusion of these vegetation types form the Proposal area. Mitigation of indirect impacts to the riparian zone from changes in surface hydrology and groundwater drawdown will primarily involve the exclusion of the islands from the Proposal area and the establishment of buffers around the islands (Appendix I.10). Additionally, potential indirect impacts will be mitigated via adaptive management and corrective actions over the staged LoM. Mitigation measures will include:

- compliance with a Flora and Vegetation Environmental Management Plan (FVEMP) and Construction Environmental Management Plan (CEMP);
- development of, and compliance with an Inland Waters Environmental Management Plan (IWEMP); and
- development and implementation of a Groundwater Monitoring Procedure.

Based on the implementation of mitigation measures to limit the direct and indirect impacts to riparian vegetation and potentially groundwater-dependent vegetation, the EPA objective for Flora and Vegetation will be met.

A



B

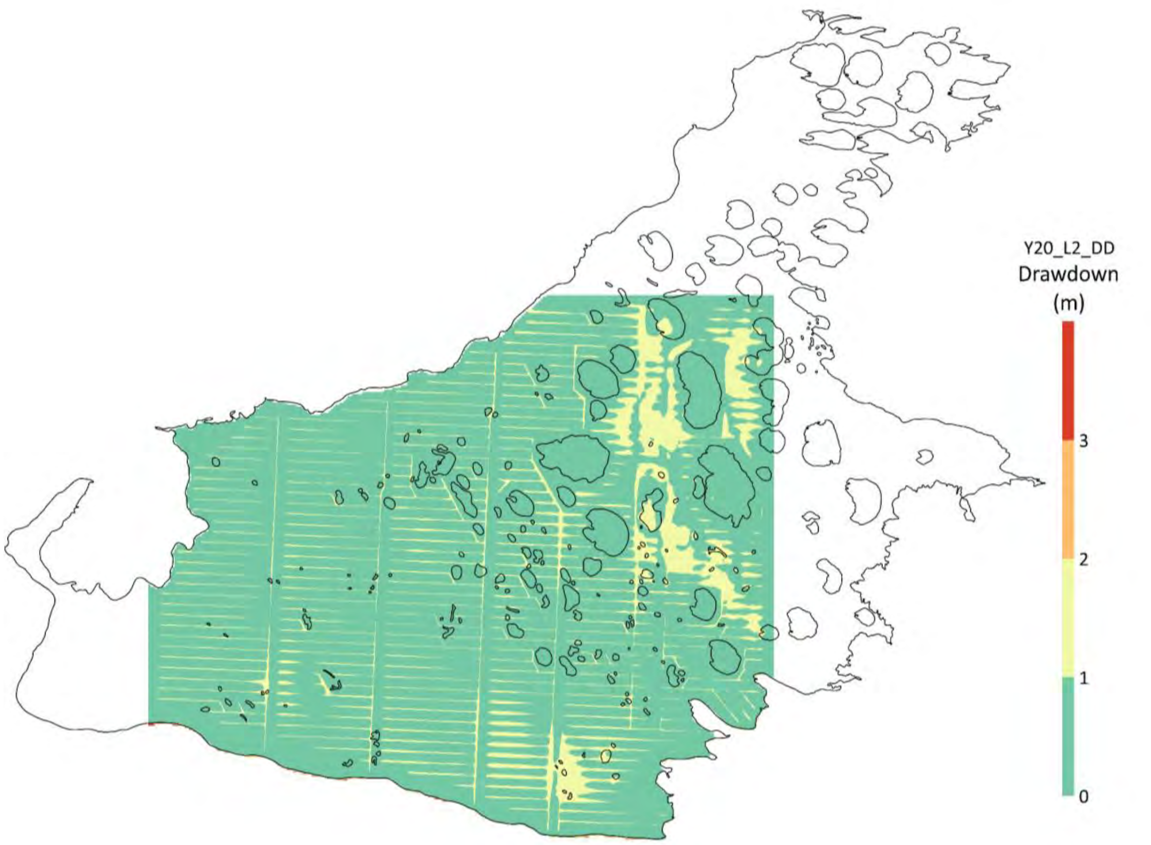


Figure 6-12: (A) 10 years LoM drawdown, (B) 20 years LoM drawdown

6.6.4 Weed introduction and proliferation resulting in disturbance and decline in vegetation health

Introduced flora (weeds) have a detrimental effect on ecological values of communities in which they invade. Weeds outcompete with native flora, alter the structure of vegetation, have an impact on fire regimes and change habitat characteristics for fauna; often leading to a decline in the quality of fauna habitat.

Six introduced flora species have been recorded within the Proposal area, all of which occur within the NIDE. However occurrences of weeds were extremely minimal within the Study Area, and therefore the Indicative Footprint, and vegetation was generally considered in Excellent condition (Table 6-18). To maintain such pristine floristic composition with the Proposal area, the implementation of several weed management actions is required. Compliance with weed hygiene procedures will prevent the introduction and/or spread of weeds as a result of the Proposal. Weed identification, including via surveys, inspections, and mitigation efforts (such as manual removal and herbicide application) shall be conducted at the appropriate seasons to minimise infestation.

Based on the implementation of mitigation measures to limit the impact of weed introduction and proliferation, the EPA objective for Flora and Vegetation will be met.

6.6.5 Changes to surface hydrology and water flows causing changes to inundation regimes resulting in disturbance and decline in flora and vegetation health

The Proposal has the potential to impact flora and vegetation as a result of changes to surface hydrology and altered water flow characteristics. The On-LDE and Off-LDE are particularly associated with the playa and riparian vegetation of Lake Mackay; operational activities, ponds, trenches and infrastructure. The evaporation ponds and trench network will be constructed progressively over the LoM and will take approximately 17 years to reach full size. The evaporation ponds and trench network will all be located on the salt lake within the On-LDE.

The filling of Australia's inland salt lakes is irregular and uncommon with flood events being primarily driven by large rain bearing tropical depressions. Although the On-LDE represents a small portion of the total surface area of the lake, the linear trench network and associated bunding has the potential to alter hydrological processes. This may result in localised changes to surface flows and inundation patterns on the lake.

Potential impacts to surface hydrology may result in a temporary change to hydrological processes during operations. Mitigation measures to reduce the risk of these impacts will include the following:

- staged development of trenches (BMUs) over a 17-year period, with appropriate engineering design, which will allow natural surface water flow and flooding in deeper parts of the basin (Figure 9-19), maintaining hydrological processes and ecological function;
- construction of trenches 1 km apart with the installation of strategic crossovers (and potential armouring), maintain hydrology and prevent backflow and inundation of riparian vegetation along the southern shoreline of the lake;
- implementation of suitable buffer zones surrounding the islands, which support riparian vegetation (Appendix I.10); and
- at closure, strategic breaching of the southern feeder of trench bunding canal to maintain hydrology, based on hydrological modelling results; and
- at closure, trenches to infill naturally, a process likely to occur within approximately 10 years (based on field observations of test trenches), aided by flooding, which will increase sedimentation into trenches.

Based on the implementation of mitigation measures to limit the impact of changes to surface hydrology and water flows, the EPA objective for Flora and Vegetation will be met.

6.6.6 Altered fire regimes resulting in disturbance and decline in vegetation health

Changes in the frequency and intensity of fire regimes can have a detrimental impact on flora and vegetation in the region. Fire is naturally associated with arid Australia, occurring as a result of lightning strikes and Traditional Owner land management. Fires may be caused as a result of operational processes (such as sparks from machinery) or anthropogenic sources (such as personnel inappropriately discarding cigarettes, or deliberate arson). Alterations in the nature of fires may inhibit the recruitment and maturity cycle of some species and reduce areas of vegetation comprised of old-growth Spinifex (*Triodia*) hummocks which are known to be important fauna habitat. Changes to vegetation structure as a result of fire may also facilitate weed species establishment and proliferation.

Chenopod shrublands, including samphires (*Tecticornia*) are less flammable that most other arid zone vegetation types; however, they are fire sensitive. The slow growing nature of *Tecticornia* shallow root systems and infrequent recruitment events suggests that regular fires would have a negative impact on populations.

The implementation of a number of fire management measures will prevent significant impacts to flora and vegetation as a result of the Proposal. Fires as a result of operational activity can be prevented by conducting hot works in areas with low potential for igniting fires. Impacts of fire can be minimised by maintaining access to appropriate firefighting equipment, other containment methods and implementing emergency response actions will reduce the likelihood of fire significantly impacting the flora and vegetation of the region.

Based on the implementation of mitigation measures to limit the impact of altered fire regimes, the EPA objective for Flora and Vegetation will be met.

6.6.7 Cumulative Impacts

The cumulative impacts of the Proposal in conjunction with other existing or reasonably foreseeable activities, developments and land uses is recognised as an important consideration for EIA (EPA 2021d).

For context, the Proposal is located in a remote and undeveloped region of WA. The majority of land within the GSD2 sub-bioregion is unallocated crown land, with areas of conservation, mining leases, and Aboriginal lands and reserves, and several small areas of urban development (DotE 2008; Kendrick 2001). Approximately 7% of the Great Sandy Desert bioregion is used for grazing (DotE 2008; Kendrick 2001). Within WA, TAN1 is dominated by unallocated crown land and crown reserves (Graham 2001).

Within the vicinity of the Proposal, existing impacts in the region are largely confined to development associated with the remote Indigenous communities, historical resources exploration and access roads. Land use is predominantly restricted to Indigenous land practices within the respective determinations.

The main impact associated with the Proposal comprises the clearing of vegetation. The majority of vegetation types proposed to be cleared are widely distributed in the broader landscape and bioregion (Stantec 2021c). The only vegetation that is not widely distributed outside the Proposal area is the riparian vegetation associated with the salt lake playa of Lake Mackay. Direct and indirect impacts to riparian vegetation from the proposal are considered negligible. There are no other proposed developments of salt lakes in the Great Sandy Desert or the Tanami bioregions and all other salt lakes in these bioregions are almost completely untouched.

Within WA, impacts from potash projects to ephemeral salt lakes of the arid zone were cumulatively assessed. This was undertaken by intersecting disturbance areas from approved potash projects with areas mapped as lake systems by Geoscience Australia (Geoscience Australia 2016). Features delineated as 'lakes' within the Geoscience Australia layer were filtered to only include features similar to Lake Mackay:

- non-perennial lakes: only ephemeral lakes which have a boom/bust hydroperiod typical of inland salt lakes were included. Permanent lakes were excluded;
- salt lake land systems: only lakes that coincided with salt lake land systems were included. Freshwater lake systems were excluded; and
- Eremaean and South-Western Interzone: only lake systems that occur within the Eremaean and South-Western Interzone botanical provinces were included. These lakes are more likely to have hydroperiods typical of the arid zone which experience irregular and infrequent inundation events similar to Lake Mackay. Lake systems from the southwest and northern interzones were excluded as they would be more likely to have regular seasonal inundation events.

In total, within the Great Sandy Desert, 508,430 ha of the lakes meet the criteria outlined above, of which, the proposed disturbance to Lake Mackay comprises 2.6 % (Table 7-15). Within WA, a total of 2,853,793 ha of lakes meets these criteria (Table 7-15). These salt lakes vary from pristine to disturbed with disturbance primarily from agriculture within the Avon Wheatbelt (lakes excluded from analysis as they occur within the southwest) and dewatering from resource projects in the Goldfields regions (Timms 2005). With respect to potash projects, four salt lake projects have been granted formal approval for development. These are:

- Beyondie Sulphate of Potash Project (Kalium Lakes Potash): Approval June 2019;
- Lake Disappointment Potash Project (Reward Minerals): Approval June 2020;
- Lake Wells Potash Project (Australian Potash Limited): Approval February 2021; and
- Lake Way Sulphate of Potash Project (Salt Lake Potash): Approval April 2021.

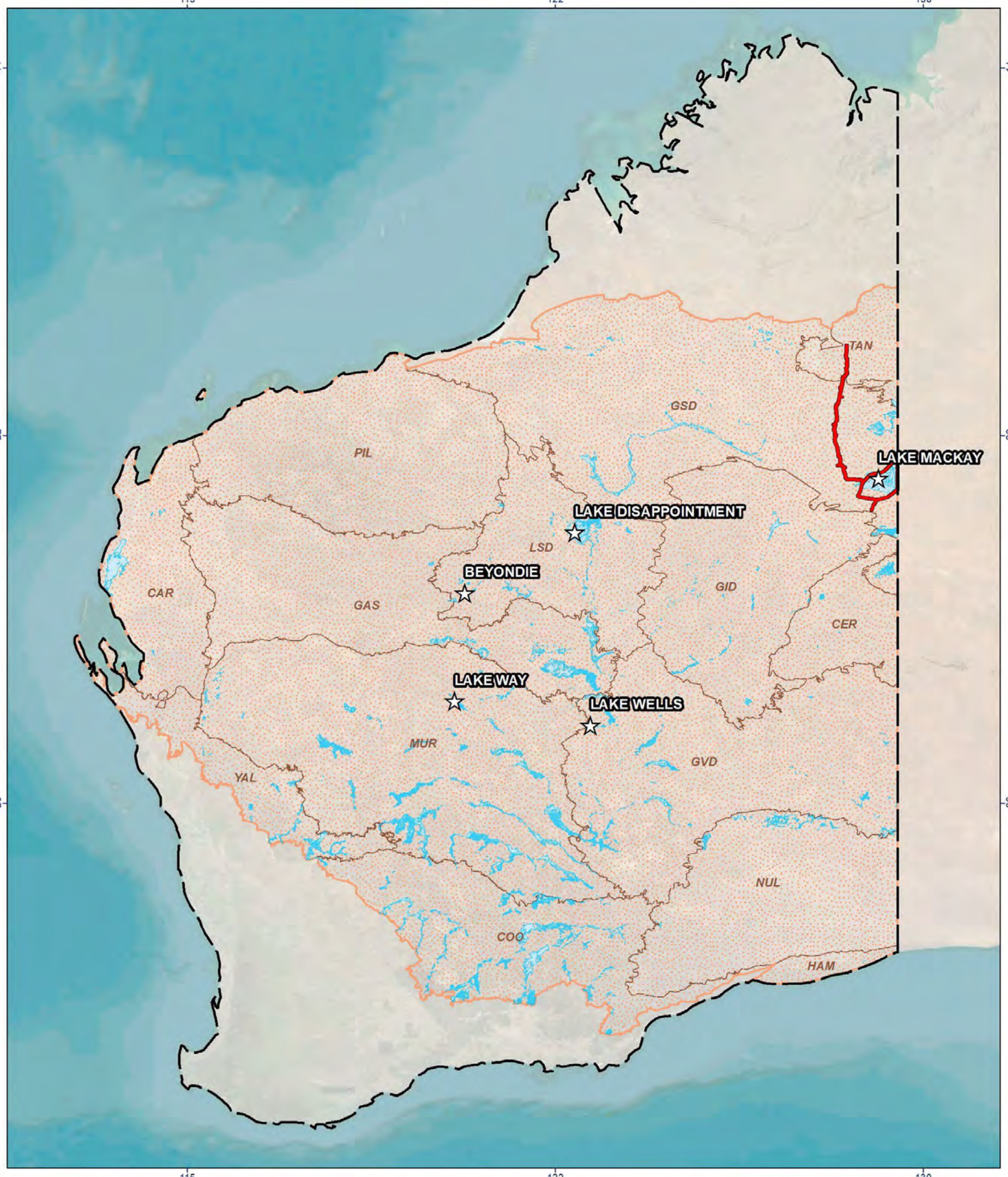
Within WA, the proposed disturbance from this Proposal comprises 0.5 % of the extent of salt lakes. The portion of Lake Mackay within the Proposal area comprises 7.6% of the extent of salt lakes by area in WA. Cumulative impacts from all approved salt lake potash projects and this Proposal will result in a disturbance comprising 0.9 % of the total extent of salt lakes within WA (Table 7-15, Figure 6-13). This will result in potash projects (based on proposal area) operating on 9.5 % of salt lakes by area within WA.

There are no other salt lake projects in the Great Sandy Desert or Tanami bioregions and the region is relatively unimpacted from human development. Consequently, any cumulative impacts in the region beyond those outlined for the Proposal are anticipated to be minimal. Additionally, within the broader context, disturbance from potash projects comprise only a small proportion of salt lakes by area in WA.

Table 6-20: Ephemeral salt lakes of the arid zone and their extent within WA with respect to this Proposal and other approved potash proposals.

Bioregion	Bioregion Code	Extent (ha)	Salt Lake Potash Proposals*	Extent within the Study Area		Extent within Proposal Area		Extent within the Indicative Footprint	
				Hectares	%	hectares	%	hectares	%
Carnegie	CAR	203,655							
Central Ranges	CER	4,988							
Coolgardie	COO	502,958							
Gascoyne	GAS	235,007							
Gibson Desert	GID	70,165							
Great Sandy Desert	GSD	508,430	Mackay Sulphate of Potash Project (this Proposal)	243,271	47.8%	216,333	42.5%	13,363	2.6%
Great Victoria Desert	GVD	191,907	Lake Wells Potash Project	10,301	5.4%	4,100	2.1%	2,180	1.1%
Hampton	HAM	98							
Little Sandy Desert	LSD	199,150	Beyondie Sulphate of Potash Project	3,225**	1.6%	^	^	197**	0.1%
			Lake Disappointment Potash Project	134,521	67.5%	35,934	18.0%	7,198	3.6%
Murchison	MUR	758,362	Lake Way Sulphate of Potash Project	16,867	2.2%	13,422	1.8%	2,549	0.3%
Nullarbor	NUL	43,914							
Pilbara	PIL	3,070							
Tanami	TAN	8,263							
Yalgoo	YAL	123,826							
Total		2,853,793	-	408,185	14.3%	269,789	9.5%	25,487	0.9%

*Note: * indicates salt lake extent as presented within each respective ERD; ** indicates combined 'salt lake playa' and 'lake margin' habitat; ^indicates not provided.*



WA State Border
Mackay Potash Project Study Area
Ephemeral Salt Lakes
Arid Zone
Arid Zone Bioregions
Sulphate of Potash Projects

0 150 300 km
(At original document size of A4)
1:12,500,000

Notes
1. Coordinate System: GCS GDA 1994
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2021).
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Stantec agrimin

Project Location
Stantec Australia Pty Ltd
Perth, Western Australia

Prepared by PR on 2021-08-19
TR by DK on 2021-08-19
IR Review by PB on 2021-08-19

Client/Project
Agrimin Ltd
Mackay Potash Project

Title
Salt Lake Systems of the Arid zone of Western Australia

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Figure 6-13: Ephemeral salt lakes of the arid zone and their extent within WA

6.7 Predicted Outcome

This Proposal is expected to result in the loss of up to 1,500 ha (0.31%) of native vegetation within the 443,985 ha within the Study Area. The remaining 15,000 ha of disturbance will be unvegetated lake playa.

There are several activities associated with the Proposal that have the potential to have an impact on flora and vegetation, including clearing and fragmentation of 1,500 ha of native vegetation, including the loss of individuals of significant flora, a small proportions of vegetation types that have the potential to support significant flora or are considered locally significant and a relatively small amount of riparian vegetation. Direct impacts to flora and vegetation when combined with indirect impacts such as groundwater drawdown resulting in a decline in vegetation health (including riparian vegetation and flora with the ability to use groundwater), weed introduction and proliferation may result in cumulative impacts from the Proposal.

The Proposal is not impacting upon any TECs, PECs, conservation reserves and vegetation types and significant flora are not restricted locally and are distributed widely in the regional context. The vegetation types are not protected under statute and the extent of impacts proposed is not likely to result in the conservation status of them being elevated or increasing the cumulative impact to a critical level.

No groundwater-dependent vegetation has been shown to occur in the Proposal 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.

The key mitigation measures that will be implemented for Flora and Vegetation for the Proposal largely avoid, mitigate, manage, monitor, and rehabilitate significant impacts to flora and vegetation receptors to reduce the environmental risk. Residual impact to Flora and vegetation for the Proposal were assessed as unlikely to result in long term or significant residual environmental impacts requiring an offset, as defined in *WA Environmental Offsets Guidelines* (Government of Western Australia 2014).

Given the above, and the management and mitigation measures proposed, the Proponent's assessment concludes this Proposal can be managed to meet the EPA's objective for Flora and Vegetation.

Based on the implementation of all mitigation measures to limit the impact of the Proposal on the environment, the EPA objective for Flora and Vegetation will be met.

7. Terrestrial Fauna

7.1 EPA Objectives

The EPA's environmental objective for terrestrial fauna is "*To protect terrestrial fauna so that biological diversity and ecological integrity are maintained*' (EPA 2016e).

7.2 Policy and Guidance

The State and Commonwealth legislative instruments, policy, guidelines, and advice relevant to the Proposal and their application are presented below. Table 7-1 also summarises the scope of each guide as relevant to the Proposal.

Table 7-1: Legislative instruments, policies and guidelines relevant to terrestrial fauna impact assessment

Legislative Instruments	
Biodiversity Conservation Act 2016	
Biosecurity and Agricultural Management Act 2007	
Environment Protection and Biodiversity Conservation Act 1999	
Environmental Protection Act 1986	
EPA Policy or Guidance	**Considerations**
Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA.	This Statement provides guidance to ensure that a Proposal addresses the holistic view of its environmental impact relevant to the EP Act.
Environmental Protection Authority. (EPA 2020b). Technical Guide: Terrestrial Fauna Surveys.	The EPA's advice for conducting desktop studies, survey preparation, habitat assessment, survey techniques, specimen handling, data analysis, mapping, and report to ensure a high standard of data available for EIA.
Environmental Protection Authority. (EPA 2016e). Environmental Factor Guideline – Terrestrial Fauna.	This guideline is intended to outline the values and significance of terrestrial fauna and the various activities that may impact this factor.
Environmental Protection Authority. (EPA 2021a). Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures.	Describes the principles and practices of EIA within the context of Part IV of the EP Act and how these processed are applied to the impact assessment of the Proposal upon terrestrial fauna.
Other Policy or Guidance	**Considerations**
Department Biodiversity, Conservation and Attraction. (DBCA 2017a). Interim Guideline for Preliminary Surveys of Night Parrot (*Pezoporus occidentalis*) in Western Australia.	This guideline details the information to determine when and where a Night Parrot survey should be conducted, as well as the methodology that should be used.
Department of Environment, Water, Heritage, and Arts. (DEWHA 2010). Survey Guidelines for Australia's Threatened Birds.	Helps to provide the necessary information and conduct the appropriate surveys to determine a presence/absence assessment for bird species listed as threatened under the EPBC Act.
Department of the Environment. (DotE 2013). Matters of National Environmental Significance: Significant impact guidelines 1.1 – *Environment Protection and Biodiversity Conservation Act 1999*	Determination of whether any part of the Proposal, pertaining to terrestrial fauna, has a significant impact on a matter protected under the EPBC Act 1999.
Other Policy or Guidance	**Considerations**
Environmental Protection Authority. (EPA 2016g). Technical Guidance: Sampling of Short-range Endemic Invertebrate Fauna.	The EPA's advice on minimum requirements of managing and surveying short-range endemic invertebrate fauna.

Environmental Protection Authority. (EPA 2020b). Technical Guidance Sampling Methods for Terrestrial Vertebrate Fauna.	Technical advice on sampling techniques for different regions of WA for the data analysis, interpretation, and reporting requirements for EIAs.
Department of Parks and Wildlife (DPaW), The Conservation and Management of the Bilby (*Macrotis lagotis*) in the Pilbara (DPaW 2017a)	Aimed at improving the understanding of Greater Bilby population characteristics in order to provide government and private companies with information to appropriately manage for persistence of the species.
Department of Biodiversity, Conservation and Attractions, Guidelines for Surveys to Detect the Presence of Bilbies, and Assess the Importance of Habitat in Western Australia (DBCA 2017b)	A guideline for detecting current or recent presence or absence of the Greater Bilby in a given area, as well as assessing the importance of the habitat proposed to be impacted.
Department of Sustainability, Environment, Water, Population and Communities, Survey Guidelines for Australia's Threatened Reptiles (DSEWPC 2011e)	This document outlines the effort and methods that are appropriate for conducting a presence/absence survey for reptiles listed as threatened under the EPBC Act.
Department of Sustainability, Environment, Water, Population and Communities, Survey Guidelines for Australia's Threatened Mammals (DSEWPC 2011d)	Advice for conducting a presence/absence survey for mammals that are listed as threatened under the EPBC Act, this includes information on the methodologies and effort that should be involved.
Department of the Environment and Energy (DotEE 2017)	EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species. Commonwealth of Australia 2017.

7.3 Overview of Studies

7.3.1 Supporting terrestrial fauna studies

The Study Area, which totals 443,985 ha, encompasses the entire Proposal area (263,675 ha) and is a consolidation of the previous survey areas for the Proposal. The Proposal area and local surrounds (the Study Area) has been the subject of 17 terrestrial vertebrate fauna surveys and an additional two GIS fauna desktop studies commissioned by Agrimin for the Proposal (Appendix G.1). Additionally, there have been six terrestrial SRE invertebrate fauna surveys commissioned by Agrimin for the Proposal (Appendix G.2). This large body of work included level 1 and level 2 terrestrial fauna surveys, as well as targeted Night Parrot, Great Desert Skink, and waterbird surveys between 2016 and 2021 (Table 7-2, Figure 7-1). In addition, from 2001 to 2018, six regional surveys have been conducted that overlap the Study Area and provide additional local and regional context (Table 7-3, Figure 7-2). The consolidation of all previous work (habitat mapping, survey effort and survey findings) is detailed in Appendix G and summarised in the following sections to inform the impact assessment for the Proposal.

Table 7-2: Summary of terrestrial vertebrate fauna surveys conducted for the Proposal

Project (Reference)	Study Type / Dates	Proximity to Proposal area	Survey Effort	Key Findings		Survey Timing (Figure 7-10)
				Fauna Assemblage	Significant Fauna	
Reference: ecologia Environment (2017a) Title: *Agrimin Mackay Project: Level 1 Fauna and Single Phase Level 2 Flora Assessment.*	Study type: Level 1 fauna Dates: 6-13 September 2016	Location: Study Area Survey Area: 400,138 ha	• Targeted searches (time spent not stated) • Habitat mapping • Nocturnal searches (time spent not stated) • 20 motion camera locations (for four nights each, totaling 80 nights) • 30-minute avifauna census (total not stated) • 3 echolocation recorders (seven nights)	• 57 taxa including: ○ 11 mammals ○ 35 birds ○ 11 reptiles	• Northern Marsupial Mole (P4) • Rainbow Bee-eater (no longer listed)	E
Reference: 360 Environmental (2017b) Title: *Waterbird Survey at Lake Mackay*	Study type: Targeted waterbird survey Dates: 14-17 April 2017 Senior Ornithologist: Dr Colin Trainor	Location: Study Area Survey Area: 256,000 ha	• 17 ground avifauna census sites, totaling 20 hrs and 47 minutes • 45 aerial avifauna census sites (hours not stated)	• 52 taxa including: ○ 25 waterbirds ○ 27 birds	• Australian Painted Snipe (EN, En) • Sharp-tailed Sandpiper (IA, Mi,) • Common Greenshank (IA, Mi) • Red-necked Stint (IA, Mi)	F
Reference: 360 Environmental (2018c) Title: *Lake Mackay Sulphate of Potash Project: Single Phase Level 2 Fauna Survey at Lake Mackay*	Study type: Level 2 fauna survey Dates: 10 – 19 May 2017	Location: Study Area Survey Area: 5,547.3 ha	• Six trapping sites over seven nights (1059 trap nights) • Six SM2 Echolocation and acoustic recorder locations (minimum 6-night total) • 90-minute avifauna census (540 person minutes) • 120 minutes of spotlighting • Six motion camera locations (minimum of 6 nights total) • 22 habitat assessments • Opportunistic records	• 76 taxa including: ○ 11 mammals ○ 39 birds ○ 24 reptiles ○ 2 amphibians	• Fork-tailed Swift (IA, Mi)	G
Reference: Strategen Environmental (2018c) Title: *Lake Mackay Sulphate of Potash Project: Level 2 Vertebrate and Targeted Fauna Survey.*	Study type: Level 2 fauna and targeted fauna survey Dates: 10-21 November 2017	Location: Study Area Survey Area: 2,419.5 ha	• Four trapping sites (7 nights) • 35 habitat assessments • 90-minute avifauna census at the four trapping sites • 240 minutes of spotlighting • Eight motion cameras (minimum of 5 nights) • 2 ha plots (quantity not stated) • 29 acoustic recorder locations (recording nights not stated) • Opportunistic records	• 117 taxa including: ○ 12 mammals (4 introduced) ○ 65 birds ○ 31 reptiles ○ 2 amphibians	• None	H
Reference: ecologia Environment (2019) Title: *Night Parrot Monitoring Lake Mackay*	Study type: Targeted automated acoustic surveys for Night Parrot Dates: 21 April and 22 May 2018	Location: Off-LDE & surrounds Survey Area: N/A	• Seven acoustic recorder locations for a total of 91 recording nights	• N/A	• None • One call was detected that was similar pitch and length to some Night Parrot calls. However, based on the analysis of the call itself and the time it was detected, it was considered unlikely this call was a Night Parrot; however, the possibility could not be ruled out.	I
Reference: (Stantec 2020b) Title: Lake Mackay Potash Project: Detailed and Targeted Vertebrate Fauna Survey and Consolidation	Study type: Preliminary survey Dates: 25 February to 4 March 2019	Location: NIDE Survey Area: 34,491 ha	• Planning/logistics survey to inform the subsequent detailed and targeted survey. Selection of indicative survey sites for plan detailed survey	• N/A	• N/A	N/A
	Study type: Consolidation survey Dates: 2 to 6 October 2019	Location: Study Area Survey Area: 443,627.69 ha	• Consolidated habitat mapping of the Study Area as a whole. • Consolidating previous habitat type mapping by aligning scale, descriptions and defining characteristics. • Survey work involved ground-truthing key areas of interest via 4WD vehicle and helicopter.	• Consolidated mapping of Study Area	• N/A	N/A
	Study type: Detailed and targeted surveys Dates: • Phase 1:	Location: NIDE Survey Area: 34,491 ha	• Detailed systematic and targeted surveys of the NIDE involving Stantec, Indigenous Rangers and Desert Support Services. • Systematic effort: ○ 16 trapping sites (8736 trap nights)	• 193 taxa including: ○ 22 mammals ○ 6 non-native mammals ○ 92 birds	• Greater Bilby • Brush-tailed Mulgara • Northern Marsupial Mole • Southern Marsupial Mole • Night Parrot	K & L

Project (Reference)	Study Type / Dates	Proximity to Proposal area	Survey Effort	Key Findings		Survey Timing (Figure 7-10)
				Fauna Assemblage	Significant Fauna	
	○ 7 to 20 October 2019, and ○ 29 October to 10 November 2019 • Phase 2: 7 to 22 March 2020		○ 3360 minutes of avifauna census at the 24 sites ○ 1440 minutes of systematic searches ○ 1440 minutes if nocturnal searches ○ 336 motion camera nights (48 locations) ○ 48 bat recording nights (24 locations) • Targeted effort: ○ 2,782 motion camera nights (128 locations) ○ 142 '2 ha plots' for Greater Bilby and Great Desert Skink ○ 829 recording nights (53 locations) for the Night Parrot ○ 188 recording nights (18 locations) for bats ○ 101 habitat assessments	○ 70 reptiles ○ 3 amphibians	• Grey Falcon • Oriental Plover • Sharp-tailed Sandpiper • Striated Grasswren • Great Desert Skink • Broad-eyed Slider • Spotted Ctenotus	
	Study type: Night Parrot Targeted Surveys Dates: • Stage 1: August 2020 • Stage 2: August – October 2020 • Stage 3: October – November 2020 • Stage 4: October 2020	Location: NIDE & surrounds Survey Area: N/A	• Targeted deployment of acoustic units around foraging records • Subsequent targeted survey to understand roost proximity • Units were deployed inside and outside the NIDE and were collected and redeployed in stages	• Foraging and roosting individuals recorded	• Night Parrot	M
	Study type: Night Parrot Fine Scale Habitat Mapping Dates: October 2020	Location: Study Area Survey Area: 443,985 ha	• Fine scale digitisation of potentially suitable habitat for Night Parrots using satellite imagery	• 11,522 ha of potential Night Parrot habitat	• N/A	N/A
	Study type: Great Desert Skink Targeted Survey Dates: 19 October – 1 November 2020	Location: NIDE & surrounds Survey Area: N/A	• Targeted survey to determine population extent • Transects • 2 ha plots	• Population size expanded to a total of 64 burrows	• Great Desert Skink	N
	Study type: Night Parrot Baseline Survey around Lake Mackay Dates: March - April 2021	Location: SIDE & OFF-LDE Survey Area: N/A	• Baseline survey to address limitations identified in previous surveys • 15 acoustic recording units deployed in areas of suitable Night Parrot habitat with potential to be impacted by the Proposal, around Lake Mackay	• No Night Parrots detected	• None	O
	Study Type: Waterbird Survey of Lake Mackay and Peripheral Wetlands Dates: 30 March – 2 April 2021 Zoologist Samantha Lostrom	Location: Study Area Survey Area: N/A	• 17 ground avifauna censuses sites totalling 11 hours and 38 minutes • 22 opportunistic observations (largely from helicopter)	• 28 taxa comprising; ○ 12 confirmed waterbirds to species level ○ 1 waterbird to genus level ○ 15 birds	• Sharp-tailed Sandpiper (IA, Mi) • Marsh Sandpiper (IA, Mi) • Princess Parrot (Vu, P4) • Gull-billed Tern (IA, Mi) • White-winged Black Tern (IA, Mi) • Stint sp. (IA, Mi) (unable to identify to species in aerial observation)	P
	Night Parrot regional modelling	Location: Study Area and within 75 km of the Study Area	• GIS modelling of prospective regional Night Parrot habitat. The modelling used Sentinel imagery trained to identify image signatures for the two areas (58 unit locations) where Night Parrots have been recorded by Stantec.	• N/A	• N/A	N/A

Table 7-3: Summary of regional vertebrate fauna surveys that intersect, occur within or lie adjacent to the Proposal area

Project (Reference)	Study Type/ Dates	Study Details	Proximity to Proposal area	Survey / study effort	Key Findings		Survey Timing (Figure 7-10)
					Fauna Assemblages	Significant Fauna	
Reference: Paltridge (2012) Title: *Kiwirrkura Threatened Species Survey 2012*	Location: Kiwirrkura, Nyinmi and Maruwa management zones (including western edge of Lake Mackay) Survey date: 12-18 May 2012	Tracking survey	Maruwa management area encompasses the western edge of Lake Mackay and a southern portion of the Stantec Survey Area.	• 29 x 2 ha tracking plots	• N/A	• Greater Bilby (Vu, Vu) • Brush-tailed Mulgara (P4) • Princess Parrot (Vu, P4)	A
Reference: Outback Ecology (2012b) Title: *Level 1 Terrestrial Fauna Assessment*	Location: Lake Mackay Survey Date: 7-14 June 2012	Level 1 fauna survey	Within the Study Area	• 24 systematic searching sites, for 60 minutes each totalling 24 hours) • 12 hours of nocturnal searching • Two motion camera locations (total of six nights) • Opportunistic records • One echolocation recorder location (four recording nights) • Habitat assessments	• 52 taxa including: ○ 15 mammals (5 introduced) ○ 14 reptiles ○ 23 birds	• Northern Marsupial Mole (P4) • Brush-tailed Mulgara (P4)	B
Reference: Paltridge (2015) Title: *Looking for animals on Ngururrpa Country*	Location: road between Yagga Yagga and Bibarrd Aboriginal Outstations Survey Date: 28 July – 1 August 2015	Tracking Survey	Overlaps the Study Area. Predominantly the Stantec Survey Area	• 32 2 ha plots	• N/A	• Greater Bilby (Vu, Vu) • Brush-tailed Mulgara (P4) • Grey Falcon (VU)	C
Reference: Cowan *et al.* (2015) also presented in BushBlitz (2015) Title: Kiwirrkurra Indigenous Protected Area BushBlitz Survey	Location: Area around Kiwirrkurra and Nyinmi (100 km west of Kiwirrkurra) and Lake Mackay Survey Date: 5-19 September 2015	Bush Blitz	Intersects the Study Area in the vicinity of Lake Mackay	• 14 trapping sites (4 within the Study Area) (333 trap nights) • 3 echolocation recorder locations for at least one night each • Active foraging (time not stated) • Targeted motion cameras (nights deployed not stated)	• 71 vertebrate taxa including: ○ 23 mammals (5 introduced) ○ 48 reptiles ○ 1 amphibian	• Greater Bilby (Vu, Vu) • Evidence of Northern Marsupial Mole (P4) • Great Desert Skink (VU, Vu)	D
Reference: Desert Support Services (2018) Title: *Bilby Blitz Survey on the proposed Ngururrpa Indigenous Protected Area*, Alice Springs.	Location: Ngururrpa IPA Survey Date: 18-22 October 2018	Targeted Greater Bilby survey	Overlaps the Study Area. Predominantly the Stantec Survey Area.	• 27 x 2 ha plots • Opportunistic records	• N/A	• Greater Bilby (Vu, Vu) • Great Desert Skink (VU, Vu)	J
Reference: Duguid *et al.* (2005) Title: *Wetlands in the Arid Northern Territory*	Location: Northern Territory (including Lake Mackay) Aerial Survey Date: 5-6 September 2001 Experienced Ornithologist: Ray Chatto Ground Survey: 3-10 Oct 2001 Zoologists: Peter Latz and Rachel Paltridge	Wetland survey (with shorebird/ waterbird survey at Lake Mackay)	Lake Mackay. Aerial survey of the perimeter of the Lake in the WA side and ground-truthed sites on the Northern Territory side of the lake.	• Aerial avifauna census (time not stated)	• 20 waterbird species (confirmed Id) (42,473 individuals)	• Gull-billed Tern (Mi, IA) • Common Greenshank (Mi, IA) • Glossy Ibis (Mi, IA)	-
Reference: Pedler *et al.* (2018) Title: *Long-distance flights and high-risk breeding by nomadic waterbirds on desert salt lakes*	Location: Lake Mackay Survey Date: 6 March 2014	One-off flight to conduct Banded Stilt survey	Lake Mackay. Aerial survey of the lake.	• Once-off aerial Banded Stilt census	• N/A	• 6,500 clutches of Banded Stilt eggs	-
Reference: AWC (2019) Title: *Newhaven Vertebrate Fauna Species List.*	Newhaven Sanctuary Species List	-	Approximately 290 km E of the Study Area Great Sandy Desert Bioregion.	• N/A	• 278 taxa including: ○ 24 mammals ○ 174 birds ○ 74 reptiles ○ 6 amphibians	• -	-

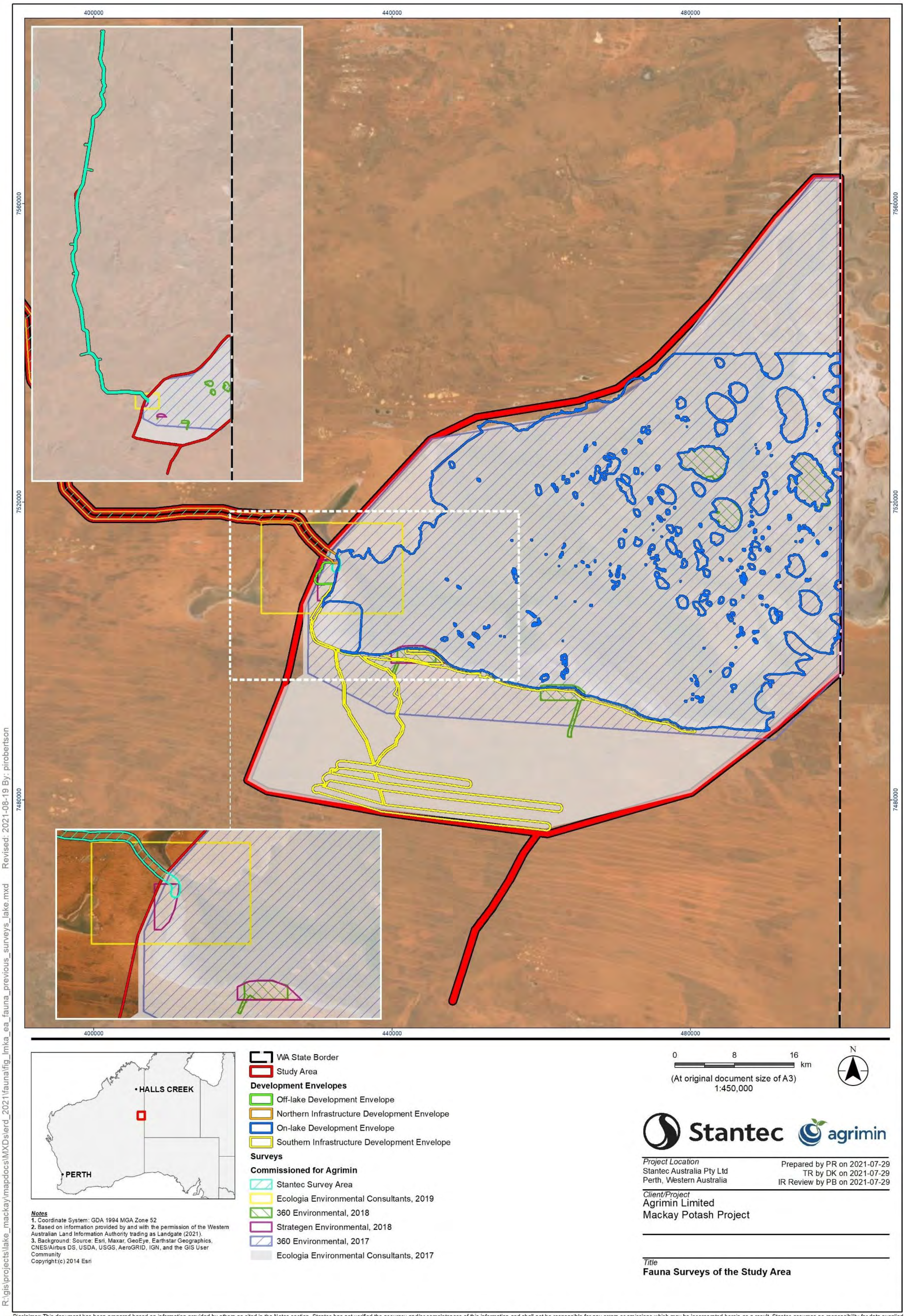

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Figure 7-1: The Study Area, Proposal area and terrestrial fauna surveys commissioned by Agrimin

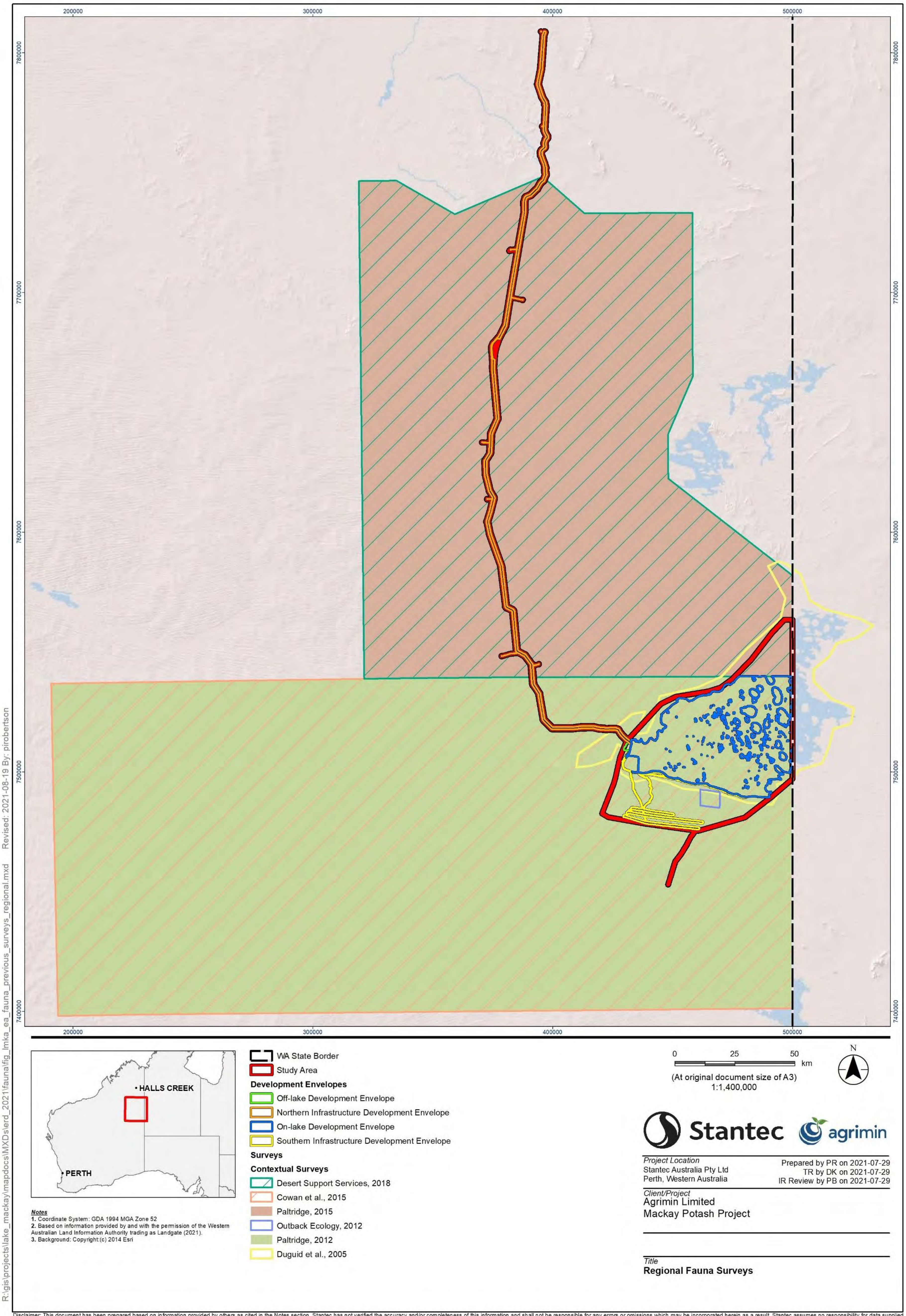

Figure 7-2: The Study Area, Proposal area and regional terrestrial fauna surveys

7.3.2 Survey Effort

7.3.2.1 Vertebrate fauna

Systematic and targeted survey effort has been undertaken across the Study Area in representative habitats to inform the impact assessment for the Proposal. In total there have been 17 vertebrate fauna surveys undertaken at Lake Mackay for the Proposal. A detailed breakdown of survey effort within each habitat and habitat extent within the Indicative Footprint, Proposal area and Study Area, is presented within Table 7-4 and Figure 7-3- Figure 7-5).

Systematic sampling totalled 11,735 trap-nights for vertebrate fauna, comprising 8,736 trap nights during the Stantec Survey (Phase 1: 5,824 trap nights and 2,912 trap nights), 1,669 trap nights during the 360 Environmental (2018a) survey, 997 trap nights during the Strategen Environmental (2018c) survey and 333 trap nights during the Cowan *et al.* (2015) survey. Additionally, systematic sampling within the Study Area accounted for 71 avifauna census hours, 24 systematic searching hours, 24 spotlighting hours, 358 motion-sensor cameras sampling nights and 54 bat echolocation recording nights.

Baseline targeted survey effort involved the use of survey methods specific to each species of significance where suitable habitats were encountered within the Study Area (Table 7-4). Motion cameras were deployed at 157 locations primarily to detect the presence/activity of the Greater Bilby and the Great Desert Skink, as well as species of marsupial mole and the Brush-tailed Mulgara. The majority of these deployments were within spinifex sandplain (42 locations), dunefield (30 locations) and gravel spinifex plain (28 locations) habitats. The majority of this effort was conducted during the Stantec survey with 128 targeted deployments totalling 2,782 recording nights.

The '2 ha plot' survey method was used primarily to detect the presence/activity of the Greater Bilby and the Great Desert Skink, but also species of marsupial mole and the Brush-tailed Mulgara. In total, 142 '2 ha plots' were conducted within the Study Area, with most undertaken in spinifex sandplain habitat (74 locations). Subsequently, a targeted survey for the Great Desert Skink was undertaken to better define the extent of a population which informed the design of the haulage corridor.

Baseline targeted survey effort for the Night Parrot was undertaken by deploying autonomous SM4 acoustic bird recorders and by conducting dusk census combined with call playback. In total, acoustic recorders have been deployed at 110 locations within the Study Area. Most of these deployments were within spinifex sandplain and dunefield habitats. The majority of these deployments were undertaken during the Stantec Survey (68 locations) totalling 829 recording nights, followed by the Strategen Environmental (2018c) survey (29 locations). Subsequent to the baseline surveys, an additional 89 units (604 recording nights) were deployed (Stage 1-4) to better understand Night Parrot occurrence at two locations that coincide with the Study Area. Targeted waterbird surveys were undertaken of Lake Mackay and peripheral wetlands when the lake was inundated in both 2021 and 2017.

No significant bat species were anticipated to occur within the Study Area; however, targeted deployment of echolocation recorders was undertaken at habitats where bat species were more likely to be recorded (water sources and caves) to increase the knowledge of what bat species utilise the Study Area. In total, 20 bat echolocation recorders were deployed within the Study Area. The majority of these were deployed within rocky ridge and gorge habitat (six locations). Most of these deployments were undertaken during the Stantec Survey (18 locations) totalling 188 recording nights.

Table 7-4: Fauna habitats, vertebrate fauna baseline survey effort and habitat extents within the Study Area, Proposal area and Indicative Footprint (habitats ordered based on extent in the Indicative Footprint)

Fauna habitat	Extent within the Study Area (ha)	Total Proposal area		Total Indicative Footprint		Level 2 systematic effort			Targeted survey effort (locations)					
		ha	%	ha	%	Phase 1	Phase 2	Total	Motion camera	2Ha Plots	Bird acoustic recorders	Night Parrot dusk census and call playback	Bat echolocation recorders	Habitat assessments
Salt lake playa	243,271.31	216,333.14	88.93	13,363.12	5.49	0	0	0	0	0	0	0	0	0
Spinifex sandplain	103,434.45	28,189.44	27.25	754.20	0.73	5	4	9	42	74	39	7	2	52
Dunefield	41,418.07	5,431.74	13.11	281.82	0.68	8	4	12	30	23	22	2	3	28
Gravel spinifex plain	9,646.21	8,613.91	89.30	248.12	2.57	4	3	7	28	29	9	5	2	24
Claypans and claypan mosaic	15,960.78	1,456.80	9.13	42.22	0.26	3	0	3	14	9	8	1	0	14
Lake margin	14,884.20	1,341.30	9.01	22.36	0.15	2	0	2	1	0	13	1	1	12
Dune	6,521.41	1,477.24	22.65	19.27	0.30	2	0	2	9	5	1	0	0	4
Cleared	115.09	92.30	80.20	18.43	16.01	0	0	0	0	0	0	0	0	0
Outcropping and stony rise	491.08	415.75	84.66	5.36	1.09	0	0	0	4	2	0	0	1	5
Saline flats and depressions	8,068.92	151.24	1.87	3.44	0.04	1	0	1	4	0	6	0	0	4
Drainage line	40.98	39.43	96.21	0.55	1.34	0	0	0	6	0	5	0	4	2
Rocky ridge and gorge	38.59	38.59	100.00	0.09	0.24	1	1	2	15	0	1	0	6	6
Ridge slope	94.24	94.24	100.00	0.00	0.00	0	0	0	4	0	6	0	1	2
Total	443,985.33	263,675.12	-	14,758.98	-	26	12	38	157	142	110*	16	20	153

*Note: *exclude additional targeted Night Parrot surveys (Stage 1-4: 89 units)(Section 7.6.3.2). These surveys were undertaken subsequent to the baseline surveys to better understand Night Parrot occurrence at two locations that coincide with the Study Areas.*

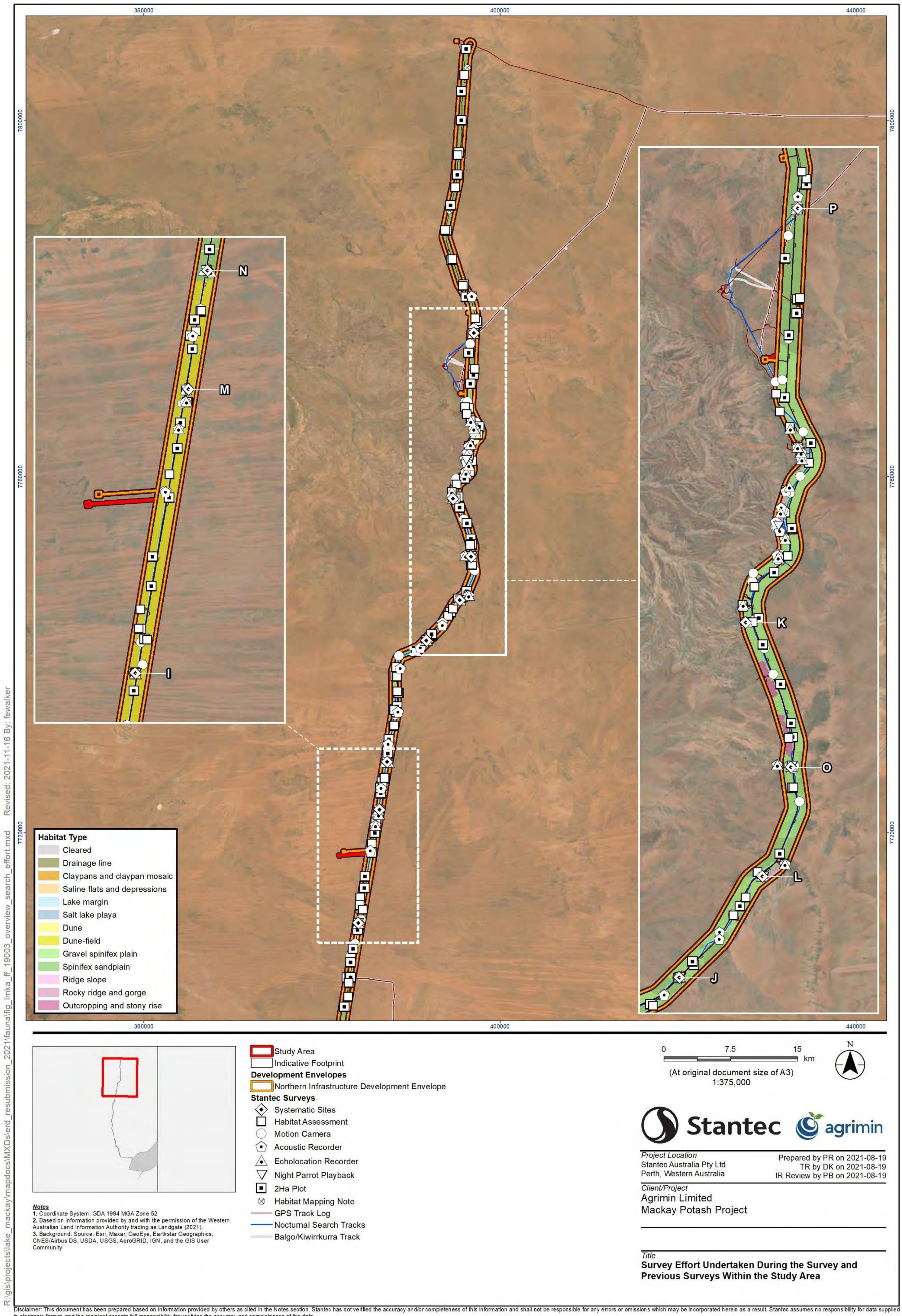

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Figure 7-3: Vertebrate fauna habitat and survey effort with respect to the Indicative Footprint, the Proposal area and the Study Area (haul road-centre portion) (trapping sites presenting within insets)

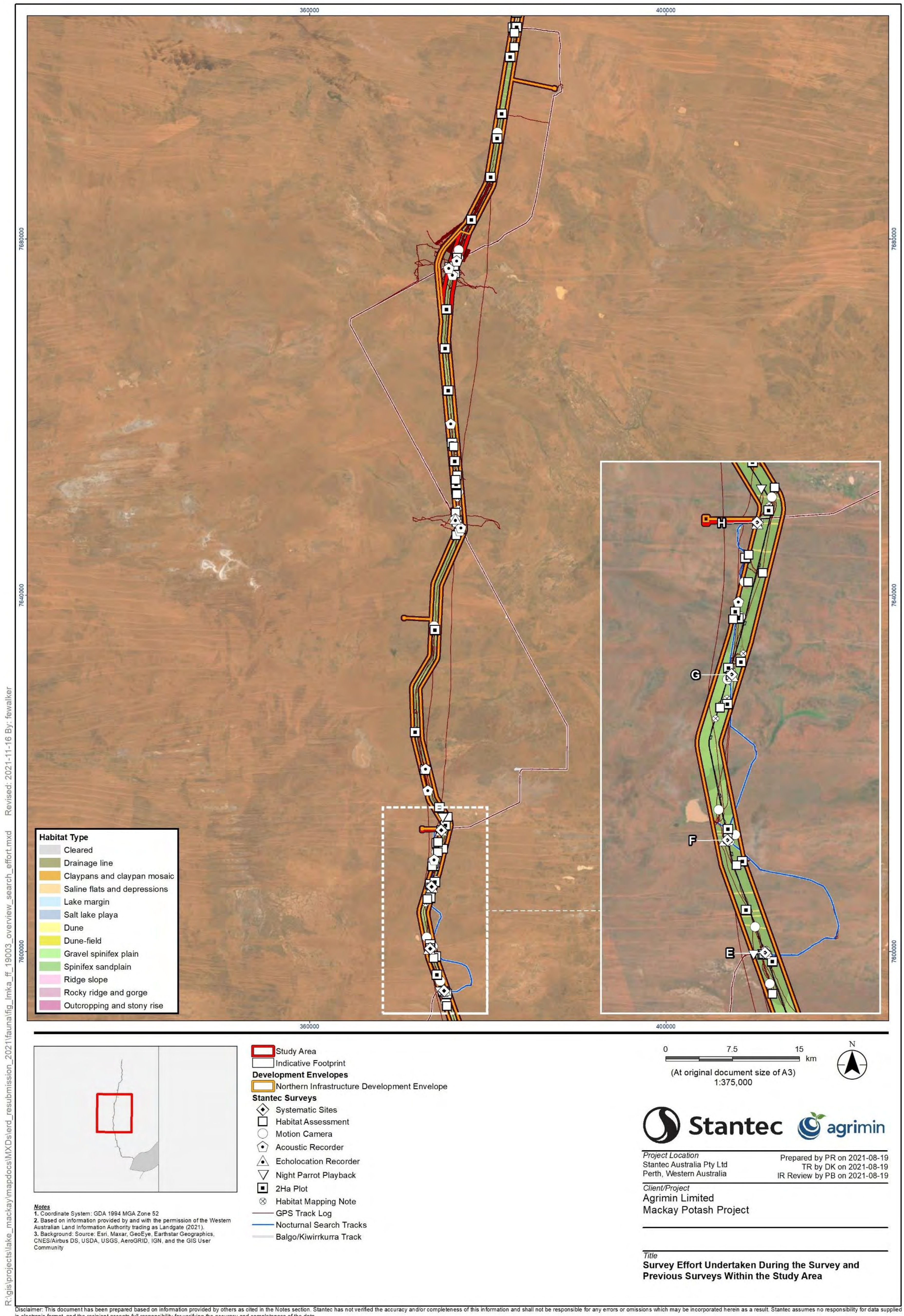

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Figure 7-4: Vertebrate fauna habitat and survey effort with respect to the Indicative Footprint, the Proposal area and the Study Area (haul road-centre portion)(trapping sites presenting within insets)

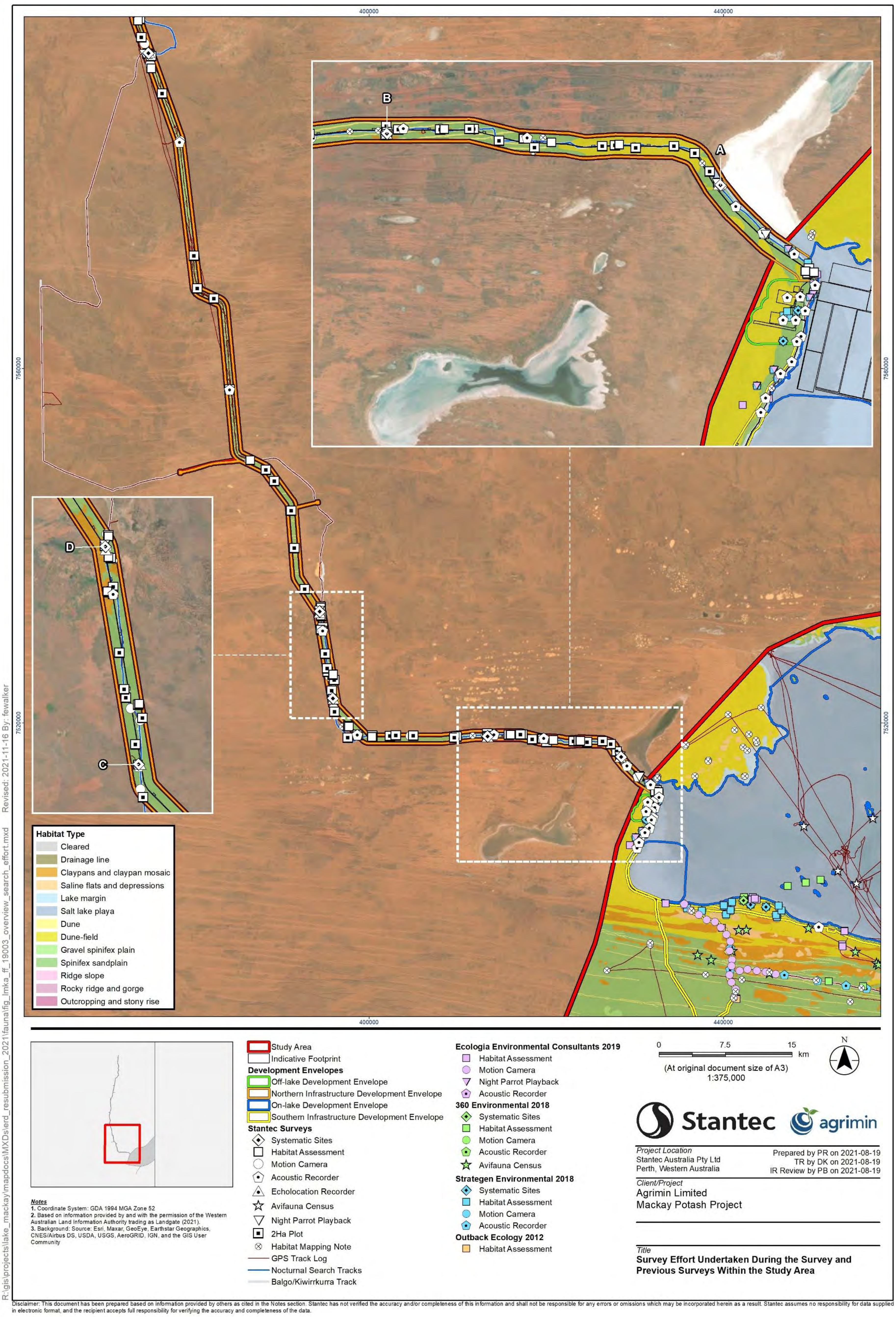

Figure 7-5: Vertebrate fauna habitat and survey effort with respect to the Indicative Footprint, the Proposal area and the Study Area (haul road-centre portion) (trapping sites presenting within insets)

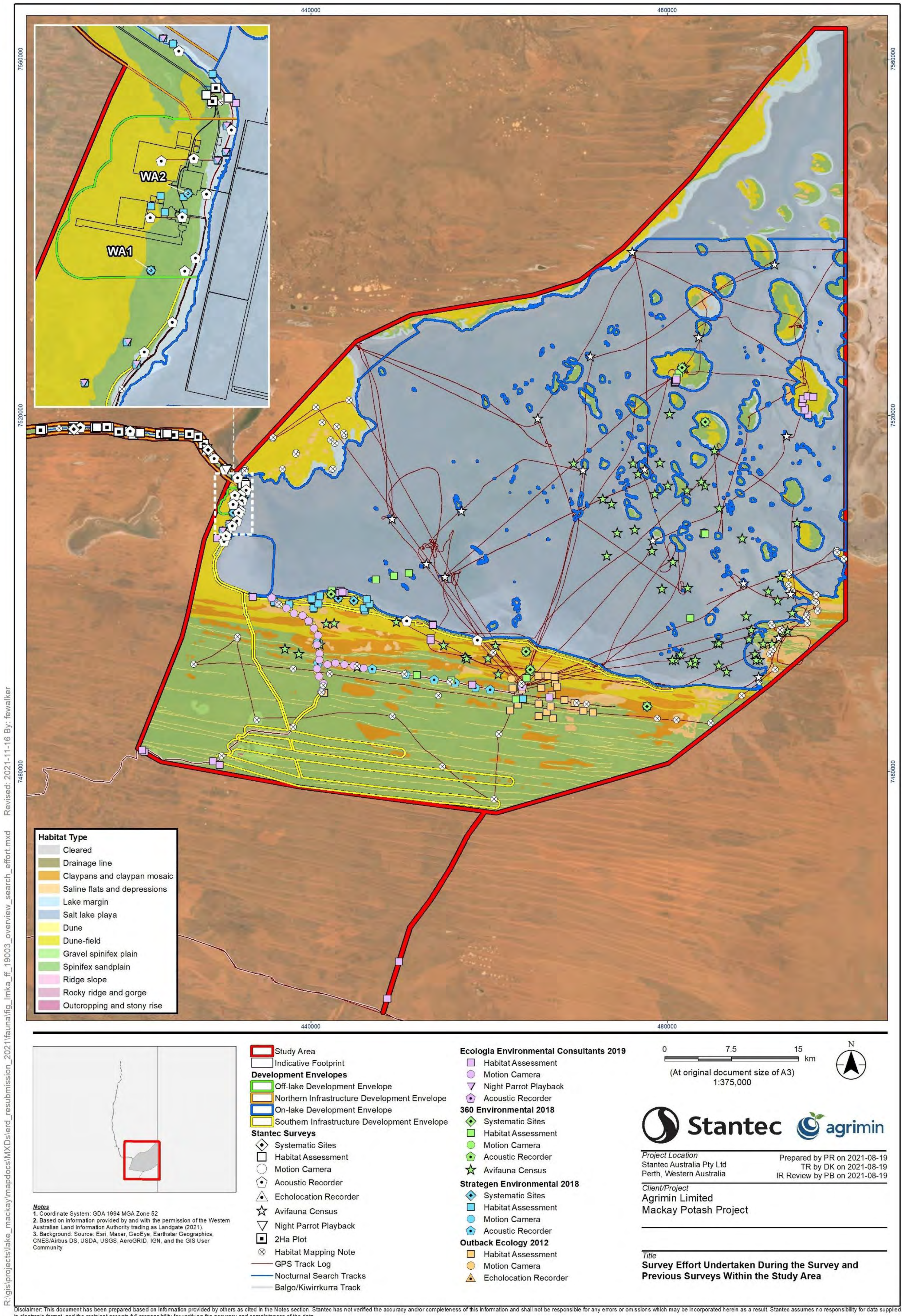

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Figure 7-6: Vertebrate fauna habitat and survey effort with respect to the Indicative Footprint, the Proposal area and the Study Area (Lake Mackay-eastern portion) (trapping sites presenting within insets)

7.3.2.2 Terrestrial SRE Invertebrate Fauna

Systematic and targeted survey effort for SRE taxa has been undertaken across the Study Area to inform the impact assessment for the Proposal. In total, there have been six SRE surveys undertaken at Lake Mackay for the Proposal. A detailed breakdown of SRE invertebrate fauna survey effort within each habitat and habitat extents within the Indicative Footprint, Proposal area and Study Area is presented within Table 7-5 and Figure 7-7 to Figure 7-9.

Different survey methods have been employed between previous surveys and habitat types of the Study Area. These methods involved dry pitfall trapping, wet pitfall trapping, systematic and targeted searches. Wet pitfall trapping has been conducted at 52 sites (156 traps) equating to a total of 15,066 wet pitfall trap nights. One third (17) of the sites (5,325 nights) were established on Lake Mackay and surrounds and two thirds (35) of the sites (9,741 nights) were established along the proposed haulage corridor and regional sites. Dry pitfall trapping was conducted at 34 sites equating to a total of 2,275 trap nights. Of these, 10 sites (595 trap nights) were conducted in habitats surrounding Lake Mackay, while 24 sites (1680 trap nights) were conducted along the proposed haulage corridor.

Trapping methods were supplemented by systematic searches for SRE taxa at trapping sites with 600 minutes conducted at sites in the vicinity of Lake Mackay and 1,440 minutes conducted along the proposed haulage corridor. Additionally, targeted searches for SRE taxa were undertaken at targeted sites in potential SRE habitats and microhabitats. In total, five targeted search sites were conducted in the vicinity of Lake Mackay and 23 targeted search sites were conducted along the proposed haulage corridor.

Table 7-5: SRE invertebrate fauna survey effort, fauna habitats and habitat extents within the Study Area, Proposal area and Indicative Footprint (habitats ordered based on extent in the Indicative Footprint)

Fauna habitat	Extent within the Study Area	Total Proposal area		Total Indicative Footprint		Survey Method								
						Wet Pitfall			Dry Pitfall			Systematic Searches*	Targeted search # sites	Tullgren Funnel # sites
	(ha)	ha	%	ha	%	Sites (Traps)	Nights Open	Trap Nights	Sites (Traps)	Nights Open	Trap Nights			
Salt lake playa	243,271.31	216,333.14	88.93	13,363.12	5.49	17 (51)	950	2,850	-	-	-	-	-	-
Spinifex sandplain	103,434.45	28,189.44	27.25	754.20	0.73	7 (21)	1028	3,084	9 (90)	61	605	540	5	3
Dunefield	41,418.07	5,431.74	13.11	281.82	0.68	6 (18)	427	1,281	11 (110)	70	700	660	7	9
Gravel spinifex plain	9,646.21	8,613.91	89.30	248.12	2.57	4 (12)	764	2,292	7 (70)	49	490	420	3	-
Claypans and claypan mosaic	15,960.78	1,456.80	9.13	42.22	0.26	3 (9)	573	1,719	2 (20)	13	130	120	1	1
Lake margin	14,884.20	1,341.30	9.01	22.36	0.15	10 (30)	479	1,437	1 (10)	7	70	60	2	2
Dune	6,521.41	1,477.24	22.65	19.27	0.30	1 (3)	191	573	2 (20)	14	140	120	1	-
Cleared	115.09	92.30	80.20	18.43	16.01	-	-	-	-	-	-	-	-	-
Outcropping and stony rise	491.08	415.75	84.66	5.36	1.09	2 (6)	382	1,146	-	-	-	-	1	-
Saline flats and depressions	8,068.92	151.24	1.87	3.44	0.04	1 (3)	37	111	-	-	-	-	-	-
Drainage line	40.98	39.43	96.21	0.55	1.34	1 (3)	191	573	-	-	-	-	1	-
Rocky ridge and gorge	38.59	38.59	100.00	0.09	0.24	-	-	-	2 (20)	14	140	120	7	-
Ridge slope	94.24	94.24	100.00	0.00	0.00	-	-	-	-	-	-	-	-	-
Total	443,985.33	263,675.12	59.39	14,758.98	3.32	52 (156)	5,022	15,066	34 (340)	228	2,275	2,040	28	15

*Note: * indicates 60 minutes/site.*

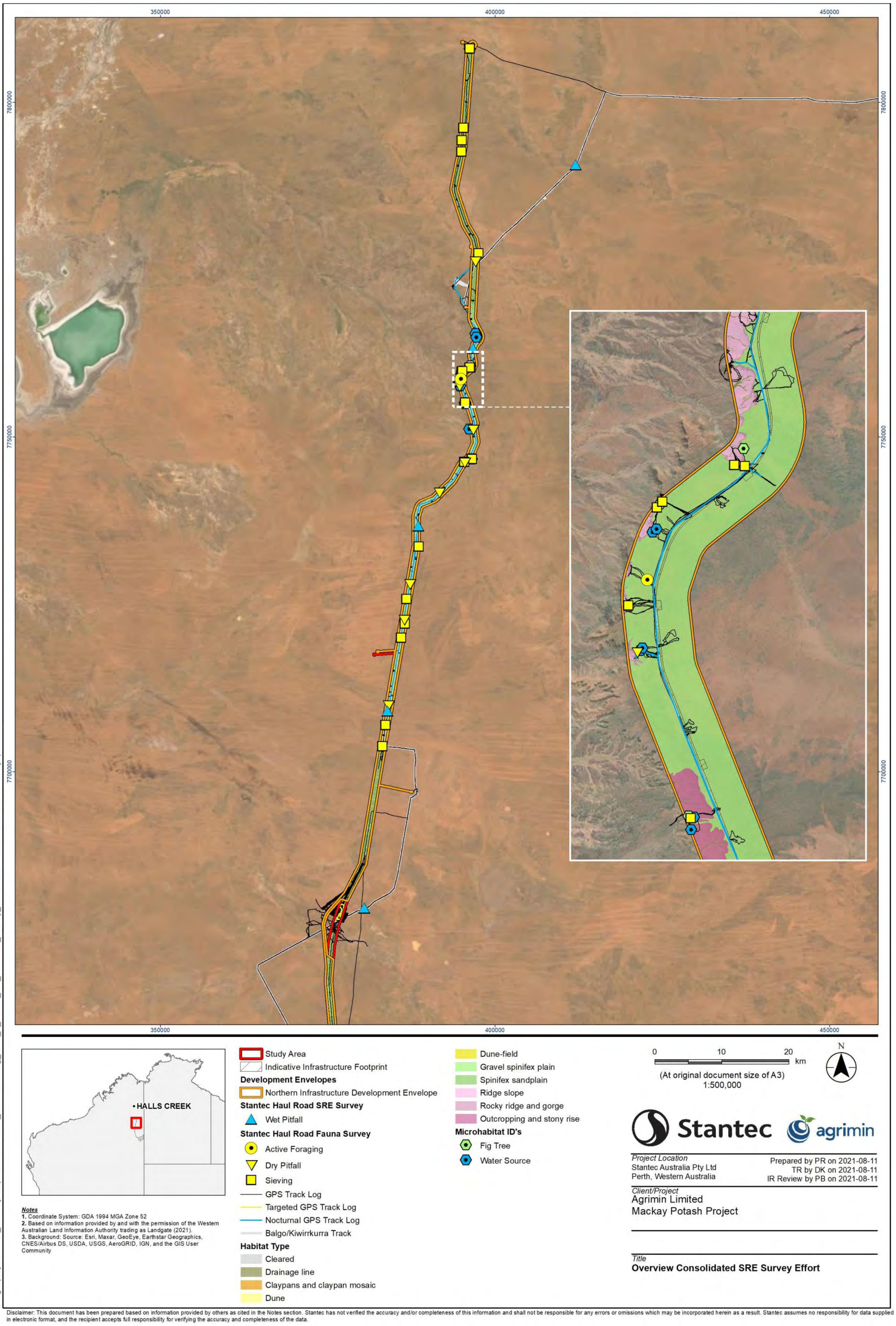

Figure 7-7: SRE invertebrate fauna habitat and survey effort with respect to the Indicative Footprint, the Proposal area and the Study Area (haul road-northern portion)

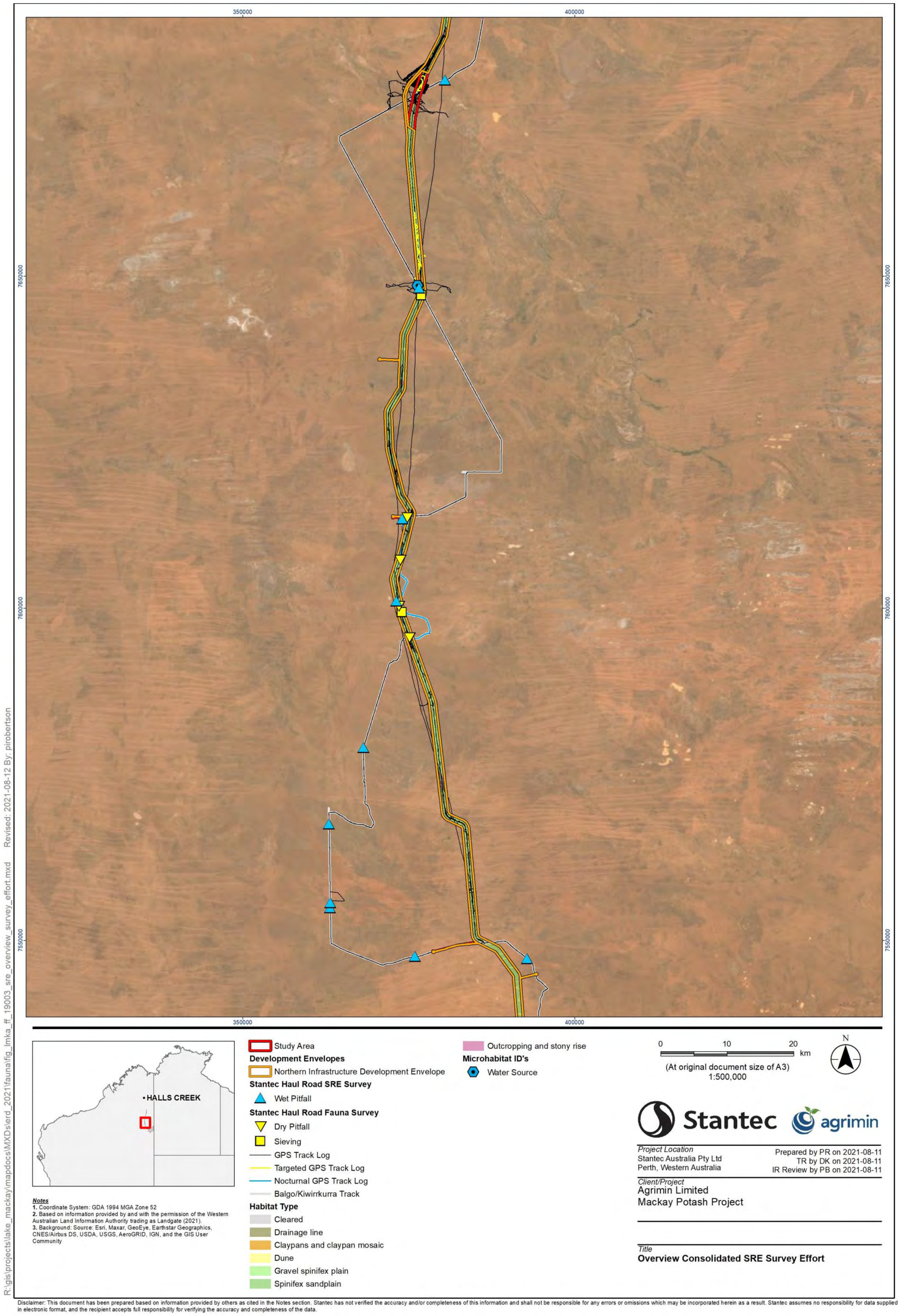

Figure 7-8: SRE invertebrate fauna habitat and survey effort with respect to the Indicative Footprint, the Proposal area and the Study Area (haul road-northern portion)

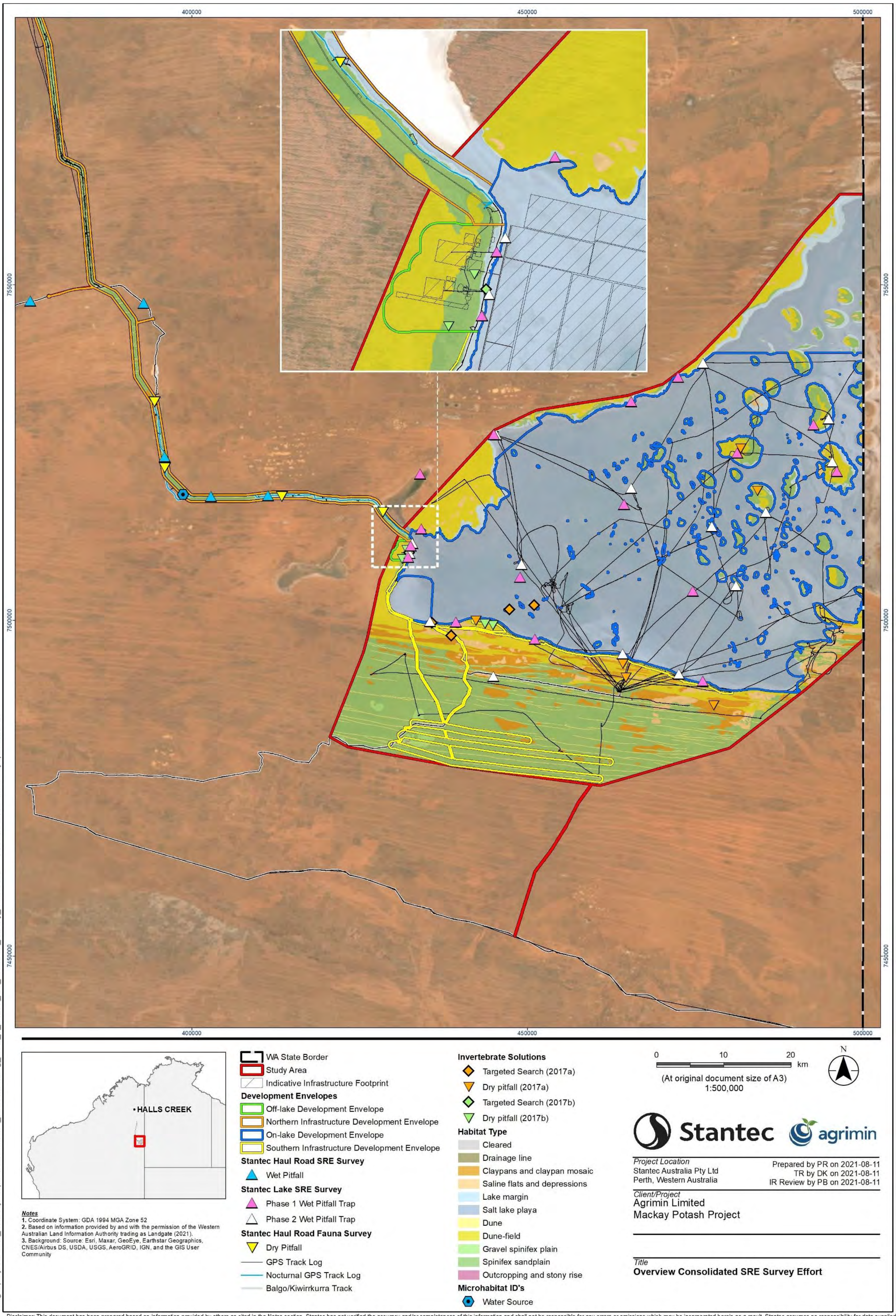

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Figure 7-9: SRE invertebrate fauna habitat and survey effort with respect to the Indicative Footprint, the Proposal area and the Study Area (haul road-southern portion and Lake Mackay)

7.3.3 Survey Limitations

There are a number of possible limitations and constraints that may have impinged on the adequacy of fauna surveys (EPA 2016h). All fauna surveys are limited to some degree by time and seasonal factors; consequently, it is preferable to undertake multiple surveys of an area over a number of years and across different seasons. Survey limitations and constraints are comprehensively discussed for all surveys within Appendix G, with key limitations and constraints summarised below:

Timing, weather and season: The Proposal is located in the Great Sandy Desert and Tanami Bioregions where the activity and therefore the detectability of fauna is driven by climatic conditions, in particular, rainfall events. Surveys for the Proposal have covered multiple years and seasons; however, due to the infrequency of rainfall events, and variation in conditions over the large Study Area, not all surveys were able to be conducted in optimal conditions (Figure 7-10). Furthermore, the large expanse of the NIDE (approximately 350 km in length) can result in significant differences in rainfall at the northern extent compared to the southern extent. Although rainfall is highly variable at the site in both time and geographic extent, the large number of surveys have allowed a thorough understanding to be developed for the occurrence of significant fauna and assemblages to inform this assessment.

In general, based on available satellite imagery and hydrological modelling, the lake appears to inundate to a depth of approximately 2 m in the deepest portions on average once every 5 to 10 years (Stantec 2021e). While two waterbird surveys of Lake Mackay (2001 and 2017) were undertaken by experienced shorebird assessors, the timing of these surveys likely to have missed the following: peak activity, optimal timing for migratory shorebirds and optimal timing for breeding events. However, during a subsequent flood event in early 2021, Stantec were able to conduct a waterbird survey in late March/early April. This survey coincided with optimal timing post rainfall and recorded substantial activity, including tens of thousands of waterbirds, migratory species and breeding events. While the flooding of Lake Mackay is irregular and infrequent, the surveys demonstrate that when in flood, the lake is an important habitat for waterbirds. Additionally, modelling of historical satellite imagery (Appendix I.21) has provided an understanding of how often suitable conditions for waterbirds occur at Lake Mackay.

Adequacy of the survey intensity and proportion of survey achieved: Survey sites were carefully selected to prioritise sampling of habitats with the greatest potential to be impacted by the Proposal; survey effort for each habitat and extent of each habitat within the Indicative Footprint for vertebrate fauna is presented in Table 7-4 and for SRE in Table 7-5. Consideration was also given to regional distribution of extensive habitats and with consideration to the potential occurrence of significant fauna or assemblages. The only habitats within the Indicative Footprint where Detailed survey effort did not occur include:

- Salt Lake Playa (14,982.2 ha, 6.16 %);
- Outcropping on Stony Rise (7.4 ha, 1.53 %); and
- Drainage Line (0.6 ha, 1.36 %).

Each of these habitats were supplemented by extensive survey effort using targeted survey methods. Additionally, each of these habitat types (except Salt Lake Playa, 6.16%) comprise a small extent and proportion within the Indicative Footprint and consequently systematic sampling was not warranted. The Salt Lake Playa was not deemed an appropriate habitat for systematic vertebrate fauna sampling. Additionally, one habitat that did not occur within the Indicative Footprint (0 ha, 0 %), Ridge slope, had no Detailed survey effort.

Due to COVID-19 travel and regional movement restrictions, the Detailed and targeted survey of the southern portion of the NIDE (Phase 2 only) and targeted survey work within the Off- LDE and SIDE had to be stopped while underway and were unable to be completed. However, overall, survey effort was sufficient to understand the occurrence of fauna assemblages and significant fauna with potential to occur in these areas. Additionally, Agrimin have committed to appropriate mitigation measures in areas that could not be surveyed, including undertaking pre-clearance surveys, refinement of disturbance areas where appropriate/possible and relocation of individuals if required.

With respect to Detailed sampling within the southern portion of the NIDE:

- Lake Margin habitat: one trapping site (A) could only be sampled during a single phase due to Covid-19 restrictions. Although this survey effort was lower than planned, the effort is proportional to the extent within the Indicative Footprint (22.9ha, 0.15%).
- Dune habitat: two trapping sites (B and H), could only be sampled during a single phase due to Covid-19 restrictions. Although this survey effort was lower than planned, the effort is proportional to the extent within the Indicative Footprint (38.5 ha, 0.59 %).

In summary, the design of the surveys ensured that survey effort was sufficient and proportional to the Indicative Footprints to understand the potential impacts of the Proposal to vertebrate and SRE invertebrate fauna.

With respect to targeted surveys within the Off-LDE and SIDE: Key species not able to be targeted during these surveys of the Off-LDE and SIDE were the Greater Bilby and Great Desert Skink. Both species have been recorded within suitable habitat within the NIDE, however previous surveys have not detected the Greater Bilby within the Off-LDE or SIDE and the only population of Great Desert Skink within the vicinity of the SIDE has been verified as no longer present. The Greater Bilby is highly mobile (can travel up to 5 km per night), displays low site fidelity and can re-establish alternative den habitat overnight. In the region, Great Desert Skink has only been recorded from two populations despite extensive survey work. Given this context, the potential risk to these species within the Off-LDE and SIDE is considered low. However, to further mitigate this potential risk, Agrimin have committed to appropriate mitigation measures in areas that could not be surveyed as presented within the CEMP. These measures include undertaking pre-clearance surveys, refinement of disturbance areas where appropriate/possible and relocation of individuals if required.

Remoteness / access constraints: The Study Area is in a remote region with limited access and consequently, not all areas of the Study Area were able to be ground-truthed and sampled. However, survey coverage was adequate to understand the occurrence of fauna assemblages, habitats, and significant species in the area.

Problems with data and analysis: Previous Night Parrot survey work around Lake Mackay had limitations due to conditions (winds), season (dry season), access, or equipment. These limitations were addressed through additional Night Parrot baseline survey work around the lake in 2021 (Appendix G).

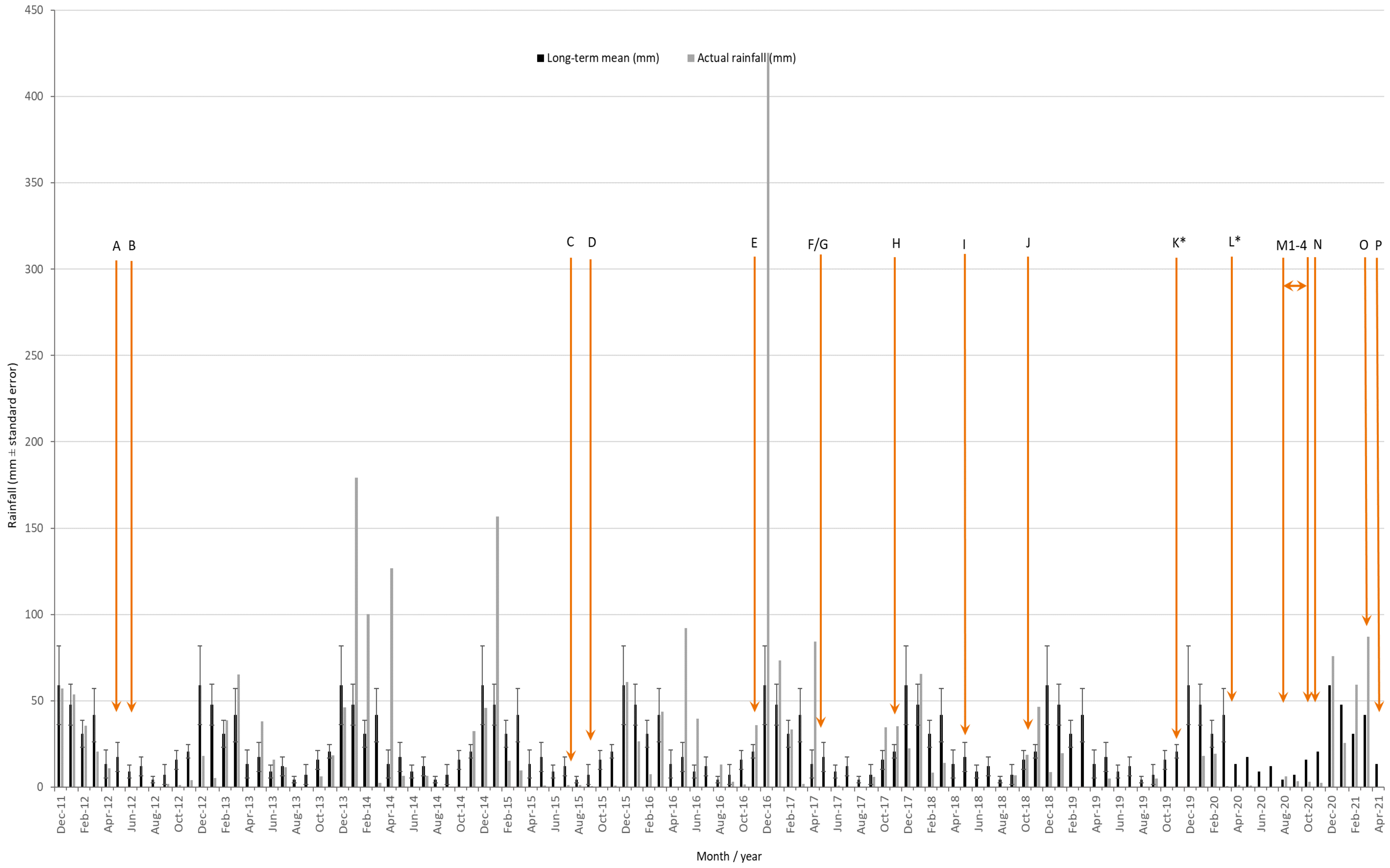

Figure 7-10: Long-term (1998-2020) mean monthly rainfall (mm) at Walungurru Airport weather station (No. 015664) (BoM 2021c). Arrows indicate terrestrial fauna survey timing as detailed in Table 7-2 and Table 7-3

7.4 Receiving Environment

7.4.1 Fauna Habitats

7.4.1.1 Broad Fauna Habitats

In total, 12 broad fauna habitats have been described and delineated during the consolidation of habitats across the Study Area (Appendix G.1)(Table 7-7). These habitats were delineated on the basis of location, landform, substrate, vegetation type, and their importance to different faunal groups, in particular their importance to fauna of significance. All habitats within the Study Area were relatively undisturbed and assessed as being in excellent condition.

The most extensive habitats in the Study Area were the salt lake playa (54.8%), spinifex sandplain (23.3%) and dunefield (9.3%). The remaining nine habitats comprised proportions that were individually less than 5% of the Study Area. The importance of each habitat for fauna is presented in the following sections:

- Assemblages (Section 7.4.2);
- Significant fauna (Section 7.4.3); and
- SRE invertebrate fauna (Section 7.4.4).

All habitats identified within the Study Area are represented within the Proposal area and Indicative Footprint and are discussed in terms of potential impacts under Section 7.6.1.

7.4.1.2 Lake Mackay Inundation Events and Waterbird Habitat

The lake and associated wetlands are predominantly dry and subject to irregular and infrequent inundation. During major flood events, Lake Mackay supports a range of waterbird species including shorebirds, terns and ducks. The larger islands serve as waterbird breeding habitat while the lake playa and surrounding claypans/ saline depressions support foraging. Migratory and threatened bird species were recorded following large inundation events in 2001 and 2016 and during a smaller inundation event in 2021 (Table 7-6) (Appendix G.1).

Table 7-6: Summary of waterbird recorded during waterbird surveys of Lake Mackay.

Waterbird Survey	Waterbird Species (Confirmed ID)*	Listed Species	Waterbird Abundance	Inundation Duration (> 20 %)
2001 Survey (Duguid *et al.* 2005)	20	3	42,473	398 days
2017 Survey (360 Environmental 2017b)	25	5	3,273	89 days
2021 Survey (Appendix G.1)	12	4	42,194	24 days
Total	34	8	-	-

*Note: * indicates that non-waterbird species and waterbird species that could not be confirmed to species level have been excluded (e.g. Tern Whiskered or White-winged).*

The waterbird survey during the 2001 flood event recorded 42,473 individuals from 20 waterbird species (with six additional unconfirmed waterbird species). These records included more than 1% of the estimated population for three shorebirds: 12,000 Banded Stilts; 3,262 Black-winged Stilts; and 1,295 Red-necked Avocets. Additionally, 4,400 immature Banded Stilts were recorded which demonstrated a breeding event. The 2017 survey recorded a nationally significant count (3,273 individuals) of the Red-necked Stint (Mi, Mi). Note, both surveys occurred in sub-optimal timing several months after the rainfall events, and as such are likely to underestimate waterbird abundance, diversity and breeding activity. The 2021 survey detected large congregations of waterbirds foraging on a localised area of the Lake Mackay playa, ranging from 9,301 to 35,038 individuals. These congregations included from 4.4% to 11.8% of the estimated population of Sharp-tailed Sandpipers (Appendix G.1). An additional four migratory waterbirds are considered likely to occur based on regional records.

Based on the analysis of available historical satellite imagery, Lake Mackay had 58 inundation events (with over 20 % inundation) over the last 33 years of available imagery (Appendix I.21) (Figure 7-11). Typically, the duration of these events lasted less than a month. Of the 58 events, 21 were equivalent or greater in duration to the event observed during the 2021 waterbird survey (24 days) while only two were greater in duration than the event observed during the 2017 waterbird survey (more than 400 mm of rainfall; 89 days duration). These large inundation events (greater than 89 days) were 139 days in 2000 and the event observed during the 2001 waterbird survey estimated to be 398 days in duration. This event in 2000/2001 was the longest inundation event on available records and was nearly 30 times the average inundation duration. Lake levels were predicted to have reached approximately 4 m in the south-east of the lake, initially spilling into the surrounding riparian vegetation zone.

Inundation events in excess of 65 days duration meets the minimum time required for successful breeding of Banded Stilts (Appendix G.1). Based on the 33 years of available satellite imagery, six inundation events exceeded this minimum duration of inundation, with three of those events being marginal (estimates of 66, 69 and 72 days). However, the 2001 inundation event likely resulted in several reproductive events over the duration of the inundation. In summary, when inundated, Lake Mackay provides an important resource for foraging and breeding of waterbirds; however, large inundation events are rare and infrequent with the majority lasting less than one month.

7.4.1.3 Island Outcropping

It has been estimated that five of the 271 islands on Lake Mackay comprise gypsiferous sediment, while the remaining islands are predominantly red/orange sands (Stantec 2021b). Outcropping and crevices on these gypsiferous islands were found to support bats belonging to the genus *Scotorepens*. Two common desert bat species from the genus *Scotorepens* have been recorded in the broader Study Area: *Scotorepens blastoni;* and *Scotorepens greyii*.

7.4.1.4 Water Sources

Water sources are a limiting factor in arid environments and are an important feature of the arid interior, albeit typically temporarily during and following rainfall events. Specifically, birds and mammals will use these areas for drinking, amphibians will use these areas to breed, and many vertebrate fauna species will benefit from increased aquatic invertebrate fauna abundance for food. A total of 13 temporary water sources were identified in the Study Area. Most were pools in exposed bedrock, associated with rocky substrates in rocky ridge and gorge (5), minor drainage line (3), and outcropping and stony rise (2) habitats. Three were identified in claypans and claypan mosaic habitat; these comprised large claypans and a soak. The location of one permanent water source supplied by Tjurabalan representatives is approximately ~250 m west and downstream of the NIDE.

Table 7-7: Consolidated fauna habitats occurring within the Study Area and the Proposal area (habitats ordered based on extent in the Indicative Footprint)

Fauna habitat	Description	Extent in Study Area		Extent in Proposal area		Extent in Indicative Footprint	
		(ha)	(%)	(ha)	(%)	(ha)	(%)
Salt lake playa	The Salt lake playa comprises the predominantly dry lake bed of Lake Mackay. The playa is vast flat salt encrusted basin which his devoid of vegetation. Larger islands on the playa support varying proportions of the broad habitats found elsewhere within the Study Area. The playa floods on average every 5-10 years and retains water for variable periods from days to months (up to six months in extreme events).	243,271.31	54.79	216,333.14	88.93	13,363.12	5.49
Spinifex sandplain	Large expanses of relatively flat *Triodia* hummock grasslands with sparse shrubs and trees. The *Triodia* spp. hummock grassland tended to be open to relatively closed. Substrates ranged from sandy to sandy clay and tended to lack coarse fragments.	103,434.45	23.30	28,189.44	27.25	754.20	0.73
Dunefield	Small closely spaced dunes interspersed by swales and relatively narrow flats. Upper and mid storey vegetation was typically sparse, ranging from isolated to 30% shrub cover and occasional thickets. The lower story was typically an open *Triodia* spp. hummock grassland.	41,418.07	9.33	5,431.74	13.11	281.82	0.68
Gravel spinifex plain	Typically elevated in the landscape with substrates made up of fine to medium gravel fragments, usually laterite, over sandy clays. Vegetation typically comprised a low open to very open shrubland of *Acacia hilliana* (<1 m tall) over an open *Triodia* hummock grassland.	9,646.21	2.17	8,613.91	89.30	248.12	2.57
Claypans and claypan mosaic	Mosaic of claypans interspersed by low lying chenopod shrublands, *Triodia* hummock grasslands and tussock grasslands. Often this habitat featured chains of claypans in the swales between dune habitat, particularly in the vicinity of Lake Mackay. The claypans in this habitat would hold freshwater or less saline water compared to the saline flats and depressions habitat when inundated.	15,960.78	3.59	1,456.80	9.13	42.22	0.26
Lake margin	The lake margin habitat fringes the salt lake playa of Lake Mackay with vegetation that is typically represented by a low open chenopod shrubland of *Frankenia cordata*, *Tecticornia* spp. and *Maireana luehmanni*. The vegetation in this habitat typically lacked an upper or mid storey.	14,884.20	3.35	1,341.30	9.01	22.36	0.15
Dune	Relatively large sand dunes which were separated by sandplains and/or large swales. Vegetation typically comprised scattered tall *Corymbia chippendalei* (3 – 5 m) (a distinct feature of larger dunes) over a mixed *Eucalyptus mallee*, *Grevillea, Hakea* and *Acacia* open shrubland over an open *Triodia* spp. hummock grassland.	6,521.41	1.47	1,477.24	22.65	19.27	0.30
Cleared	-	115.09	0.03	92.30	80.20	18.43	16.01
Outcropping and stony rise	Outcropping rock-faces (less than 5 m tall), exposed bedrock and/or extensive stony substrates. The rocky features within this habitat were less prominent than within the rocky ridge and gorge habitat, but more pronounced than other habitats in the broader landscape.	491.08	0.11	415.75	84.66	5.36	1.09
Saline flats and depressions	Flat low-lying saline plains interspersed with depressions that had the potential to hold water. This habitat was restricted to the immediate surrounds of Lake Mackay. Typically, this habitat featured chains of depressions or complex saline drainage areas. These features were interspersed with a mosaic of chenopods (*Tecticornia* spp., *Frankenia cordata*) *Triodia* spp hummock grasslands and tussock grasslands.	8,068.92	1.82	151.24	1.87	3.44	0.04
Drainage line	Channels which temporarily carried water after rainfall events. Substrates ranged from sandy to rocky outcropping, with the latter occasionally supporting semi-permanent water sources after recent rains. A relatively high cover of herbs and tussocks grasses was present in areas with low proportions of exposed bedrock.	40.98	0.01	39.43	96.21	0.55	1.34
Rocky ridge and gorge	Large sandstone ridgelines with exposed outcropping greater than 5m high and large boulders which formed substantial crevices, alcoves and shallow caves. Exposed bedrock formed collection points for semi-permanent water, which was relatively common in this habitat.	38.59	0.01	38.59	100.00	0.09	0.24
Ridge slope	Sloped rocky habitat that occurred between the ridge-faces and the low-lying stony plains. Vegetation comprised scattered trees and shrubs of *Corymbia candida* and *Acacia* spp. over an open *Triodia* spp. hummock grassland. Substrate was dominated by a dense cover of coarse rocky fragments on sandy clays	94.24	0.02	94.24	100.00	-	-
Total		443,985.33	100.0	263,675.12	59.39	14,758.98	3.32

*Note: * indicates discrepancies between total Study Area and calculated total habitat areas are due to spatial digitisation misalignments, less than 0.1% error*

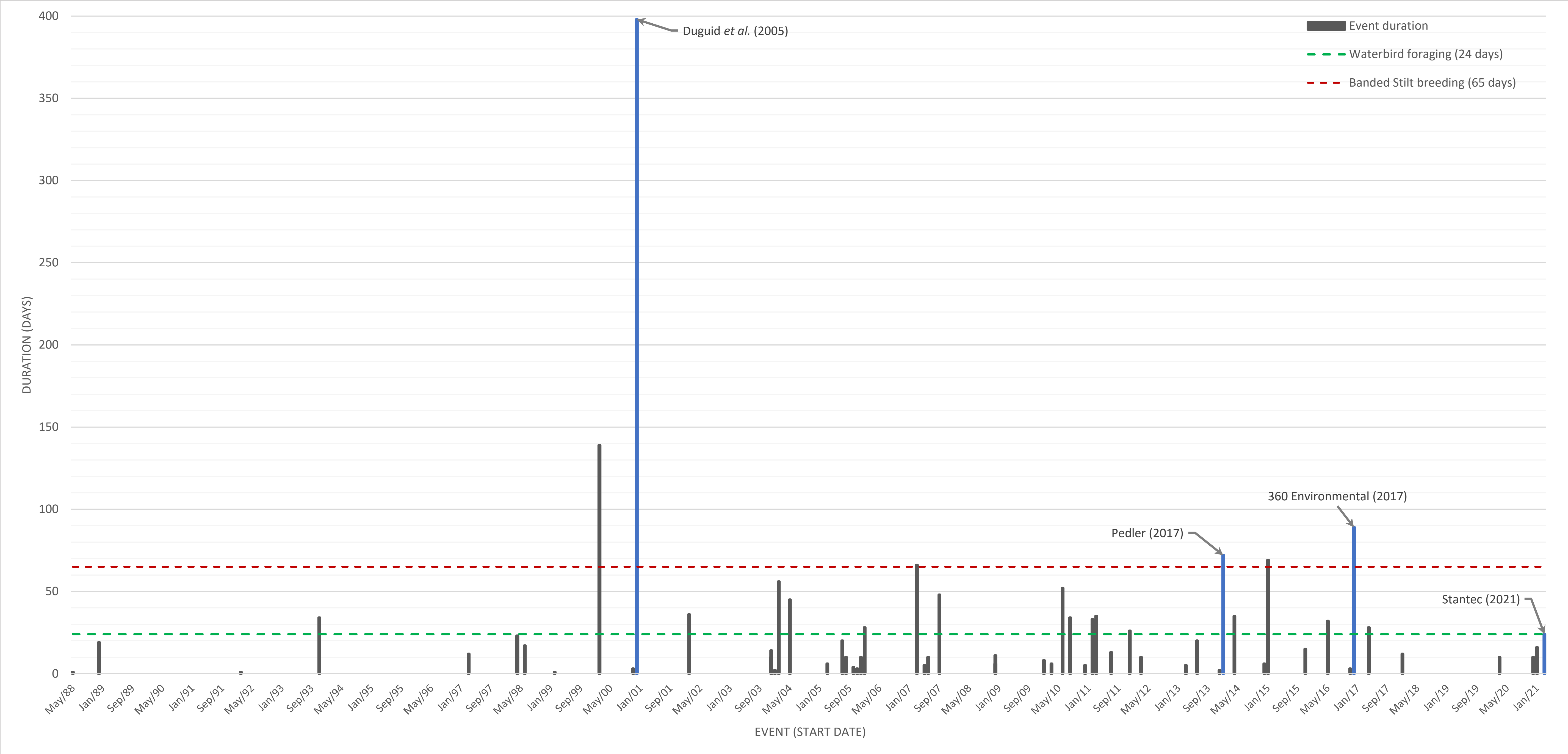

Figure 7-11: Frequency of Lake Mackay inundation events with limits for potentially supporting waterbird foraging (green) and Banded Stilt Breeding (red). Estimations of event duration are based on analysis of aerial imagery (Stantec 2021d). Banded Stilt breeding duration represents the minimum time required to raise chicks to fledge based on literature, while waterbird foraging suitability is based on the smallest observed event supporting significant foraging behaviour (2021, Appendix G.1).

7.4.2 Fauna Assemblage

The desktop assessment (database searches and the literature review) identified a total of 421 species of vertebrate fauna which have previously been recorded and/or have the potential to occur within the Study Area and therefore the Proposal area (Appendix G.1). In total, across all previous surveys that intersect the Study Area, a total of 245 vertebrate fauna species have been recorded, comprising 23 native mammals, eight introduced mammals, 129 birds, 1 introduced bird, 80 reptiles and four amphibians. A complete list of all fauna species recorded within the Study Area is presented in Appendix G.1.

Overall, during dry season surveys, the spinifex sandplain habitat had the highest species richness (n=52), followed by dunefield (n=43) and gravel spinifex plain (n=41). In comparison, during wet season surveys, dunefield habitat had the highest species richness (n=68), followed by gravel spinifex plain (n=46) and claypans and claypan mosaic (n=45).

For mammals, the most diverse habitat types were the dunefield (53 captures of 6 species), claypans and claypan mosaics (44 captures of 4 species) and spinifex sandplains (32 captures of 3 species). The most commonly recorded mammal was the Desert Mouse (*Pseudomys desertor*) which was captured on 48 occasions, most of which occurred in the dunefield habitat.

For birds, the most diverse habitat types were the dunefield (1245 records of 24 species), claypans and claypan mosaic (746 records of 28 species) and spinifex sandplain (706 records of 22 species). The most commonly recorded bird species from systematic sites was the Masked Woodswallow (*Artamus personatus*), (366 records), followed by the Budgerigar (*Melopsittacus undulatus*) (239 records) and Zebra Finch (*Taeniopygia guttata*) (138 records). These species are considered common and widespread throughout the region (Menkhorst *et al.* 2017).

For reptiles, the most diverse habitat types were the dunefield (1,273 records of 46 species), spinifex sandplain habitat (750 records of 40 species) and gravel spinifex plain (619 records of 35 species). These habitats offered a range of microhabitats for reptiles, often with a high proportion of *Triodia* cover and sandy or sandy clay substrates that are suitable for burrowing. The most commonly recorded reptile from systematic sites was the Leopard Ctenotus (*Ctenotus pantherinus*) (147 records), followed by the North-western Sandslider (*Lerista bipes*) (316 records) and the Bynoe's Gecko (*Heteronotia bynoei*) (109 records). All of these species are considered common and/or widespread throughout the region (Wilson and Swan 2017).

During flood events, the Lake Mackay playa and peripheral wetlands provide habitat with that supports assemblages of waterbirds which are otherwise absent from the region during dry conditions. These assemblages are discussed under Section 7.4.1.2.

7.4.3 Significant Fauna Species

Based on all previous surveys, 21 significant species have been confirmed in the Study Area (Table 7-8). This includes one species, the Broad-eyed Slider (*Lerista* aff. *robusta*) (P1) that was not identified in the desktop assessment. These species included three mammals, 14 birds (9 migratory) and three reptiles. Of these, the following are of note due to their conservation status, relative abundance and/or potential to be impacted by the Proposal:

- Greater Bilby (*Macrotis lagotis*) (Vu);
- Night Parrot (*Pezoporus occidentalis*) (En);
- Great Desert Skink (*Liopholis kintorei*) (Vu);
- Spotted Ctenotus (*Ctenotus uber. Johnstonei*) (P2); and
- Migratory or threatened waterbirds and shorebirds including:
    - Red-necked Stint (*Calidris ruficollis*) (Mi: migratory shorebird);
    - Sharp-tailed Sandpiper (*Calidris acuminata*) (Mi: migratory shorebird);
    - Marsh Sandpiper (*Tringa nebularia*) (Mi: migratory shorebird);
    - Oriental Plover (*Charadrius veredus*) (Mi: migratory shorebird);
    - Common Greenshank (*Tringa nebularia*) (Mi: migratory shorebird);
    - Glossy Ibis (*Plegadis falcinellus*) (Mi);
    - Gull-billed Tern (*Sterna nilotica*) (Mi);
    - White-winged Black Tern (*Sterna leucopterus*) (Mi); and
    - Fork-tailed Swift (*Apus pacificus*) (Mi).

In addition, five species were considered likely to occur and comprise one mammal, the Spectacled Hare-wallaby (P3) and four waterbirds (migratory). The Spectacled Hare-wallaby may occur throughout the year in suitable habitat within the NIDE; the waterbirds would only occur on the lake and surrounds after rainfall, particularly large flood events.

Primary habitats for each significant species were identified based on survey findings (intersects of recorded locations and habitats) and supplemented with known ecology for each species. It is acknowledged that some species may occasionally be recorded outside their primary habitats and these were differentiated as secondary habitats. Each of these habitats have potential to be impacted by the Proposal and are discussed under Section 7.6.1.

Table 7-8: Significant fauna confirmed or likely to occur within the Study Area including number of locations where each species was recorded.

Common Name	Scientific Name	EPBC Act	BC Act	Study Area		Primary habitat & number of locations recorded											
				Confirmed	Likely	Salt lake playa	Lake margin	Claypans and claypan mosaic	Saline flats and depressions	Dunefield	Dune	Spinifex sandplain	Gravel spinifex plain	Rocky ridge and gorge	Outcropping and stony rise	Ridge slope	Drainage line
Mammalia																	
Greater Bilby	*Macrotis lagotis*	Vu	Vu	✓				3		1	1	33	92				
Brush-tailed Mulgara	*Dasycercus blythi*	-	P4	✓			1		1	2	1	19	1				
Northern Marsupial Mole	*Notoryctes caurinus**	-	P4	✓						3	6	1					
Southern Marsupial Mole	*Notoryctes typhlops**																
Spectacled Hare-wallaby	*Lagorchestes conspicillatus leichardti*		P3		✓												
Aves																	
Night Parrot	*Pezoporus occidentalis*	En	Cr	✓				1					1**				
Australian Painted Snipe	*Rostratula australis*	En	En	✓					1								
Princess Parrot	*Polytelis alexandrae*	Vu	P4	✓						1		1##					
Grey Falcon	*Falco hypoleucos*	-	Vu	✓								1					
Striated Grasswren	*Amytornis striatus striatus*	-	P4	✓							1	1	2				
Fork-tailed Swift	*Apus pacificus*	Mi	IA	✓		May use all habitats within the Study Area without being dependent on specific types.											
Oriental Plover	*Charadrius veredus*	Mi	IA	✓								1					
Glossy Ibis	*Plegadis falcinellus^*	Mi	IA	✓													
Sharp-tailed Sandpiper	*Calidris acuminata*	Mi	IA	✓		5		1	5								
Marsh Sandpiper	*Tringa stagnatilis*	Mi	IA	✓					1								
Gull-billed Tern	*Sterna nilotica^*	Mi	IA	✓		11	2		3								
White-winged Black Tern	*Sterna leucopterus*			✓		1											
Red-necked Stint	*Calidris ruficollis*	Mi	IA	✓		4			1								
Common Greenshank	*Tringa nebularia^*	Mi	IA	✓					1								
Common Sandpiper	*Actitis hypoleucos*	Mi	IA		✓												
Pectoral Sandpiper	*Calidris melanotos*	Mi	IA		✓												
Oriental Pratincole	*Glareola maldivorum*	Mi	IA		✓												
Wood Sandpiper	*Tringa glareola*	Mi	IA		✓												
Reptilia																	
Great Desert Skink	*Liopholis kintorei*	Vu	Vu	✓								32^^					
Broad-eyed Slider	*Lerista aff. robusta*	-	P1	✓								1		1			
Spotted Ctenotus	*Ctenotus uber johnstonei*	-	P2	✓									6		1	1	

*Note: Green shading indicates primary habitat for the species based on survey records and known ecology; * indicates both species have been recorded in the Study Area and have an overlapping range. As they cannot be differentiated based on tracks and signs and have the same conservation listing, they are discussed collectively; ** indicates this record was in close proximity to claypan mosaic. The gravel spinifex plain is likely to have low potential to support foraging habitat from the spp when not in association with claypan and claypan mosaic; ^ indicates the species recorded from Lake Mackay during waterbird survey in 2001. Location of records unavailable.; ^^ denotes active burrows from within the Study Area. The population, which extends outside the Study Area exceeds a total of 64 active burrows; ## denotes the species was flying over spinifex plain, with part of the flock landing to drink at a freshwater claypan. As such, spinifex plain is not considered primary habitat.*

7.4.4 Terrestrial SRE Invertebrate Species

Terrestrial short-range endemic (SRE) invertebrate fauna are species defined as having a restricted range and have been broadly defined by Harvey (2002) as species with a maximum range of 10,000 km². Taxa prone to short range endemism tend to share several ecological and life-history characteristics, such as poor powers of dispersal, confinement to discontinuous habitats, highly seasonal activity patterns and low fecundity (Harvey 2002). These taxa are typically associated with sheltered and mesic microhabitats, such as the southeast aspect of slopes, trees, boulders and rock piles, outcrops, mesas, drainage systems, deep gorges, natural springs and fire refuges (EPA 2016g). Invertebrate groups typically prone to short range endemism and considered during impact assessment include mygalomorph spiders; scorpions; pseudoscorpions; millipedes; slaters; and terrestrial snails. In addition to these groups, surveys for the Proposal also included salt-lake specialists, specifically: salt lake wolf spiders; salt lake crickets; and tiger beetles.

The combined surveys of the Study Area yielded a total of 48 taxa from target groups which were represented by 1,490 invertebrate specimens. All specimens collected over previous surveys for the Proposal have been compared and consolidated, with naming revised and aligned across the collection records as a whole. Based on the morphological identifications and known species distributions, no taxa collected during the survey were identified as confirmed SRE species. However, a total of 40 taxa represented by 1,350 specimens were identified as potential SRE species due to insufficient geographical context, or a lack of taxonomic resolution. A further eight taxa represented by 140 specimens were identified as widespread.

A number of potential SRE specimens were not able to be identified to species level, as they were of an inappropriate sex or life stage, or due to a lack of taxonomic resolution. Consequently, the following assumptions have been made when assessing interrelatedness between the specimens identified:

- Specimens that have been listed under a single genus in the taxonomic report due to poor taxonomic resolution within the group have been discussed collectively as a single taxon e.g. the pseudoscorpion '*Beierolpium* sp'.
- Specimens identified as potentially belonging to a species complex in the taxonomic report have been discussed collectively as a single taxon at the Proposal scale e.g. *Lychas* '*multipunctatus* complex'.
- Specimens that have been listed under a single genus in the taxonomic report due to the specimens being of an inappropriate age or sex for morphological identification have been discussed as a single taxon e.g. the scorpion *Urodacus sp.*

Due to insufficient geographical context, or a lack of taxonomic resolution of many specimens, the SRE status was often difficult to determine. For these specimens, habitat associations and the known distribution patterns and ecology of other species in the same genus was used to inform potential distribution or SRE status of the taxa (EPA 2016g).

Within the Study Area, the 12 broad habitats (Section 7.4.1) were assessed based on their potential to support terrestrial SRE taxa (Appendix G.2). Based on this assessment, seven habitats were classified as having potential to support SRE taxa: salt lake playa; lake margin; saline flats and depressions; claypan and claypan mosaic; rocky ridge and gorge; outcropping and stony rise; and drainage line. Based on the habitat associations of taxa recorded during the surveys, nine potential SRE taxa were recorded exclusively from habitats with potential to support SRE species (Table 7-9, Figure 7-23).

All nine of these taxa were considered to be salt lake specialists and were recorded from exclusively from the playa of Lake Mackay or associated riparians habitats. Consequently, these nine taxa are of a higher risk of potential impacts from the Proposal compared to species collected from widespread and well-connected habitats. Each of these nine potential SRE taxa are considered likely to be distributed throughout their associated habitats at and surrounding Lake Mackay.

Table 7-9: Number of locations of potential SRE taxa recorded only from restricted habitats during the Surveys.

Taxa	SRE Status	Fauna Habitat											Grand Total
		Claypans and claypan mosaic	Drainage Line	Dune	Dunefield	Gravel spinifex plain	Lake margin	Outcropping and stony rise	Rocky ridge and gorge	Saline flats and depressions	Salt lake playa	Spinifex sandplain	
Wolf Spiders													
Hogna 'FP-11090'	Potential SRE: Geographic										7		7
Tetralycosa sp.	Potential SRE: Taxonomic						1				1		2
Venator `sp. (VWF1177)`	Potential SRE: Geographic						2						2
Other Araneomorph Spiders													
Dictynidae 'LM1'	Potential SRE: Geographic										1		1
Snails													
Leichhardtia cf. sisurnius	Potential SRE: Taxonomic	2								1			3
Insects													
Australicapitona 'LM1'	Potential SRE: Geographic									1			1
Pseudotetracha 'blackburni complex'	Potential SRE: Taxonomic	1					3				9		13
Pseudotetracha 'cf helmsi'	Potential SRE: Taxonomic						1				2		3
Rivacindela 'LM1'	Potential SRE: Geographic										1		1

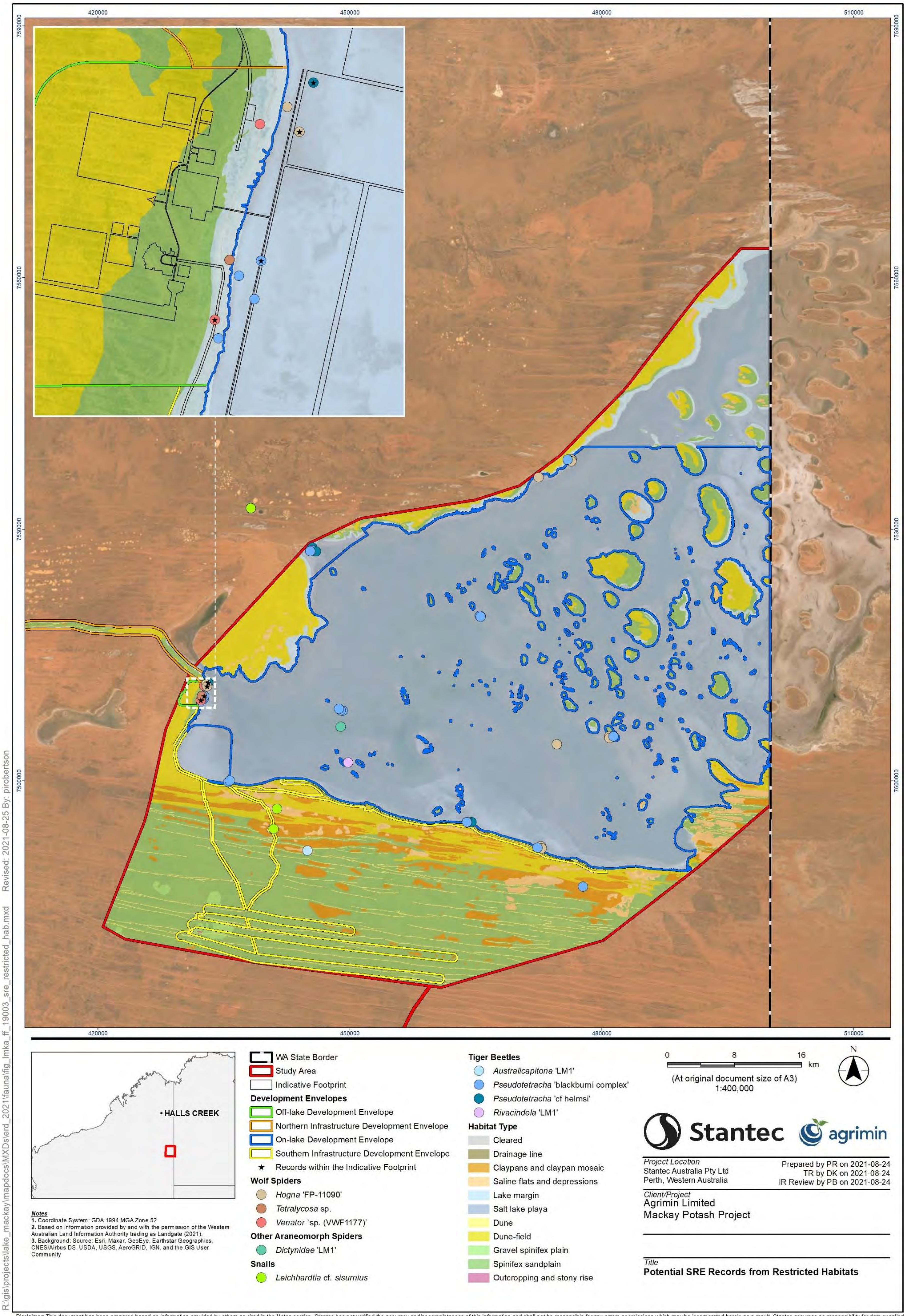

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Figure 7-12: Potential SRE invertebrates recorded exclusively from SRE habitats

7.4.5 Introduced Fauna

The desktop assessment identified nine species of introduced mammal and one introduced bird that potentially occur in the Study Area. In total, eight of these species were recorded within the Study Area and therefore have potential to occur in the Proposal area, including European Cattle (*Bos taurus*), the Camel (*Camelus dromedarius*), Feral Cat (*Felis catus*), Feral Dog (*Canis lupus*), Horse (*Equus caballus*), Red Fox (*Vulpes vulpes*), House Mouse (*Mus musculus*), and the Rabbit (*Oryctolagus cuniculus*).

7.5 Potential Impacts and Mitigation Measures

The potential exists for direct and indirect impacts from the Proposal to the fauna values within the Proposal area. The key risks of activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of the environmental risk assessment completed by the Proponent. A summary of potential impacts and mitigation measures that were identified in the risk assessment are provided in Table 7-10. The key potential impacts associated with the development of the Proposal comprise and are discussed in detail in Sections 7.6.1 to 7.6.16 and provides local and regional ecological context for the impact assessment, and include:

- habitat loss, fragmentation, or modification;
- loss of individuals;
- loss of significant fauna (individuals and habitat; Greater Bilby, Night Parrot, Great Desert Skink, Brush-tailed Mulgara, Spotted Ctenotus);
- waterbirds – loss of foraging habitat;
- waterbirds – loss of breeding habitat;
- SRE invertebrate fauna – loss of species or habitat;
- bird strike (wind turbines);
- attraction to artificial water bodies: loss of waterbirds;
- fauna entrapment;
- road strike;
- altered fire regimes;
- feral predators;
- weed spread;
- islands habitats – direct and indirect impacts;
- altered hydrology (excluding lake operations); and
- noise and vibration.

Additional potential impacts were identified during the risk assessment which were ranked as lower risk (Table 7-10). These impacts were considered as having a risk level that can be managed appropriately and are not discussed in detail in the following sections; however, these risks will be addressed via management measures in the relevant EMPs. These additional potential impacts to terrestrial fauna include:

- light exposure resulting in disruption of fauna behaviour including significant fauna; and
- fugitive dust emissions from clearing of native vegetation and haulage activities, resulting in decline in health of fauna habitats and water sources

The mitigation hierarchy has been considered and applied to potential Proposal impacts 'to protect terrestrial fauna so that biological diversity and ecological integrity are maintained', aligning with the EPA objective for the Terrestrial Fauna Factor (EPA 2016f) and are summarised in Table 7-10.

Mitigation measures are summarised in Table 7-10 which largely avoid, mitigate, manage, monitor, and rehabilitate significant impacts to terrestrial fauna values to reduce the environmental risk.

The mitigation measures are discussed in more detail in the subsequent sections and will ensure the EPA objective for Terrestrial Fauna will be met.

Table 7-10: Mitigation hierarchy applied to mitigate impacts from the Proposal on Terrestrial Fauna

Key Proposal Impact (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
Fauna habitat loss, fragmentation or modification from vegetation clearing impacts (including primary habitats for significant species) *Direct impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas • Clearing for haul road pavement width has been reduced from 7.5 m to 6.5 m. Limiting clearing/open areas will minimise open space able to generate dust emissions • Avoid or limit clearing primary habitat where possible for significant fauna species • Haulage corridor has been designed to avoid impacts to suitable breeding trees for the Grey Falcon (tall trees with raptor nests) and Princess Parrot (large stands of trees with hollows or potential to form hollows (e.g. stands of *Allocasuarina* sp. and *Corymbia* sp).	• Implement strict clearing mitigation that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries. • Clearing activities will primarily be carried out during daylight hours • Minimise clearing / disturbance where possible • Where possible minimise disturbance to primary habitats for significant species • During road construction within drainage features, maintain ecosystem function i.e. surface hydrology (within and outside the DE). • Weed management strategy to prevent the spread of existing weed species and the establishment of new weeds.	• Comply with FVEMP • Comply with Terrestrial Fauna Environmental Management Plan (TFEMP) • Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure • Develop a Weed Management Plan (WMP) • Develop an Incident Reporting Procedure	• Post clearing surveys • Annual inspections of cleared and rehabilitated areas to detect presence of new weed species and to determine success of weed mitigation measures • Internal incident reporting and investigation process • Monitoring for significant species as required	• Rehabilitation of temporary cleared areas	✓	No
Loss of individuals (including significant species) from native vegetation clearing *Direct impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas	• Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing • Conduct targeted pre-clearance survey (four weeks prior to clearing) within the Indicative Footprint • Clearing activities will primarily be carried out during daylight hours • During clearing activities, have a fauna spotter present to relocate fauna out of the way of machinery. • Wherever possible, undertake clearing progressively over time to allow fauna to disperse to other suitable habitats within the surrounds.	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure • Comply with Feral Predator Control Program • Develop a Fire Management Procedure • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process	• NA	✓	No
Greater Bilby (Vu, Vu): loss of individuals and / or habitat loss, fragmentation, or modification from native vegetation clearing *Direct & indirect impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas	• Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing • Conduct targeted pre-clearance survey (four weeks prior to clearing) within the Indicative Footprint • Where possible minimise disturbance to primary habitats, of significant species • Clearing activities will primarily be carried out during daylight hours • Where clearing of suitable Greater Bilby habitat is unavoidable, mitigate impacts by	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure • Comply with Feral Predator Control Program • Develop a Fire Management Procedure • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas	✓	No

Key Proposal Impact (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
		clearing outside breeding season where possible. • Where clearing of burrows is unavoidable, mitigate impacts by relocating individuals to alternative suitable habitat ideally with existing burrows: • Initially encourage burrow abandonment by disturbing entrance and monitoring (e.g. burrow sweeps and motion cameras) to confirm individual has left. Close burrow once abandoned • If burrow not abandoned, trap and cage individual at entrance and relocate before collapsing burrow, in the presence of suitably qualified fauna experts • Dynamic nature of the Greater Bilby means that individuals may establish burrows between the pre-clearance survey and clearing activities. During clearing activities, have a fauna spotter present to identify any new burrows. If a new burrow is detected, pause clearing activities, and relocate individual as per methods above • Implement Feral Predator Control Program to manage any potential increase in the prevalence of feral predators as a result of the Proposal • Restrict road haulage operations to daylight hours					
Night Parrot (EN, CR): loss of individuals and / or habitat loss, fragmentation, or modification from native vegetation clearing *Direct & indirect impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas • Avoid clearing old growth spinifex and primary habitats where possible (as identified by the fine scale mapping)	• Implement strict clearing mitigation that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries • Clearing activities will primarily be carried out during daylight hours • Pre-clearance Night Parrot recording surveys in suitable habitat i.e. old-growth spinifex. • If Night Parrots are detected (or are known to occur) surveys will be conducted to identify if any roost sites occur within the Indicative Footprint • In the unlikely event that a Night Parrot roost is detected within the Indicative Footprint, field staff will wait for the bird to leave the roost in the evening (confirmed by visual inspection of roost) before disturbing or removing the roost hummock to discourage the bird from returning. As Night Parrots are likely to use several roosts within their range, and extensive similar roosting habitat is present adjacent to the clearing footprint, it is anticipated that this will not have any long-term negative effects on the individual. If a nest is detected during pre-clearance listening surveys, these methods will not apply and the nest area will be avoided entirely until any chicks have fledged or a qualified fauna handler can relocate the nest. • During road construction within drainage features, maintain ecosystem function i.e.	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure • Comply with Feral Predator Control Program • Develop a Fire Management Procedure • Develop an Emergency Response Plan • Develop a TMP • Develop a Hot Works Permit System • Develop an Incident reporting Procedure	• Monitor activity at known locations to determine success of mitigation • Monitor vegetation heath / hydrology along drainage features within suitable Night Parrot habitat to determine success of mitigation • Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas	✓	No

Key Proposal Impact (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
		surface hydrology (within and outside the Proposal area). The drainage features have been identified as supporting primarily habitat for the Night Parrot for up to 5 km either side of the Proposal area. • Restrict road haulage operations to daylight hours					
Great Desert Skink (Vu, Vu): loss of individuals and / or habitat loss, fragmentation, or modification from native vegetation clearing *Direct & indirect impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas	• Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing • Clearing activities will only be carried out during daylight hours • Conduct pre-clearance surveys within the Indicative Footprint within primary habitat. There exists the potential for populations to occur elsewhere in the Proposal area that have not been intensively surveyed. • If burrows are encountered during pre-clearance, where possible avoid active burrows, ideally with a buffer accounting for foraging behaviour (>200m). If direct impact is unavoidable relocate individual to similar habitat in the area by a suitably qualified fauna expert. • Restrict road haulage operations to daylight hours	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure • Comply with Feral Predator Control Program • Develop a Fire Management Procedure • Develop an Incident Reporting Procedure	• Monitor burrow activity in proximity of disturbance to determine success of avoidance • Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas	✓	No
Brush-tailed Mulgara (P4): loss of individuals and / or habitat loss, fragmentation, or modification from native vegetation clearing *Direct & indirect impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas	• Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing • Clearing activities will only be carried out during daylight hours • Conduct pre-clearance survey (four weeks prior to clearing) within the Indicative Footprint. • Where burrows are identified during pre-clearance surveys, mitigate impacts by relocating individuals to alternative suitable habitat • Implement Feral Predator Control Program to mitigate predation pressure prior to relocation program to increase success of program	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure • Comply with Feral Predator Control Program • Develop a Fire Management Procedure • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas	✓	No
Loss of Waterbirds foraging habitat from disturbance to playa from lake construction *Indirect impact*	• Limit disturbance to On-LDE (15,000 ha) • Northern territory portion of the lake will remain undisturbed (56,506 ha) • Exclusion zone on WA side of the lake that will remain undisturbed (32,261 ha) • Avoid impacts to Islands (total of 20,119 ha of islands excluded from OnLDE) • Trench network will be outside a suitable buffer zone from island formations (buffer dependent on island size)(Appendix I.10).	• Detailed hydrological modelling of surface water flows, simulation 1:100-year events to determine impacts • Where required, mitigate secondary impacts to waterbird foraging habitat on the playa through the installation of suitable drainage mitigation features. These features should be designed to convey flow past On-LDE infrastructure and return flow to its natural path and area of inundation. Mitigation measures to be informed by hydrology models that replicate flood events of a sufficient size and duration to trigger invertebrate & macrophyte abundance and therefore sufficient waterbird foraging resources.	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Comply with IWEMP • Develop a Ground Disturbance Permit System and Procedure • Develop an Incident Reporting Procedure • To avoid disturbance to foraging waterbirds, no access will be permitted to inundated portions of Lake Mackay when more than 20 % of the lake is inundated. Similarly, no access will be permitted to inundated claypans or salt pans with the exception of	• Design a waterbird monitoring program prior to construction / operations. • Conduct opportunistic waterbird surveys in response to suitable conditions, if they occur, prior to and during construction/operation of the Proposal • Document utilisation of the lake by waterbirds with respect to areas of proposed disturbance and use findings to	• at closure, strategic breaching of the southern feeder of trench bunding canal to maintain hydrology, based on hydrological modelling results; and • at closure, trenches to infill naturally, a process likely to occur within approximately 10 years (based on field observations of test trenches), aided by flooding, which will increase sedimentation into trenches.	✓	No

Key Proposal Impact (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
		• Where required, mitigate secondary impacts from changes in hydrology to claypans and claypan mosaics, and saline flats and depressions surrounding Lake Mackay that are dissected by the Indicative Footprint. These habitats comprise only a small portion of the Proposal area. • Staged development of trenches via BMUs and engineering design (1 km spacing, install crossovers) to maintain natural hydrological processes. The staged approach will allow for adaptive management to be implemented.	inspections and evaporation ponds.	inform management actions, if required.			
Loss Waterbirds breeding habitat from disturbance to playa from lake construction *Indirect impact*	• Limit disturbance On-LDE (4.4%; 15,000 ha) • Avoid impacts to NT section of the lake (16.6%; 56,506 ha) • Exclusion zone on WA side of the lake that will remain undisturbed (9.5%; 32,261 ha) • Trench network will be outside a suitable buffer zone from island formations (buffer dependent on island size)(Appendix I.10). • Avoid impacts to Islands (total of 20,119 ha of islands excluded from OnLDE)	• Detailed hydrological modelling of surface water flows, simulation 1:100-year events to determine impacts • Staged development of trenches via BMUs and engineering design (1 km spacing, install crossovers) to maintain natural hydrological processes.	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Comply with IWEMP • Develop a Ground Disturbance Permit System and Procedure • Comply with Feral Predator Control Program • Develop an Incident Reporting Procedure • To avoid disturbance to breeding waterbirds, no access will be permitted to islands used for breeding by banded stilts or other waterbirds	• Conduct waterbird surveys during inundations which are sufficient enough to trigger breeding events to monitor for potential impacts and /inform management actions if required.	• at closure, strategic breaching of the southern feeder of trench bunding canal to maintain hydrology, based on hydrological modelling results; and • at closure, trenches to infill naturally, a process likely to occur within approximately 10 years (based on field observations of test trenches), aided by flooding, which will increase sedimentation into trenches.	✓	No
Loss of population or species and / or habitat for Terrestrial SRE invertebrate fauna from land disturbance or native vegetation clearing *Direct & indirect impact*	• No clearing of vegetation on lake islands • 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas • Limit disturbance On-LDE (4.4%; 15,000 ha) • Avoid impacts to NT section of the lake (16.6%; 56,506 ha) • Exclusion zone on WA side of the lake that will remain undisturbed (9.5%; 32,261 ha) • Trench network will be outside a suitable buffer zone from island formations (buffer dependent on island size)(Appendix I.10). • Avoid impacts to Islands (total of 20,119 ha of islands excluded from OnLDE)	• Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing • Maintain ecosystem function of SRE habitats that have potential to be impacted by the Proposal i.e. Lake playa and salt lake margin habitat	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure	• N/A	• Rehabilitation of temporary cleared areas	✓	No
Loss of individuals including species of significance from Bird	• The location of the wind turbines has been offset from the lake where	• NA	• Implement appropriate avoidance, mitigation measures according to results of monitoring	• Conduct opportunistic waterbird surveys in response to suitable	• NA	✓	No

Key Proposal Impact (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
strike from windfarm operations *Direct impact*	possible to avoid migratory bird pathways • Location of the wind turbines was selected to be on the western edge of the lake, which is away from the deeper eastern parts of the lake which are more likely to flood during inundation events and hence attracting water birds		• Develop an Incident Reporting Procedure • Implement adaptive management • Report incidents of fauna mortalities	conditions, if they occur, during construction / operation of the Proposal; • Monitor bird strikes and report on species and numbers • Internal incident reporting and investigation process			
Loss of individuals including species of significance from attraction of waterbirds to artificial water bodies *Indirect impact*	• The creation of artificial waterbodies with high brine concentrations is considered an unavoidable part of the development of the Proposal	• Implementation bird deterrents if required. To be informed from the monitoring program. • Natural trench fill-in (within approximately 10 years) and breaking of pond bunds at closure to allow flow of water	• Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop an Incident Reporting Procedure	• Implement a monitoring program from inception of the Proposal with corrective actions to be implemented if required. Given the large scale of the Proposal, monitoring for bird mortality will focus on the evaporation ponds and a representative portion of the trench network. (once a week for southern trench and evaporation ponds, once every 6 months for infiltration trenches). • Maintain records and report on fauna mortality rates to determine fauna at risk and potential locations of interest. • Baseline information to determine effectiveness and focus of further mitigation and adaptive management if necessary • Internal incident reporting and investigation process	• Revise plan for the artificial waterbodies post closure depending on the findings of the monitoring.	✓	No
Injury or Loss of individuals including species of significance fauna entrapment from ponds/trenches *Indirect impact*	• The creation of trenches is considered an unavoidable for the development of the Proposal	• Approximately 1.5 m high bunding adjacent to trenches • Fauna egress will be provided for temporary ponds such Turkeys nests along the haul road • Fencing will be installed around the perimeter of permanent freshwater storage dam/s	• Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop an Incident Reporting Procedure	• Implement a monitoring program from inception of the Proposal with corrective actions to be implemented if required. Given the large scale of the Proposal, monitoring will focus on the evaporation ponds and a representative portion of the trench network. (once a week for southern trench and evaporation ponds, once every 6 months for infiltration trenches)	• at closure, strategic breaching of the southern feeder of trench bunding canal to maintain hydrology, based on hydrological modelling results; and • at closure, trenches to infill naturally, a process likely to occur within approximately 10 years (based on field observations of test trenches), aided by flooding, which will	✓	No

Key Proposal Impact (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
				• Maintain records and report on fauna mortality rates to determine fauna at risk and potential locations of interest • Baseline information to determine effectiveness and focus of further mitigation and adaptive management if necessary • Internal incident reporting and investigation process	increase sedimentation into trenches.		
Injury or loss of individuals including species of significance due to road strike *Direct impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Clearing will only occur in approved ground disturbance areas	• Design haul road and manage road verges to minimise roadside water sources and foraging opportunities for fauna, and maximise visibility of road edges for drivers • Engage and educate other haul road users of the importance in restricting driving to day time hours and following speed restrictions outside of these hours	• Comply with TFEMP • Comply with CEMP • Develop a TMP • Restricting haulage operations to daylight hours. • Restrict public access to haul road (Agrimin staff, contractors, and Traditional Owners only) • Implement speed limits for all traffic at dawn/dusk and night time in habitats and areas of importance to significant species • Develop education programs for haul road users (including Traditional Owners)	• Record mortality events; establish a baseline to determine future mitigation effectiveness and potential 'hot spots' or periods of increased risk (e.g. mating dispersal) requiring particular focus • Maintain a fauna mortality register to identify at risk species • Report mortalities • Monitor local traffic levels	• NA	✓	No
Altered fire regimes resulting in the loss of important habitat for fauna including significant fauna *Indirect impact*	• Avoid hot works in fire sensitive habitats	• Engagement of Traditional Owners for understanding local fire regimes and fire management practices • Establish Emergency Response Plan and Emergency Response Team (ERT) • Fire response equipment maintained at site and in vehicles and machinery and Haul Trucks • Water trucks fitted with high pressure monitors and pumps for fire management • Implement a hot works permit system for high ignition risk work activities high ignition risk work activities • Develop education programs for haul road users (including Traditional Owners)	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Develop a Fire Management Procedure • Develop an Emergency Response Plan • Develop a TMP • Develop a Hot Works Permit System • Develop an Incident Reporting Procedure	• Monitor success of fire management, particularly near significant species/habitat e.g. NP • Internal incident reporting and investigation process	• NA	✓	No
Feral predators (cats & foxes) resulting in increased predation on fauna including significant fauna *Indirect impact*	• Ban all staff and contractors brining any animals to site	• Educate staff and local traffic on the importance of not feeding feral animals • Putrescible waste to be stored and disposed of in a way that cannot be accessed by fauna • Landfill wastes will be covered promptly, and active waste disposal cells will be fenced to exclude large fauna	• Comply with TFEMP • Comply with CEMP • Comply with Feral Predator Control Program; • Develop a Waste Management Plan • Liaise with traditional owners to manage feral predators, particularly in habitat important to significant species and/or locations where significant species have been recorded	• Record and monitor the presence of feral predators including an assessment of abundance compared to baseline levels and to determine the effectiveness of control program • Internal incident reporting and investigation process • Include monitoring of the Silver Gull (*Larus*	• NA	✓	No

Key Proposal Impact (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
			• Develop an Incident Reporting Procedure	*novaehollandiae*) population (predator of waterbird fledglings including Banded Stilts) during waterbird monitoring and implement management actions if required.			
Weed spread resulting in increased risk of fire, reduced native vegetation cover / alteration of fauna habitat *Indirect impact*	• Avoid facilitating the spread of current weed populations from along Tanami Road to the haul road	• Implement weed hygiene procedures for clearing and construction equipment coming into the Proposal area, and equipment moving between Development Envelopes • Include hygiene obligations into clearing contractor contracts • Establish weed hygiene zones if conducting earthworks near known weed locations • Timely response for management of any declared weed occurrences • Weed mitigation to be undertaken prior to the wet season to minimise weed infestation • Limit vehicle and personnel movements outside of approved access and disturbance envelopes • Training for personnel to identify weed species and process for reporting weed locations • Incident reporting of new weed species and new locations	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with MCP • Develop a Weed Management Procedure • Develop a Ground Disturbance Permit System and Procedure • Develop a Topsoil Stripping and Storage Procedure. • Develop a Waste Management Procedure • Develop an Incident Reporting Procedure	• Annual inspections of cleared and rehabilitated areas to detect presence of new weed species and to determine success of weed mitigation measures • Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas • Seed rehabilitation areas with local native species from reputable supplier (certified seed purity). Seed quality certification from external suppliers • Contingency weed spraying during rehabilitation	✓	No
Hydrocarbon and chemicals spills resulting in injury or loss of individuals (including significant species) and decline of health of fauna habitats and water sources *Indirect impact*	• Power generation by using LNG, solar and wind operation reduces field usage required for the Proposal • Salt harvesters will be powered using reticulated power sources saving 19,658,141 L of diesel being used on the lake surface • Avoid fuel/chemical storage and transfer from occurring outside of designated area • Avoid off-road driving and stay on approved access ways	• Spill response equipment available (including on all Haul Trucks) • Spill response training for all personnel and contractors • Dedicated workshop for maintenance • Maintain high standard of housekeeping around processing plant • Prevent chemical / hydrocarbon spill from spreading to native vegetation	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Develop a Hazardous Substances Management Plan (HSMP) and Procedure • Develop a Refuelling Procedures of on-lake vehicles, plant, and equipment • Develop an Emergency Response Plan • Develop a Spill Response Plan • Develop a Controlled Waste Management Procedure • Bioremediation facility for the treatment of contaminated fill, soils, or sediment • Management of sites as per the *Contaminated Site Act 2003* • Develop a Contaminated Sites Register • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process • If required, sampling of soils to ensure all contaminated material has been removed and *in situ* soils sediment have been remediated • If required, monitoring vegetation health in affected areas and adjacent areas.	• If required, contaminated site rehabilitation	✓	No
Altered hydrology: Island habitats – direct and indirect impacts *Indirect impact*	• Limit disturbance On-LDE 15,000 ha) • The location and layout of the On-LDE infrastructure has been designed to minimise impacts to the	• Detailed hydrological modelling of surface water flows, simulation 1:100-year events to determine impacts • Staged development of trenches via BMUs and engineering design (1 km spacing, install	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Comply with IWEMP	• NA	• NA	✓	No

Key Proposal Impact (Direct/Indirect)	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
	Lake Islands and the lake fringe riparian zone, including avoidance buffers ranging from 250 to 500 m	crossovers) to maintain natural hydrological processes					
Altered Hydrology (excluding lake operations). Changes to surface hydrology and water flows during inundation, resulting in disturbance and decline of fauna habitats including significant fauna habitats and islands habitats *Indirect impact*	• Avoid clearing within drainage features and drainage lines where possible	• Design of infrastructure to minimise changes to natural hydrological flow. For example, haul road crossing of drainage features known to support Night Parrot will follow natural contours so that natural hydrology is maintained downstream of the crossing.	• Comply with FVEMP • Comply with TFEMP • Comply with CEMP • Develop a Ground Disturbance Permit System and Procedure • Develop an Incident Reporting Procedure	• Monitor vegetation health along drainage features, particularly along drainage features known to be used by the Night Parrot (see Night Parrot).	• NA	✓	No
Noise and vibration exposure resulting disruption of fauna behaviour including significant fauna *Indirect impact*	• Restrict operations on the haul road to daylight hours where possible	• The haul road will initially be unsealed; however, Agrimin plan to bituminise the haul road and this will subsequently reduce noise and vibration • Implement and enforce speed limits for all traffic, particularly at dawn/dusk and night time in habitats and areas of importance to significant species	• Compliance with CEMP • Develop a TMP • Develop a training and awareness packages and inductions	• Monitor activity of Great Desert Skink burrows within close proximity of haul road to determine success of speed limits in mitigating noise and vibration impacts	• NA	✓	No
Light exposure resulting in disruption of fauna behaviour including significant fauna *Indirect impact*	• Design artificial lighting to illuminate designated operations areas and limit illumination of the surrounding landscape	• NA	• Compliance with CEMP • Develop awareness and training packages and inductions • Complaints Procedure and Register	• NA	• NA	✓	No
Fugitive dust emissions from clearing of native vegetation and haulage activities, resulting in decline in health of fauna habitats and water sources *Indirect impact*	• 30% of the haulage corridor will be constructed on the existing cleared track reducing total clearing • Haul road will be sealed in the early stages of the Proposal, limiting dust emissions that would otherwise be likely from an unsealed haul road	• Use of dust suppression (water carts) during clearing activities and operations • Dust suppression measures to focus on areas in proximity to Priority flora, significant vegetation, and riparian vegetation • Vehicle speeds on construction roads will be reduced where necessary to minimise dust emissions	• Comply with FVEMP • Comply with CEMP • Develop a DMP • Develop a TMP • Develop a Complaints Procedure and Register	• Monitor daily wind conditions will be taken into consideration when clearing activities are proposed • Vegetation health monitoring (with particular attention to areas where Priority species have been identified) for dust deposition • Monitor all populations of known Priority flora and other significant species to observe for signs of stress due to dust suffocation • Internal incident reporting and investigation process	• Progressive rehabilitation will be undertaken to reduce the area susceptible to wind erosion	✓	No

7.6 Assessment of Key Impacts and Mitigation Measures

7.6.1 Fauna Habitat Loss, Fragmentation or Modification

Clearing and disturbance of fauna habitats is a necessary part of the development of the Proposal, and represents the most direct impact to fauna habitats, assemblages, and significant species. Clearing may reduce the size and quality of habitats, through edge effects and habitat fragmentation, and potential to heighten the effects of other threatening processes, including introduced flora (Section 7.6.13), introduced fauna (Section 7.6.12), altered hydrology (Section 7.6.14) and altered fire regimes (Section 7.6.11). Fauna habitat, survey effort and proportions of each habitat with potential to be impacted by the Proposal is provided as follows:

- vertebrate fauna: Table 7-4 and Figure 7-3 to Figure 7-6; and
- SRE invertebrate fauna: Table 7-5 and Figure 7-7 to Figure 7-9.

Land disturbance for the Proposal will total up to 16,500 ha and comprise up to 15,000 ha within the On-LDE, 1,000 ha within the NIDE, 300 ha within the SIDE and 200 ha within the Off-LDE.

Of the 12 broad fauna habitats mapped within the Study Area, all intersect the Proposal area and have the potential to be affected by disturbance during the construction and operation of the Proposal. Although the Proposal area comprises a large proportion of the habitats, based on the Indicative Footprint only a small proportion are likely to be disturbed in the context of the Study Area (Table 7-11). The habitat with the largest extent proposed to be disturbed for the Proposal is the salt lake playa within the ON-LDE. A total of 243,271 ha of the salt lake playa occurs within the Study Area, of which 216,333 ha (88.9 %) occurs within the Proposal area. However only, 5.49 % (13,363 ha) of this extent occurs within the Indicative Footprint.

Based on the Indicative Footprint, the remaining off-lake disturbance will be largely confined to the spinifex sandplain, dunefield and gravel spinifex plain habitats. Disturbance to these habitats is proposed to be no greater than 2.6% of their individual extents in the Study Area. Disturbance within each of the remaining habitats is proposed to be individually less than 45 ha or less than 1.5 % of their individual extent within the Study Area.

In addition to total areas of habitats to be directly disturbed, development of the Proposal may also contribute to habitat fragmentation. The potential fragmentation of habitats will be largely confined to the clearing for the haulage corridor within the NIDE. The main factors influencing the barrier effect of a road relate to road width, traffic volume, and behaviour of the species (van der Ree *et al.* 2008). The width of clearing for the haul road will be limited to a 24 m wide corridor and haulage along the road will be limited to daytime hours (Section 7.6.10). Given that the proposed haul road is relatively narrow within habitats that are otherwise extensive in the surrounding landscape, the proposed clearing and operation of the haul road is unlikely to fragment habitats to the extent that the road forms a major barrier to dispersal for terrestrial fauna. Additional information regarding potential impacts of the haul road specific to significant species is detailed in Section 7.6.2.

With respect to significant landscape features (Section 7.4.1), the importance of Lake Mackay to waterbirds as foraging and breeding habitat is discussed separately under Section 7.6.4 and Section 7.6.5. With respect to island outcropping, the islands have been excluded from the Proposal area and will not be directly impacted by the Proposal and any indirect impacts are anticipated to be negligible. With respect to temporary water sources, potential impacts are discussed under changes to surface hydrology (Section 7.6.14).

In summary, all habitats proposed to be directly impacted by the Proposal comprise a minor proportion of their extents within the Study Area. Additionally, habitats with potential to be fragmented, will be predominantly limited to the proposed haul road where clearing and operation is unlikely to form a major barrier to dispersal. Mitigation of disturbance and fragmentation to fauna habitats will involve the implementation of the CEMP (Appendix C.1) and the TFEMP (Appendix C.3) and will primarily include mitigation that strict clearing mitigation that avoids disturbance as a priority, and clearly demarcate and monitor disturbance boundaries.

Based on the implementation of mitigation measures to limit impacts resulting in fauna habitat loss, fragmentation or modification, the EPA objective for Terrestrial Fauna will be met.

Table 7-11: Consolidated fauna habitats occurring within the Study Area and within each of the Development Envelopes and Indicative Footprint (habitats ordered based on extent in the Indicative Footprint)

Fauna habitat	Extent within the Study Area (ha)	Proposal area										Indicative Footprint									
		On-LDE		Off-LDE		SIDE		NIDE		Total Proposal area		On-LDE		Off-LDE		SIDE		NIDE		Total Indicative Footprint	
		ha	%	ha	%	ha	%	ha	ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Salt lake playa	243,271.31	216,243.31	88.89	0.08	<0.01	0.24	<0.01	89.50	0.04	216,333.14	88.93	13,363.12	5.49	-	-	-	-	-	-	13,363.12	5.49
Spinifex sandplain	103,434.45	72.84	0.07	189.99	0.18	8,175.02	7.90	19,751.60	19.10	28,189.44	27.25	-	-	35.82	0.03	130.28	0.13	588.11	0.57	754.20	0.73
Dunefield	41,418.07	16.95	0.04	430.42	1.04	1,809.92	4.37	3,174.46	7.66	5,431.74	13.11	-	-	103.96	0.25	88.11	0.21	89.75	0.22	281.82	0.68
Gravel spinifex plain	9,646.21	-	-	-	-	357.28	3.70	8,256.63	85.59	8,613.91	89.30	-	-	-	-	-	-	248.12	2.57	248.12	2.57
Claypans and claypan mosaic	15,960.78	-	-	-	-	376.20	2.36	1,080.59	6.77	1,456.80	9.13	-	-	-	-	6.08	0.04	36.13	0.23	42.22	0.26
Lake margin	14,884.20	918.93	6.17	66.03	0.44	290.49	1.95	65.86	0.44	1,341.30	9.01	0.38	<0.01	4.00	0.03	17.98	0.12	-	-	22.36	0.15
Dune	6,521.41	-	-	-	-	621.03	9.52	856.20	13.13	1,477.24	22.65	-	-	-	-	1.42	0.02	17.84	0.27	19.27	0.30
Cleared	115.09	-	-	1.21	1.05	19.48	16.92	71.62	62.23	92.30	80.20	-	-	0.44	0.39	5.98	5.20	12.01	10.43	18.43	16.01
Outcropping and stony rise	491.08	6.65	1.35	-	-	-	-	409.10	83.31	415.75	84.66	-	-	-	-	-	-	5.36	1.09	5.36	1.09
Saline flats and depressions	8,068.92	2.10	0.03	-	-	149.14	1.85	-	-	151.24	1.87	-	-	-	-	3.44	0.04	-	-	3.44	0.04
Drainage line	40.98	-	-	-	-	-	-	39.43	96.21	39.43	96.21	-	-	-	-	-	-	0.55	1.34	0.55	1.34
Rocky ridge and gorge	38.59	-	-	-	-	-	-	38.59	100.00	38.59	100.00	-	-	-	-	-	-	0.09	0.24	0.09	0.24
Ridge slope	94.24	-	-	-	-	-	-	94.24	100.00	94.24	100.00	-	-	-	-	-	-	-	-	-	-
Total	443,985.33	217,260.78	48.93	687.72	0.15	11,798.79	2.66	33,927.82	7.64	263,675.12	59.39	13,363.51	3.01	144.22	0.03	253.29	0.06	997.96	0.22	14,758.98	3.32

*Note: % of extent values are calculated as the area of that particular habitat in the Development Envelope as a proportion of the area of that habitat within the entire Study Area; * indicates discrepancies between total Study Area and calculated total habitat areas are due to spatial digitisation misalignments, less than 0.1% error.*

7.6.2 Loss of individuals (including species of significance)

Habitat clearing may result in the direct loss of individual animals. Species at greatest risk are those that reside in habitats that are more limited in their extent or species that are sedentary in nature and will be unable to move during clearing activities. However, even mobile fauna, which may be able to avoid direct mortality, may face subsequent impacts depending on the availability of suitable habitat elsewhere and the ability to disperse to those habitats.

Loss of individuals during the clearing of vegetation will be limited to the construction phase of the Proposal. Mitigation of the potential loss of individuals during land clearing will involve the implementation of the CEMP (Appendix C). In addition to the mitigation summarised above, Agrimin have also developed a TFEMP (Appendix C) to assist with the implementation of the mitigation hierarchy for the Proposal.

Based on the implementation of mitigation measures to limit the impacts of clearing on individual fauna, the EPA objective for Terrestrial Fauna will be met.

7.6.3 Significant fauna (direct and indirect)

A total of 21 significant species have been confirmed in the Study Area and an additional five species considered likely to occur (the Spectacled Hare-wallaby (P3) and four waterbirds (Migratory)). These species differ in their conservation status, relative abundance and/or potential to be impacted by the Proposal. Consequently, significant species have been addressed independently or grouped accordingly within this section. Significant species or groups of significant species assessed as having potential to be impacted by the Proposal include the following:

- Greater Bilby (Section 7.6.3.1);
- Night Parrot (Section 7.6.3.2);
- Great Desert Skink (Section 7.6.3.3);
- Brush-tailed Mulgara (Section 7.6.3.4);
- Spotted Ctenotus (Section 7.6.3.5); and
- Migratory or threatened waterbirds (Section 7.6.4).

The significant species that were assessed as having a low potential to be impacted by the Proposal included the following species as detailed within Table 7-10:

- Northern Marsupial Mole;
- Southern Marsupial Mole;
- Spectacled Hare-wallaby;
- Princess Parrot;
- Grey Falcon;
- Striated Grasswren;
- Fork-tailed Swift; and
- Broad-eyed Slider.

Each of these species were assessed as having low potential to be impacted by the Proposal as they were recorded in low numbers and / or had an ecology which meant they were unlikely to be directly or indirectly impacted. Any refinements in the layout of Indicative Footprint would be unlikely to change the low potential impact to these species given the extent of suitable habitat outside the Indicative Footprint.

7.6.3.1 Greater Bilby – habitat and individuals

The Greater Bilby is a solitary species and individuals shelter in deep burrows and have large, shifting home ranges that change in response to food resources. Greater Bilby burrow use is relatively dynamic, with individuals maintaining several burrows at once and abandoning, re-using, or excavating new burrows continually. Gravel spinifex plain is likely to be an important foraging habitat for the species due to the presence of *Acacia hilliana* which is a host species for root larvae known to be an important food resource for the Greater Bilby. The key threats to the species include predation by introduced predators (feral cats and foxes and to a lesser extent by dingos/wild dogs), altered fire regimes and habitat degradation (Woinarski et *al.* 2014).

The Greater Bilby has been recorded at 130 locations within the Study Area, all of which occur within the NIDE (Figure 7-13). These records included 77 active burrows as well as tracks, scats and diggings. Additionally, the species has been recorded at 165 locations in the surrounding region (within 150 km of the Study Area), of which 66 occur near the Study Area (within 25 km). Of these local records, 56 were recorded in the last 10 years by the Kiwirrkurra and Ngururrpa Indigenous groups and Desert Support Services (Desert Support Services 2018; Paltridge 2012;2015). Based on the occurrence of records, primary habitat for the species has been defined as gravel spinifex plain (92 locations) and spinifex plain (33 locations).

Key threats from the Proposal include the direct loss of individuals and the direct loss of habitat during clearing. Additional potential impacts from the Proposal that are collectively relevant to a number of significance fauna are discussed under subsequent sections: Altered fire regimes (Section 7.6.11), feral predation (Section 7.6.12) and road strike (Section 7.6.10). The direct loss of individuals may occur if individuals are present in burrows during clearing. Based on survey work, 77 burrows have been recorded in the NIDE, of which seven burrows (11 %) occur within the Indicative Footprint. Additional Greater Bilby burrows are likely to occur within suitable habitat within the NIDE, Off-LDE and potentially within the SIDE. Areas of the Off-LDE and SIDE were not permitted to be surveyed due to COVID-19 restrictions (Section 7.3.3).

Options investigated to mitigate potential direct impacts to the species included realignment of the Indicative Footprint to avoid known burrow locations. However, this option was considered unlikely to result in any meaningful reduction of potential impacts due to the following reasons: the species is highly mobile, dynamic in its burrow use and occurs in the relatively high density within and immediately surrounding the Study Area. Consequently, any changes in the Indicative Footprint may end up avoiding burrows that are no longer in use or may impact new burrows established after the baseline surveys. Additionally, given the extensive nature of suitable habitat, any changes in the alignment are likely to intersect similar numbers of burrows compared to the current Indicative Footprint.

Instead, potential impact on individuals through clearing will be mitigated through the implementation of the CEMP and TFEMP which will primarily include the following measures aligned with "Guidelines for relocation of bilbies prior to vegetation clearing" within "The conservation and management of the bilby (Macrotis lagotis) in the Pilbara" (DBCA 2018):

- conduct a pre-clearance survey within primary habitat within the Indicative Footprint;
- where clearing of burrows is unavoidable, mitigate impacts by relocating individuals to alternative suitable habitat:
  - initially encourage burrow abandonment by disturbing entrance and monitoring (e.g. burrow sweeps and motion cameras) to confirm individual has left. Close burrow once abandoned; and
  - if burrow not abandoned, trap individual and relocate before collapsing burrow, in the presence of suitably qualified fauna experts.
- During operations, restrict haulage to daylight hours (see Section 7.6.10).

Potential impacts during operations will primarily be mitigated by restricting haulage operations to daylight hours (see Section 7.6.10). The direct loss of primary habitat for the Greater Bilby will occur during clearing of native vegetation. Within the Study Area, primary habitat with potential to be disturbed comprises:

- Spinifex sandplain: A total of 103,435 ha occurs within the Study Area, of which 28,189 ha (27.25%) occurs within the Proposal area and 754 ha (0.73 %) occurs within the Indicative Footprint; and
- Gravel spinifex plain: A total of 9,646 ha occurs within the Study Area, of which 8,614 ha (89.30%) occurs within the Proposal area and 248 ha (2.57 %) occurs within the Indicative Footprint.

The proportion of each habitat within the Indicative Footprint comprises a minor proportion of the extent within the Study Area. Additionally, each habitat is well distributed outside the Study Area in the local and regional surrounds of the Great Sandy Desert. The impact on Greater Bilby habitat through clearing will be mitigated through the implementation of the CEMP which will include the following:

- minimising disturbance to primary habitats, particularly gravel spinifex plain (location of borrow pits); and
- implement strict clearing mitigation that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries.

The mitigation measures summarised above have been incorporated into the CEMP and TFEMP to address the mitigation hierarchy for the Proposal. After applying the mitigation hierarchy, there is not expected to be a significant residual impact to the Greater Bilby. However, there is potential for significant residual impact to critical and supporting habitat of the Greater Bilby. Agrimin are committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).

Based on the implementation of mitigation measures to limit the impacts to the Greater Bilby, the EPA objective for Terrestrial Fauna will be met.

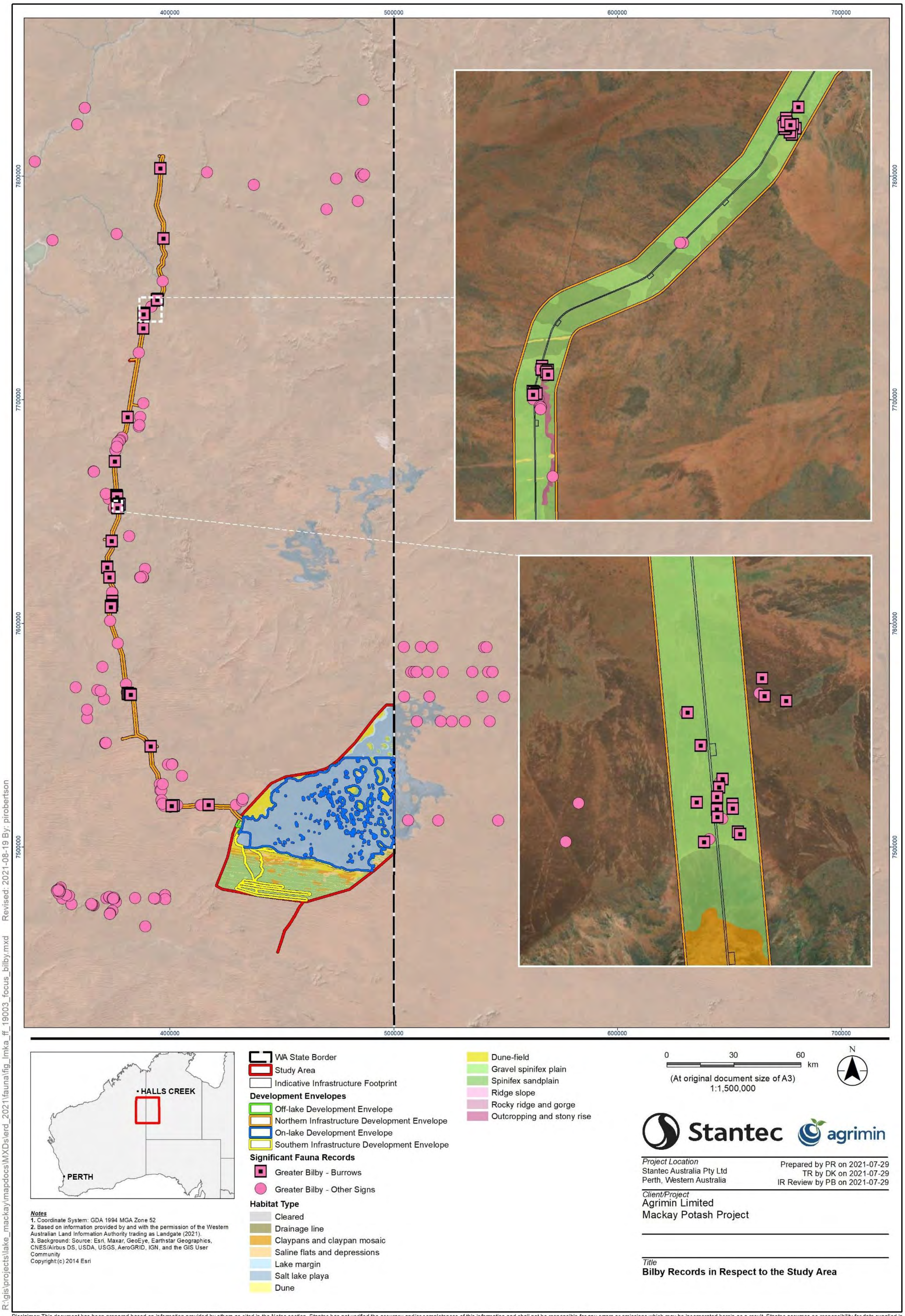

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Figure 7-13: Greater Bilby records with respect to the Indicative Footprint, Proposal Area and Study Area.

7.6.3.2 Night Parrot – habitat and individuals

The Night Parrot is a small, green, highly cryptic parrot. They are nocturnal, primarily ground-feeding and inhabit remote arid and semi-arid Australia. The species roosts in clumps of dense vegetation, primarily long unburnt *Triodia* hummocks. Individual Night Parrots are known to use several different roosts within their range (N. Jacket pers. comms.). The species is likely to feed on seeding grasses, forbs, herbs, and succulents, particularly in low-lying areas that are seasonally inundated promoting diverse, seeding ephemerals. Locations of low-lying ephemeral drainage areas (Saline Flats and Depressions as well as Claypans and Claypan Mosaic Habitats) containing old-growth spinifex appear to be important habitat within the Study Area, as these areas provide protection from fire, sustaining the old-growth spinifex. Night Parrots may move up to 9.4 km from a roost in a night during foraging expeditions, collectively flying between 29.9 – 41 km (Murphy *et al.* 2017). The key threats faced by the species includes predation by introduced and feral cats and potentially foxes (DBCA 2017c; DotE 2016; DPaW 2017b; NESP 2019), altered fire regimes (DBCA 2017c; DotE 2016; DPaW 2017b; NESP 2019) and the loss or degradation of habitat (DBCA 2017c; DPaW 2017b).

Initially, the Night Parrot was recorded foraging at two locations 25 km apart via four acoustic units (two at each location) within the NIDE (Figure 7-14)(Appendix G.1). The foraging calls were detected during long-term deployments after Phase 2 of the Stantec Survey, which occurred after rainfall. No calls were recorded at these same locations during the Phase 1 or during Phase 2 survey (Stantec 2020b).

Targeted Night Parrot survey work was subsequently undertaken at the two locations over four stages of survey work to better understand how the species was utilising the drainage features both within and outside the Study Area (Stantec 2020b). During the targeted surveys, a total of 89 recording units were deployed and a total of 604 nights of recordings were analysed. Calls were recorded on 58 units: 38 units in the north, and 20 units in the south. Analysis of the calls indicates that across the surveys, on average there were between two and five individuals in the north and between two and three individuals in the south. Including both the baseline and targeted surveys, Night Parrot calls were recorded both inside the Proposal area (north: 2 locations, south: 4 locations) and outside the Proposal area (north: 36 locations, south 16 locations). Of the total of 58 units, only two units were located within the Indicative Footprint (Figure 7-14). Calls were recorded along the drainage features for approximately 10 km in the north and approximately 5 km in the south.

The majority of the calls at each location were best attributed to foraging or nightly movement within the landscape. However, the timing of calls detected at 19 units are suggestive of one or more roost sites within approximately 1 km of each of these recording units. No units within the Proposal area in the north and two units within the Proposal area in the south recorded calls which indicate roost sites are within 1 km of the units (i.e. two of the 19 locations). None of these recording units were within the Indicative Footprint. The exact locations of these roosts were not able to be determined from recording units and on-ground listening surveys and searching would be required to find the roost locations. Individual Night Parrots are known to use several different roosts within their range (N. Jacket pers. comms.). Little is known about the fidelity of Night Parrots to their roost locations, but they may move and use different roosts in response to seasonal inundation, proximity to food resources, or proximity to nesting sites.

Within the vicinity of the Study Area, Night Parrots have been recently recorded (acoustic recordings and photos) by Paruku rangers near Lake Gregory (~50 km west of the northern end of the Study Area) in 2017 (Figure 7-15). The location of these recent records are documented along with an additional record from 2001 (~70 km north of the Study Area) in a recent publication of Night Parrot records and distributions (Leseberg *et al.* 2021). The species has also been recorded historically at two locations in the surrounding region (150 km) in 1972 and 1977, neither of which occur near the Study Area (DBCA 2020). Subsequent to the discovery of the Night Parrot populations by Stantec in March 2020, Ngururrpa rangers discovered an additional three locations within the vicinity of the proposed haulage corridor during the first half of 2021. All of these additional locations are from outside the Proposal area (Figure 7-15). At the time of this report, the original populations discovered by Stantec represented the 6th and 7th known populations in WA (Nigel Jacket pers comms) while the additional populations discovered by the Ngururrpa rangers are likely to represent the 11th, 12th and 13th populations in WA (Nigel Jacket, pers comms).

Based on the occurrence of records and known ecology, primary habitat for the species has been defined as claypan and claypan mosaic, and saline flats and depressions. Both locations where the species was recorded occurred in broad drainage basins which extend for more than 5 km either side of the NIDE. Habitats mapped in these areas included claypans and claypan mosaic in association with gravel spinifex plain or spinifex sandplain. Both areas supported old-growth spinifex and a high cover of diverse seeding tussocks and herbs, and limited shrubs and trees. Such sites are likely to provide natural protection to old-growth spinifex from fire and be productive foraging areas for Night Parrots. Similar drainage features appear to be relatively common in association with palaeodrainage systems in the surrounding landscape and within both the Great Sandy Desert and Tanami Desert bioregions. Although Night Parrots have not been recorded within the saline flats and depressions habitat, this habitat occurs with similar mosaics of old growth spinifex and may also provide suitable habitat. It is acknowledged that the species is likely to occur widely in other suitable habitats in the landscape; however, these mosaic habitats, particularly in broad drainage basins, are likely to represent the most important habitat for the species in the Study Area.

Key threats from the Proposal include the direct loss of individuals and the direct loss of habitat during clearing. Additional potential impacts from the Proposal that are collectively relevant to a number of significance fauna are discussed under subsequent sections: Altered fire regimes (Section 7.6.11), feral predation (Section 7.6.12) and road strike (Section 7.6.10).

Although very unlikely given the rarity of the species, the direct loss of individuals has potential to occur if individuals are roosting in old-growth spinifex during clearing operations. Suitable habitat for roosting has been detected within the Study Area and within the Indicative Footprint, in the form of old-growth spinifex. These areas are visible on aerial imagery both within and outside the Study Area, particularly in association with the drainage basins containing claypan and claypan mosaic habitats. Based on fine scale desktop mapping, it is estimated that a total of 11,522 ha of old growth spinifex occurs within the Study Area, of which 646 ha (5. 61%) occurs within the Proposal area and 23.55 ha (0.20 %) occurs within the Indicative Footprint. Of this proposed clearing, the majority occurs as a linear corridor within the NIDE for the purpose of the haul road.

Options investigated to mitigate direct impact to the species and its habitat included realignment of the haul road to avoid the locations where Night Parrot had been recorded. On a regional scale, the species has been recorded from two broad drainage features that run perpendicular to the proposed haulage corridor. These drainage features run for approximately five kilometres either side of the of the proposed alignment. Options were investigated to deviate around these features; however, these options were constrained by Aboriginal heritage sites. Additionally, any realignment was constrained by similar broad drainage features which may also support Night Parrots. Additionally, a less direct route would likely have resulted in a larger total clearing footprint and therefore greater potential to impact significant fauna.

As a result, the Proposal area for the alignment was discussed and agreed in consultation with traditional owners and largely followed existing cleared areas for the Balgo Track. In areas where the alignment deviates from the existing Balgo Track, the Indicative Footprint (within the Proposal area) was further refined to avoid the occurrence of old-growth spinifex as much as practicable. These efforts included refining the alignment of the road to avoid patches of old growth spinifex, as well designing areas for borrow pits to occur outside of areas with old-growth spinifex.

Given the rarity of the species, clearing is highly unlikely to result in the direct loss of any individuals; however, any loss of individuals is considered to have a significant consequence given the small population size of the species. Consequently, the potential for direct loss of individuals through clearing will primarily be mitigated through the following measures as detailed in the CEMP:

- Within the two areas where Night Parrots have been detected, pre-clearance listening surveys will be undertaken to determine if any roost sites occur within or in the vicinity of the Indicative Footprint. In the unlikely event that a Night Parrot roost is detected within the Indicative Footprint (24 m wide corridor), staff will use non-invasive methods similar to those already accepted and used for other species (e.g. Greater Bilby) (DBCA 2018) to encourage the bird/s to leave the area prior to clearing. Field staff will wait for the bird to leave the roost in the evening (confirmed by visual inspection of roost) before disturbing or removing the roost hummock to discourage the bird from returning. As Night Parrots are likely to use several roosts within their range, and extensive similar roosting habitat is present adjacent to the clearing footprint, it is anticipated that this will not have any long-term negative effects on the individual. Staff will continue to monitor the area to ensure the bird has abandoned the roost site. These potential dispersal methods will be discussed and refined in consultation with DBCA. If a nest is detected during pre-clearance listening surveys, these methods will not apply and the nest area will be avoided entirely until any chicks have fledged.
- Although Night Parrots have not been detected elsewhere within the Study Area, there is potential for the species to occur due to the presence of suitable habitat. Potential foraging and roost habitat in the form of old-growth spinifex has been identified and delineated though desktop mapping (Stantec 2020b). Pre-clearance Night Parrot recording surveys will be undertaken in these areas of old-growth spinifex where they occur within the Indicative Footprint. If any calls indicate a roost site may occur in the area, then pre-clearance listening surveys will be undertaken to identify the location of the roost as above.

The loss of primary habitat for the Night Parrot will occur during clearing; however, the extent will comprise a very minor proportion of the extent within the Study Area and wider region. Within the Study Area, primary habitat with potential to be disturbed comprises:

- Claypans and claypan mosaic: A total of 15,960 ha occurs within the Study Area, of which 1,457 ha (9.13 %) occurs within the Proposal area and 42.2 ha (0.26 %) occurs within the Indicative Footprint; and
- Saline flats and depressions: A total of 8,069 ha occurs within the Study Area, of which 151 ha (1.87 %) occurs within the Proposal area and 3.44 ha (0.04 %) occurs within the Indicative Footprint.

Additionally, based on fine scale desktop mapping of old-growth spinifex within the Study Area, it is estimated that a total of only 23.55 ha (0.2 %) occurs within the Indicative Footprint. In summary, proportion of these habitats within the Indicative Footprint comprises only a very minor proportion of the extent within the Study Area. Each habitat is well distributed outside the Study Area in the local and regional surrounds.

To place these potential impacts in a regional context, Stantec conducted modelling of prospective Night Parrot habitat within a 20 km buffer of the Proposal. This modelling was carried out using object-based image analysis (OBIA) of Sentinel-2 imagery. The short-wave infrared spectral signatures of the two areas (58 unit locations in total) where Stantec recorded the Night Parrot were used to develop a support vector machine model to identify other similar areas. In total, the regional modelling identified 46,199 ha of additional habitat within 10 km of the Proposal which is potentially suitable for Night Parrots (Figure 7-15). This regional modelling was further substantiated by the discovery of three additional Night Parrot locations in the first half of 2021 by Ngururrpa rangers and Desert Support Services, all of which occur within the modelled areas but cannot be fully confirmed as the coordinates for these locations were not provided (Figure 7-15). Based on the modelling and the subsequent records, Night Parrot habitat is considered to be well represented in the local and regional contexts.

To further reduce any potential impacts to the species during clearing, additional mitigation measures as detailed in the CEMP and TFEMP will primarily include the following:

- implement strict clearing mitigation that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries;
- during road construction within drainage features, maintain ecosystem function i.e. surface hydrology (within and outside the Proposal area). The drainage features have been identified as supporting primarily habitat for the Night Parrot for up to 5 km either side of the Proposal area; and
- restrict haulage operations to daylight hours (see Section 7.6.10).

The mitigation measures summarised above have been incorporated into the CEMP and TFEMP to address the mitigation hierarchy for the Proposal. After applying the mitigation hierarchy, there is not expected to be a significant residual impact to the Night Parrot. However, there is the potential for significant residual impact to critical and supporting habitat, given the current lack of knowledge on this species. While survey work and analysis have substantially contributed to the knowledge of the ecology of the Night Parrot, it is acknowledged that there are remaining knowledge gaps, which may better inform the conservation management of the species across its range. As a result, Agrimin have committed to two voluntary indirect offsets that have potential for meaningful conservation outcomes for this species, while concurrently supporting Indigenous groups on the associated IPAs. These voluntary indirect offsets are discussed within Section 13.4.1.

Based on the implementation of mitigation measures to limit the impacts to the Night Parrot, the EPA objective for Terrestrial Fauna will be met.

Redacted

Figure 7-14: Night Parrot records with respect to the Indicative Footprint, Proposal area and Study Area (redacted from public version of ERD)

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Figure 7-15: Regional Night Parrot records and modelled of prospective habitat with respect to the Indicative Footprint, Proposal area and Study Area (redacted from public version of ERD)

7.6.3.3 Great Desert Skink – habitat and individuals

The Great Desert Skink is a large long lived burrowing lizard that can grow up to 44 cm long and live potentially up to 20 years. The species tends to occupy sandplains and swales with hummock grasses and scattered shrubs. The species lives communally in multi-generational family groups, with up to 10 individuals occupying a burrow system, using a shared latrine, and maintaining the burrow. Individuals are relatively sedentary, only moving up to 150 m from the burrow while foraging at night; however, juveniles may move up to 10 km to colonise new areas (DAWE 2020i). The species hibernates from the end of May through to September or October. During the breeding season, males will mate with multiple females at multiple nearby burrows (DAWE 2020i). The species has undergone a widespread decline, with many historical populations no longer occurring. Key threatening processes for the species include altered fire regimes and predation by feral cats and introduced foxes (McAlpin 2001; Pavey 2006), additional impacts include development and habitat destruction by introduced rabbits (McAlpin 2001; Pavey 2006).

Knowledge of the species current fine-scale distribution is unclear due to the remote and inaccessible nature of sites. However eight key populations occur in the following areas (TSSC 2016a), with population estimates listed where available (McAlpin 2001):

WA (population=~3,000, may exceed):

- Kiwirrkurra Indigenous Protected Area (managed by Central Desert Native Title Services) (n=<500);
- Karlamilyi National Park (managed by the Kanyirninpa Jukurrpa);
- Ngaanyatjarra Indigenous Protected Area (managed by Ngaanyatjarra Council);

NT (Tanami Desert population=<2,250):

- North-western Tanami Desert (Sangsters bore – Rabbit Flat region);
- Southern Tanami Indigenous Protected Area;
- Uluru-Kata Tjuta National Park (jointly managed by its traditional owners Anangu and Parks Australia) and adjoining Yulara freehold land (managed by the Indigenous Land Corporation) (n=~800);
- Newhaven Wildlife Sanctuary (managed by the Australian Wildlife Conservancy); and

SA (population=<50):

- Watarru on Anangu Pitjantjatjara Yankunytjatjara Lands.

The Great Desert Skink has been recorded from three areas within the Study Area in association with Spinifex Sandplain (Figure 7-16):

- Yagga Yagga population adjacent to the NIDE: exceeds 64 active burrows recorded approximately 22 km south of Yagga Yagga.
- Murrawa population within the NIDE: two locations recorded in 2000. Subsequent targeted survey work has established that this population is no longer present; and
- Lake Mackay population within the Study Area but outside the Proposal area: one location 10 km south of Lake Mackay from 2018. Subsequent targeted survey work has established that this population is no longer present.

Additionally, the species has been recorded at 138 locations in the surrounding region (150 km). Almost all are in a 30 km stretch of the Kiwirrkurra road ~20 km southeast of the Kiwirrkurra community (the Kiwirrkurra population) (DBCA 2020).

Key threats from the Proposal include the direct loss of individuals during clearing and operations, and the direct loss of habitat during clearing. Additional potential impacts from the Proposal that are collectively relevant to a number of significant fauna are discussed under subsequent sections: Altered fire regimes (Section 7.6.11); feral predation (Section 7.6.12); and road strike (Section 7.6.10).

The direct loss of individuals may occur if burrows occur within the clearing area. Additionally, given the species is known to forage at least 150 m from the burrow, operations within 200 m of burrows are considered likely to also result in the loss of individuals over time. During the breeding season in spring and summer, males will mate with multiple females at nearby burrow systems. During this time, males are at greater risk of road strike (Section 7.6.10) and feral predation (Section 7.6.12) and this in turn may have a large impact on the breeding success of numerous burrow systems (DAWE 2020i). Additionally, juveniles face similar risks when dispersing. Based on survey work, 64 active burrows have been recorded as forming the Yagga Yagga population. Based on this information, the NIDE and associated Indicative Footprint was realigned so that all active burrows associated with the population were avoided with a buffer of 300 m. Additionally, the new alignment avoids the core population and reduces impacts associated with fragmentation. The new alignment of the NIDE means that the Proposal will have a low potential to result in the direct loss of individuals of the Yagga Yagga population through clearing and through indirect impacts over time.

Although the realignment of the haulage corridor has been a key measure implemented by Agrimin to avoid impacts the Yagga Yagga population, it is acknowledged that not all areas of suitable habitat within the Indicative Footprint have been surveyed for this species. However, it is important to note the following information which has been used to inform mitigation measures:

- Extensive survey work: Survey work for the species both within the Study Area and Indicative Footprint has been extensive during the Stantec survey and during previous surveys by ranger groups which overlap the Study Area (Section 7.3.2). In total, 142 '2 ha plots' were conducted within the Study Area during the Stantec survey, with most undertaken in spinifex sandplain habitat (74 locations). Additionally, 27, 32, and 29 '2 ha plots' have been completed by ranger groups within and overlapping the Study Area (Appendix G see (Desert Support Services 2018), (Paltridge 2015), and (Paltridge 2012) respectively).
- Previous Records ground-truthed: All previous records of the species within the Study Area were ground-truthed. See above reference to the Murrawa population recorded in 2000 and the Lake Mackay population recorded in 2018. Both populations were found to be no longer present. Additionally, both records occur outside the Indicative Footprint.
- Surveys of the OFF-LDE & SIDE: Planned targeted surveys of OFF-LDE and the SIDE were not able to proceed due to COVID-19 restrictions.

Given the large areas surveyed and the rarity of the species, it is considered unlikely that additional populations occur within the Indicative Footprint; however, the possibility does exist. Additionally, the species may recolonise areas which it inhabited previously. As a result, Agrimin have committed to pre-clearance surveys in areas of suitable habitat for the species and have developed a mitigation approach in the case that any individuals are located. Any potential impacts on the Great Desert Skink will be mitigated through the implementation of the CEMP and the TFEMP which will include the following:

- implement strict clearing mitigation (daylight hours only) that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries;
- conduct pre-clearance surveys within primary habitat where it occurs within the Indicative Footprint. There exists the potential for populations to occur elsewhere in the Proposal area not already surveyed. If burrows are encountered during pre-clearance, where possible avoid active burrows by changing the location of infrastructure, ideally with a buffer accounting for foraging behaviour (>200 m). If direct impact is unavoidable, pause clearing activities and relocate individual to similar habitat in the area by a qualified fauna expert; and
- restrict haulage operations to daylight hours (see Section 7.6.10).

The loss of primary habitat for the Great Desert Skink will occur during clearing. Within the Study Area, primary habitat with potential to be disturbed comprises:

- Spinifex sandplain: A total of 103,435 ha occurs within the Study Area, of which 28,189 ha (27.25%) occurs within the Proposal area and 754 ha (0.73 %) occurs within the Indicative Footprint.

The proportion of spinifex sandplain within the Indicative Footprint comprises a minor proportion (0.73 %) of the extent within the Study Area. Additionally, spinifex sandplain habitat is well distributed outside the Study Area in the local and regional surrounds. The impact on Great Desert Skink habitat through clearing will be mitigated through the implementation of the CEMP which will include the implementation of strict clearing mitigation that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries.

The mitigation measures summarised above have been incorporated into the CEMP and TFEMP to address the mitigation hierarchy for the Proposal. However, there is potential for significant residual impact to critical and supporting habitat of the Great Desert Skink. Agrimin are committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).

Based on the implementation of mitigation measures to limit the impacts to the Great Desert Skink, the EPA objective for Terrestrial Fauna will be met.

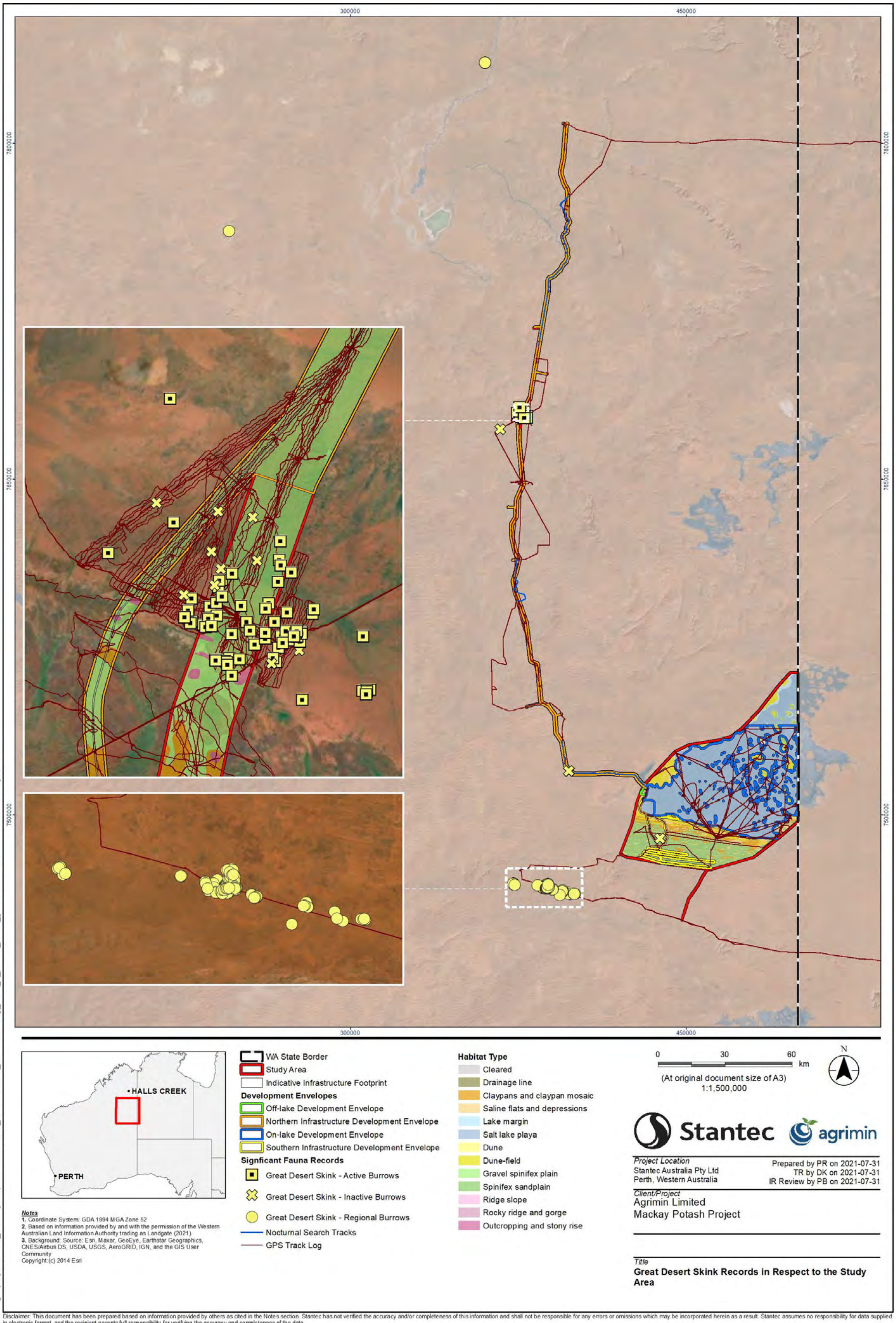

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Figure 7-16: Great Desert Skink records with respect to the Indicative Footprint, Proposal Area and Study Area

7.6.3.4 Brush-tailed Mulgara (*Dasycercus blythi*) (P4)

The Brush-tailed Mulgara has a wide distribution across central and inland Australia, with a population that fluctuates in response to seasonal conditions. The Brush-tailed Mulgara is solitary, nocturnal, and typically inhabits spinifex grasslands with medium to dense cover in the arid zone. They shelter in burrows systems which they dig in the flats between low sand dunes (van Dyck *et al.* 2013; van Dyck and Strahan 2008)). Their diet consists of a broad range of invertebrate and small vertebrates (Woinarski *et al.* 2014). Their primary habitat for foraging and breeding is Spinifex Sandplain. Key threats faced by the species includes, predation by, and competition with, feral cats and red foxes, altered fire regimes, habitat degradation, including change and loss due to livestock, clearing and development, and weeds and climate changing causing prolonged and server drought conditions (Woinarski *et al.* 2014).

The Brush-tailed Mulgara was recorded at 25 locations within the Study Area, including 15 within the NIDE, two within the SIDE and eight within the Study Area but outside the Indicative Footprint (Figure 7-17). Additionally, the Brush-tailed Mulgara has been recorded at 31 locations from 2012 – 2016 in the surrounding region (150 km), of which two locations were near the Study Area (25 km) (DBCA 2020; Outback Ecology 2012b; Paltridge 2015).

Key threats from the Proposal include the direct loss of individuals and the direct loss of habitat during clearing. Additional potential impacts from the Proposal that are collectively relevant to a number of significance fauna are discussed under subsequent sections: Altered fire regimes (Section 7.6.11), feral predation (Section 7.6.12) and road strike (Section 7.6.10).

The direct loss of individuals may occur if individuals are present in burrows during clearing. Based on survey work, three burrows have been recorded in the Proposal area, of which one occurs within the Indicative Footprint. Additional Brush-tailed Mulgara burrows are likely to occur within suitable habitat within the NIDE and the SIDE (Section 7.3.3). The potential impact on individuals through clearing will be mitigated through the implementation of the CEMP which will include the following measures:

- conduct pre-clearance survey (four weeks prior to clearing) within primary habitat where it occurs within the Indicative Footprint; and
- where burrows are identified during pre-clearance surveys, mitigate impacts by relocating individuals to alternative suitable habitat.

The loss of primary habitat for the Brush-tailed Mulgara will occur during clearing. Primary habitat for the species in the Study Area has been defined as spinifex sandplain (19 locations), of which the following proportions have potential to be disturbed by the Proposal:

- Spinifex sandplain: A total of 103,435 ha occurs within the Study Area, of which 28,189 ha (27.25%) occurs within the Proposal area and 754 ha (0.73 %) occurs within the Indicative Footprint.

The proportion of spinifex sandplain within the Indicative Footprint only comprises a minor proportion (0.73 %) of the extent within the Study Area. Additionally, spinifex sandplain habitat is well distributed outside the Study Area in the local and regional surrounds. The impact on Brush-tailed Mulgara habitat through clearing will be mitigated through the implementation of the CEMP which will primarily include the implementation of strict clearing mitigation that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries.

The mitigation measures summarised above have been incorporated into the CEMP and TFEMP to address the mitigation hierarchy for the Proposal.

Based on the implementation of mitigation measures to limit the impacts to the Brush-tailed Mulgara, the EPA objective for Terrestrial Fauna will be met.

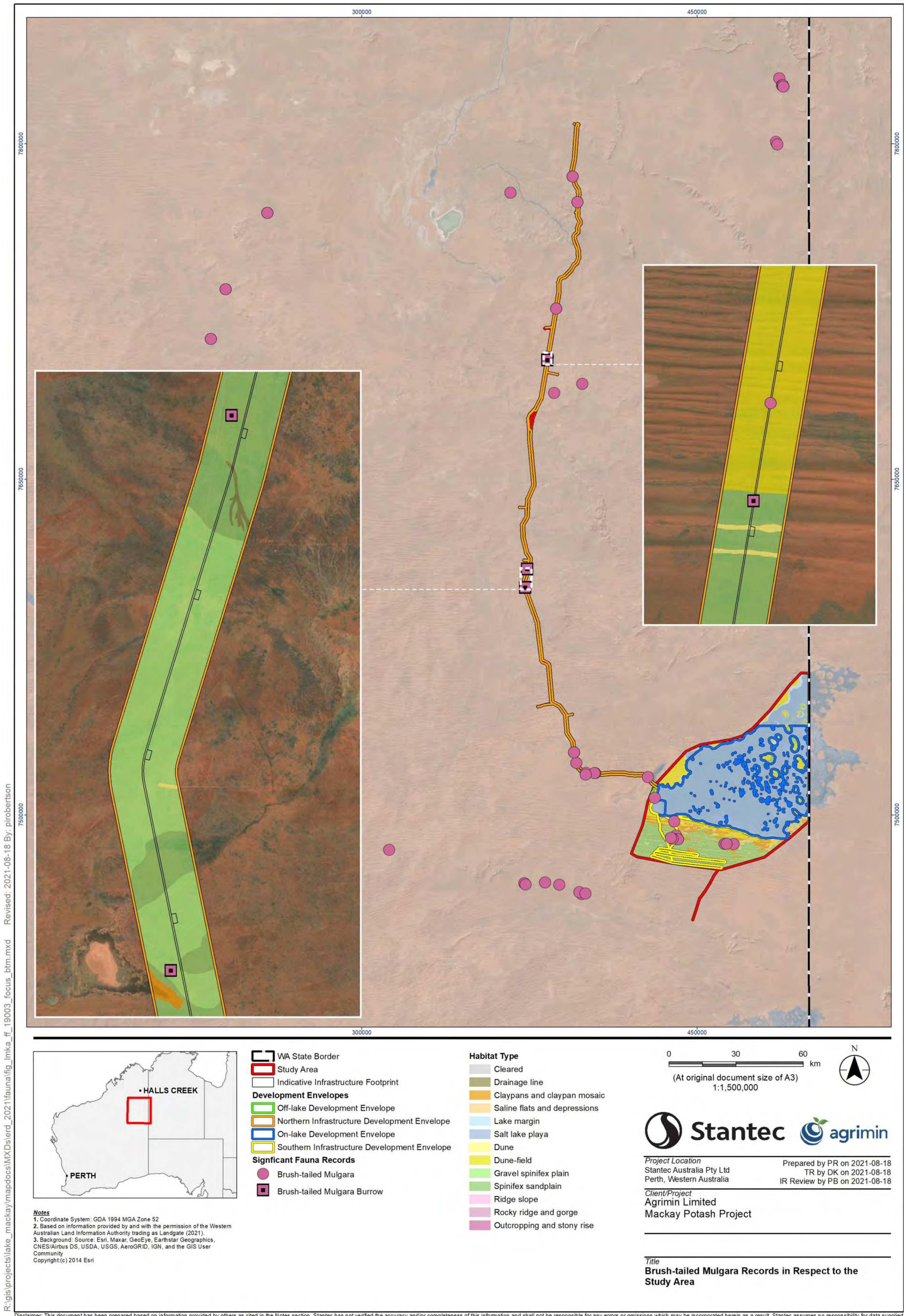

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Figure 7-17: Brush-tailed Mulgara records with respect to the Indicative Footprint, Proposal area and Study Area

7.6.3.5 Spotted Ctenotus *(Ctenotus uber johnstonei)* (P2)

The Spotted Ctenotus was previously only known from the holotype collected at Balgo (21 km west of the Study Area) in 1979 and a record approximately 105 km northwest of the Study Area in 2012 (DBCA 2020). The general ecology and habitat preferences of the subspecies *C. u. johnstonei* is poorly understood. The population of the species is poorly understood, and potential threats are unknown.

The Spotted Ctenotus was recorded from eight locations in the Study Area all within the NIDE. These were represented by 55 records. These records extend the previously known range of the species and its habitat associations. The primary habitat for the species has been defined as the gravel spinifex plain (six locations)(Figure 7-18). The species was commonly encountered during the survey. The species limited distribution is likely a reflection of limited survey effort. Species distribution is likely to occur in association with gravel spinifex plain habitat in the vicinity of Balgo and possibly more widely.

Key threats from the Proposal include the direct loss of individuals and the direct loss of habitat during clearing. Based on survey work, the species was found to be common within the northern portion of the NIDE, particularly in association with gravel spinifex plain habitat. The potential impact on individuals through clearing will be mitigated through the implementation of the CEMP which will include measures to have a fauna spotter present to relocate fauna out of the way of machinery during clearing activities.

The loss of primary habitat for the Spotted Ctenotus will occur during clearing. Within the Study Area, Primary habitat for the species has been defined as gravel spinifex plain. Within the Study Area, primary habitat with potential to be disturbed comprises:

- Gravel spinifex plain: A total of 9,656 ha occurs in the Study Area, of which 8,614 ha (89.30%) occurs within the Proposal area and 248 ha (2.57 %) occurs within the Indicative Footprint.

The proportion of gravel spinifex plain within the Indicative Footprint only comprises a minor proportion (2.57 %) of the extent within the Study Area. Additionally, gravel spinifex plain habitat is well distributed outside the Study Area in the local and regional surrounds. The impact on primary habitat for the species during clearing will be mitigated through the implementation of the CEMP which will include the following:

- where possible minimise disturbance to primary habitats, particularly spinifex gravel plain (location of borrow pits); and
- implement strict clearing mitigation that avoids clearing as a priority, and clearly demarcate and monitor clearing boundaries.

The mitigation measures summarised above have been incorporated into the CEMP and TFEMP to address the mitigation hierarchy for the Proposal.

Based on the implementation of mitigation measures to limit the impacts to the Spotted Ctenotus, the EPA objective for Terrestrial Fauna will be met.

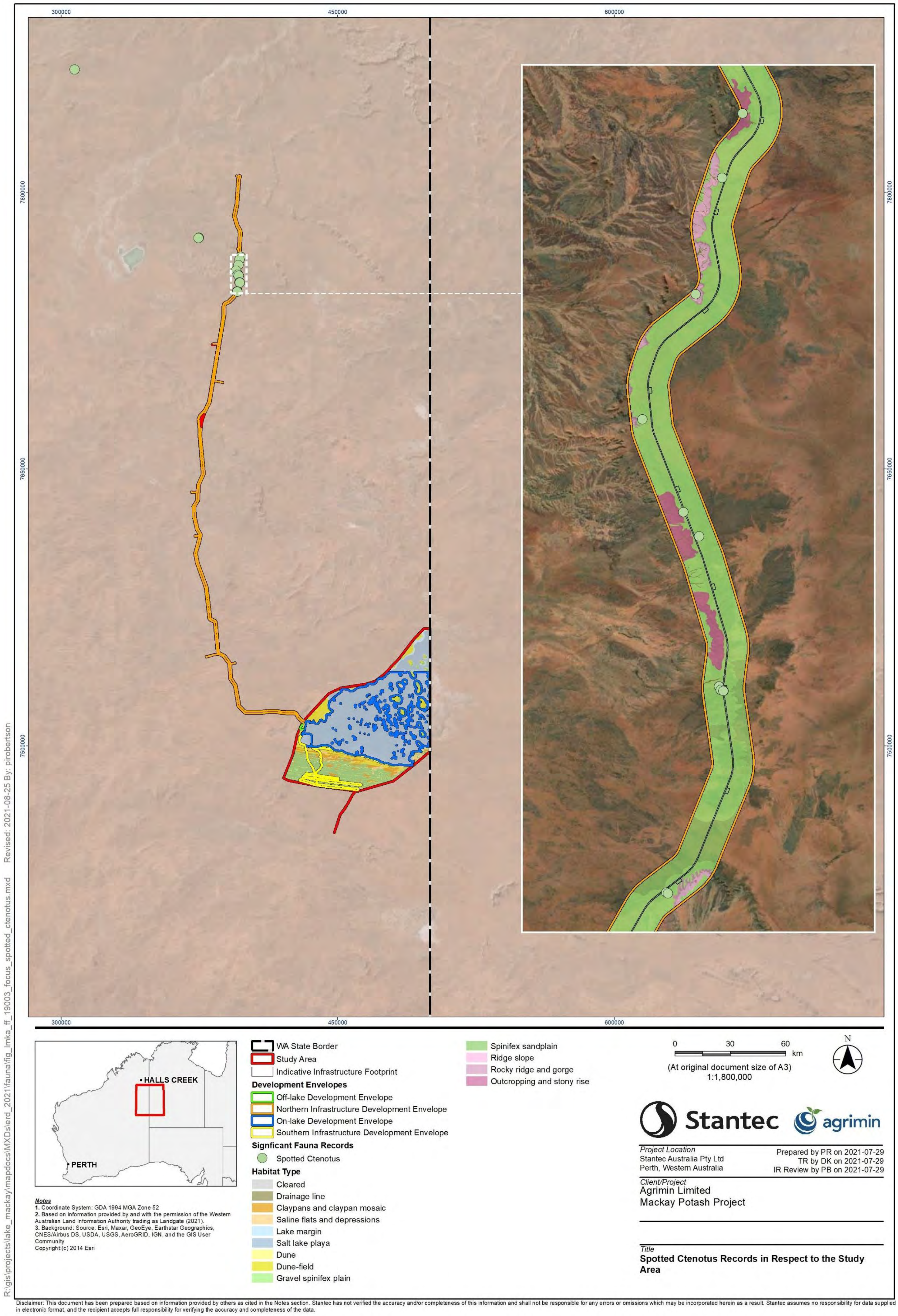

Figure 7-18: Spotted Ctenotus records with respect to the Indicative Footprint, Proposal area and Study Area

7.6.4 Waterbirds – foraging habitat

The filling of Australia's inland salt lakes is irregular and uncommon with flood events being primarily driven by large rain bearing tropical depressions. When Australia's inland salt lakes fill, they provide an abundance food resource for waterbirds including aquatic invertebrates and macrophytes. Based on analysis of the last 33 years of available satellite imagery, inundation events (greater than 20 %) were typically less than a month in duration and large inundation events (greater than 100 days) only occurred twice in available data (Appendix I.21). During inundation events, the lake is known to support breeding and foraging for various waterbird species including migratory shorebirds, terns and ducks, with the playa and associated wetlands forming an important foraging and freshwater resource.

Three waterbird surveys have been conducted at Lake Mackay: September/October 2001 (whole lake), April 2017 (WA portion) and March/April 2021 (WA portion)(Section 7.3)(Appendix G.1). These surveys occurred following a variety of inundation events; the 2001 survey occurred after the longest inundation in available records (398 days inundation), the 2017 survey followed an extreme isolated rainfall event in 2016 (more than 400 mm of rainfall; 89 days inundation) and the 2021 survey followed multiple infills (inundation of 24 days) (Appendix I.21). In comparison to previous inundation events over 33 years of available data, 21 were equivalent or greater in duration to the event observed during the 2021 waterbird survey (Appendix I.21). Combined, these waterbird surveys provide important information on how regularly and to what extent Lake Mackay is important to waterbirds during different conditions.

The 2001 waterbird survey comprised a two hour aerial survey conducted by experienced ornithologist Ray Chatto (Parks and Wildlife Commission of the Northern Territory) on 5 and 6 September 2001 and ground surveys were conducted at Lake Mackay in September/October 2001 by zoologists Peter Latz and Rachel Paltridge (Duguid *et al.* 2005). The 2001 waterbird survey detected 20 waterbird species (with six additional unconfirmed waterbird species) represented by 42,473 individuals. These included Banded Stilts (12,070 individuals, over 1 % of the total population), Black-winged Stilts (3,262) and Red-necked Avocets (1,295), and counts of 4,653 Grey Teals, 8,460 ducks and 4,602 White-winged or Whiskered Terns (Duguid *et al.* 2005). This survey occurred several months after water had begun to recede, potentially underestimating waterbird activity (Appendix G.1).

The April 2017 waterbird survey was conducted by senior ornithologist Dr Colin Trainor; however, it occurred when flood water had started to recede on the playa. At the time of the survey, the lake was likely in the 'bust' phase of the hydroperiod, evident by a lack of aquatic invertebrates on the playa (Invertebrate Solutions 2017b). As a result, most waterbird species were likely to have dispersed and remaining individuals were largely recorded within the peripheral wetlands (Section 7.3.3). The 2017 waterbird survey detected 25 waterbird species represented by 3,273 individuals. This included numbers of the Red-necked Stint (502 individuals), which exceeded 0.1% of the East Asian-Australasian Flyway Population (0.1 % threshold = 475 individuals) (Appendix G.1) (Hansen *et al.* 2016a).

The March 2021 waterbird survey was undertaken by Stantec senior zoologist Samantha Lostrom and coincided with high aquatic invertebrate productivity (Section 9) and high waterbird activity. The survey detected 12 waterbird species (with one additional unconfirmed waterbird species) represented by 42,194 individuals, most of which were foraging on the playa. Waterbird species largely comprised Whiskered and/or White-winged Black Terns (Mi) (12,426), Banded Stilts (5,886) and Sharp-tailed Sandpipers (Mi) (3,758 to 10,000 per observation). Sharp-tailed Sandpiper observations equated to 4.4% to 11.8% of the species estimated flyway population.

The Lake Mackay playa is large and varies in topography and therefore depth when inundated. Drying trends visible from analysis of satellite imagery indicates that there are three areas of the playa that are deeper and retain water for a relatively long time. These deeper areas would be particularly suitable for waterbird foraging as they are likely to support lower salinities, longer sustained productivity, and increased concentrations of aquatic invertebrates as the lake dries (Appendix G.1). These areas comprise the southeast corner, a portion of the central southwest and a constriction at the southwest of the lake. Notably, the central southwest area supported large congregations of foraging waterbirds in 2021 (up to 35,058 individuals in one observation)(Appendix G.1) and the southeast corner was one of the only playa areas where waterbirds were observed during the survey in 2017 (Appendix G.1).

Collectively, the three waterbird surveys recorded a number of threatened and migratory waterbird species (Figure 7-20), including the following:

Threatened:

- Australian Painted Snipe (En) (1 in 2017);

Migratory:

- Gull-billed Tern (Mi) (125 from nine observations in 2021, 39 in 2017, 14 in 2001);
- Gull-billed Tern (Mi) or Caspian Tern (Mi) (339 in 2001; identification could not be confirmed);
- White-winged Black (Mi) or Whiskered Tern (14,583 from three observations in 2021, 4,602 during 2001; identification could not be confirmed, note Whiskered Tern is unlisted);
- White-winged Black Tern (Mi) (83 from one observation in 2021); and
- Glossy Ibis (Mi) (110 in 2001).

Migratory Shorebird:

- Common Greenshank (Mi) (3 in 2017, 1 in 2001);
- Red-necked Stint (Mi) (502 in 2017);
- Sharp-tailed Sandpiper (Mi) (3,758 to 10,000 per observation in 2021, 37 in 2017);
- Small unidentified shorebirds (potential to include listed species) (1,934 in 2001);
- Stint sp. (Mi) (224 from two observations in 2021; identification could not be confirmed); and
- Marsh Sandpiper (Mi) (six from one observation in 2021).

Potential impacts from the Proposal to waterbirds includes the loss of foraging habitat through direct disturbance and indirect loss of foraging habitat through changes to surface hydrology or changes in groundwater. Additional potential impacts from the Proposal that are collectively relevant to waterbirds and a number of significant fauna are discussed under subsequent sections: loss of breeding habitat (Section 7.6.5), bird strike from wind turbines (Section 7.6.7), attraction to artificial water bodies (Section 7.6.8), fauna entrapment (Section 7.6.9) and feral predators (7.6.12).

The direct loss of primary waterbird foraging habitat will occur during construction. Within the Study Area, primary habitat with potential to be directly disturbed comprises:

- Salt lake playa: A total of 243,271 ha occurs within the Study Area, of which 216,333 ha (88.93 %) occurs within the Proposal area and 13,363 ha (5.49 %) occurs within the Indicative Footprint.
- Lake margin: A total of 14,884 ha occurs within the Study Area, of which 1,341 ha (9.01 %) occurs within the Proposal area and 22.4 ha (0.15 %) occurs within the Indicative Footprint.
- Claypan and claypan mosaic: A total of 15,960 ha occurs within the Study Area, of which 1,547 ha (9.13 %) occurs within the Proposal area and 42.2 ha (0.26 %) occurs within the Indicative Footprint.
- Saline flats and depressions: A total of 8,069 ha occurs within the Study Area, of which 151 ha (1.87 %) occurs within the Proposal area and 3.4 ha (0.04 %) occurs within the Indicative Footprint.

Collectively, within the Indicative Footprint, these habitats make up 13,431 ha; however, the proportions of each habitat in the Study Area are low, ranging from 0.04 % - 5.49 %.

The greater potential impact to waterbird foraging habitat has the potential to be through changes in hydrology of the lake during inundation events. These changes to hydrology would be confined to the salt lake playa habitat within the On-LDE. Broadly, the Proposal has the potential to impact hydrology of the lake during inundation in two ways:

- Surface water: changing the areas of inundation through the construction of on lake infrastructure; and
- Groundwater: changing the depth and duration of inundation events through groundwater drawdown

Changes in surface hydrology could occur through the construction of trenches, ponds, bunds, and associated infrastructure which have the potential to change the areas, depths and duration of flood events. These changes to surface hydrology could in turn affect the productivity of the lake as a whole and may not be limited to the Indicative Footprint.

Surface water modelling has been undertaken for the different stages of construction for the Proposal (Section 9). The modelling results indicate that during flood events, the total inundated area of the lake effectively remains the same as under baseline conditions. While the presence of bunds around the trenches results in water levels that are deeper on the upslope side of the bunds and shallower on the downslope side of bunds, the water ultimately ponds in the deepest parts of the lake under all scenarios. Additionally, exclusion zones have been established around the edges of the lake and islands to avoid potential impacts associated with changes in hydrology to the riparian zone and associated lake margin habitat. See Section 7.6.14 for an assessment of potential secondary impacts to island habitats from surface water and groundwater.

Groundwater modelling has been undertaken for the different stages of construction and operation of the Proposal (Section 9). Baseline groundwater levels range from 0.4 to 0.7 mbgl within the lake bed sediments. Following rainfall, infiltration saturates the lake bed sediments and once saturated, the accumulated rainfall presents as inundation of the playa. Groundwater drawdown during operation has the potential to reduce the depth and duration of flood events as a greater proportion of rainfall is required to infiltrate and saturate the lake bed sediments, prior to being expressed as inundation.

Groundwater drawdown from brine abstraction within the lake bed sediments (up to 100 GL/a) will be progressive over the LoM operation. The construction of the BMUs will be staged over 17 years and allow for adaptive management of potential impacts. Generally, trench water levels within the BMUs will be drawn down to a sustained level of approximately 3 mbgl within two years after pumping begins, with an associated lowering of groundwater levels occurring laterally away from the trenches. After 10 years of abstraction, drawdown across the BMUs averages 0.52 m to 0.73 m. After 20 years of abstraction, drawdown across the BMUs averages 0.41 m to 0.74 m (Figure 7-24) (see detailed modelling within Section 9.5.4.1, Figure 9-31).

Based on historical satellite data, on average, Lake Mackay had suitable foraging conditions for waterbirds, equivalent to the 2021 event (24 days or greater), on 21 occasions over the last 33 years of available data (Figure 7-11)(Appendix I.21). Additionally, analysis of the satellite data showed a trend of increasing number of events over the period of available imagery (R^2 = 0.5329)(Section 9.5) (Table 7-12) (Figure 7-19).

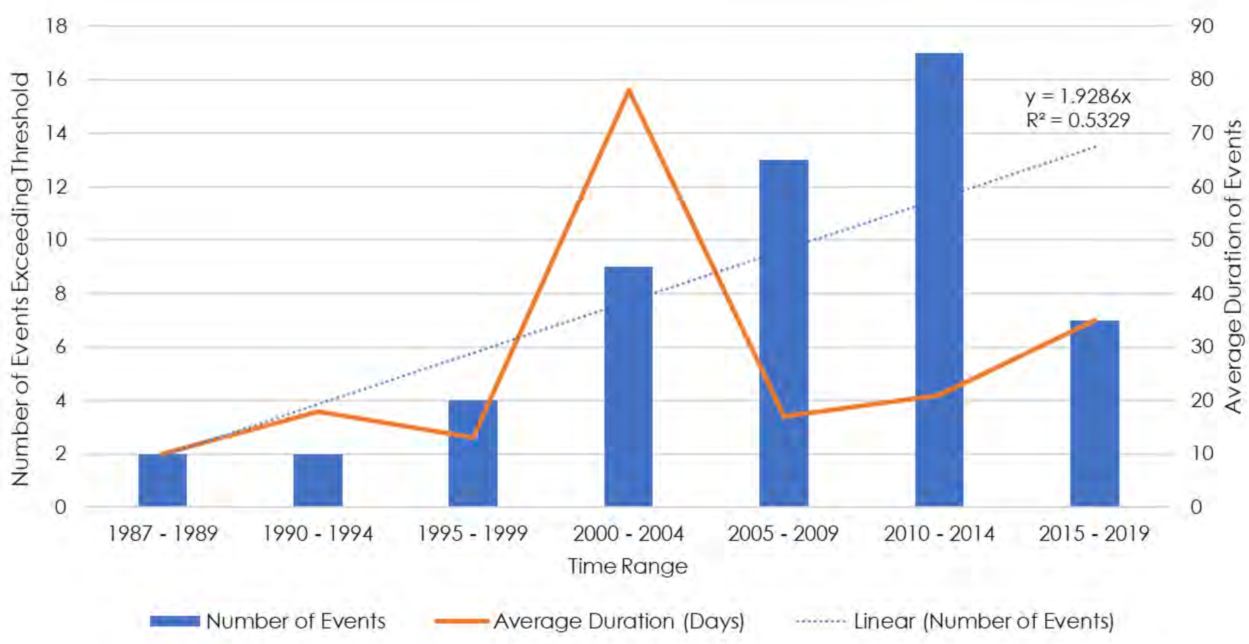

Figure 7-19: Number and duration of inundation events exceeding 20% threshold at Lake Mackay since 1987

To predict inundation scenarios under operational (drawdown) conditions, additional modelling has been completed using GoldSim over the 48 years of available data (1973-2021) (Table 7-12) (Appendix I.21). The GoldSim model considered parameters including Lake Surface Area, Catchment Area, Pan Factor, Runoff Coefficient, Unsaturated Evaporation Factor, Unsaturated Zone thickness, and Airfilled porosity above water table. In comparison to historical satellite data, the GoldSim modelling tended to better predict larger events than smaller events. However, for the purposes of this assessment, changes in the ratio of events during baseline conditions compared to operational conditions is more important for the purposes of predicting potential impacts.

The modelling indicates that the effects of drawdown during operations conditions will have some effect on the number of inundation events equivalent to the 2021 event when considering the entire dataset (24 days inundation: 15→12 events)(Figure 7-21). However, when considering the most recent dataset from 2000 – 2020, the effects of drawdown on the number of events are minimal (24 days: 9 → 8 events). The cause of this difference is an increasing trend in inundation events, with a greater number of inundation events occurring in the most recent 20 years of available data compared to the previous 25 years of available data (Table 7-12). Based on the drawdown modelling and the trend of recent inundation events, suitable foraging conditions for waterbirds equivalent to the 2021 event, are predicted to continue during operations. Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions (Section 7.6.4).

Table 7-12: Inundation events: analysis of satellite imagery and GoldSim modelling

Inundation Classification	Year	GoldSim Baseline Scenario	GoldSim Operational Scenario
Events with duration of 24 days or greater	(1974-99)	6	4
	(2000- 2020)	9	8
	Total	15	12
Events with duration of 65 days or greater	(1974-99)	5	2
	(2000- 2020)	6	5
	Total	11	7

The duration of potential direct and indirect impacts to waterbird foraging habitat has the potential to extend from construction through to post closure. The impact on waterbird foraging habitat will be mitigated through the implementation of the CEMP which will include the following:

- Where required, mitigate secondary impacts to waterbird foraging habitat on the playa through the installation of suitable drainage control features. These features should be designed to convey flow past On-LDE infrastructure and return flow to its natural path and area of inundation. Mitigation measures to be informed by hydrology models that replicate flood events of a sufficient size and duration to trigger invertebrate & macrophyte abundance and therefore sufficient waterbird foraging resources.
- Where required, mitigate secondary impacts from changes in hydrology to claypans and claypan mosaics, and saline flats and depressions surrounding Lake Mackay that are dissected by the Indicative Footprint. These habitats comprise only a small portion of the Proposal area.

In addition to the mitigation summarised above, Agrimin have developed a CEMP and a TFEMP to assist with the implementation of the mitigation hierarchy for the Proposal. As anthropogenic activities on the lake can cause disturbance to foraging waterbirds, including migratory shorebirds (DotE 2015; DotEE 2017), specific waterbird mitigation measures will be implemented over the staged approach of the Proposal and adaptive management implemented, including:

- To avoid disturbance to foraging waterbirds, no access will be permitted to inundated portions of Lake Mackay when more than 20 % of the lake is inundated. Similarly, no access will be permitted to inundated claypans or salt pans with the exception of areas that coincide with the Indicative Footprint.

Based on the implementation of mitigation measures to limit the impacts to waterbird foraging habitat, the EPA objective for Terrestrial Fauna will be met.

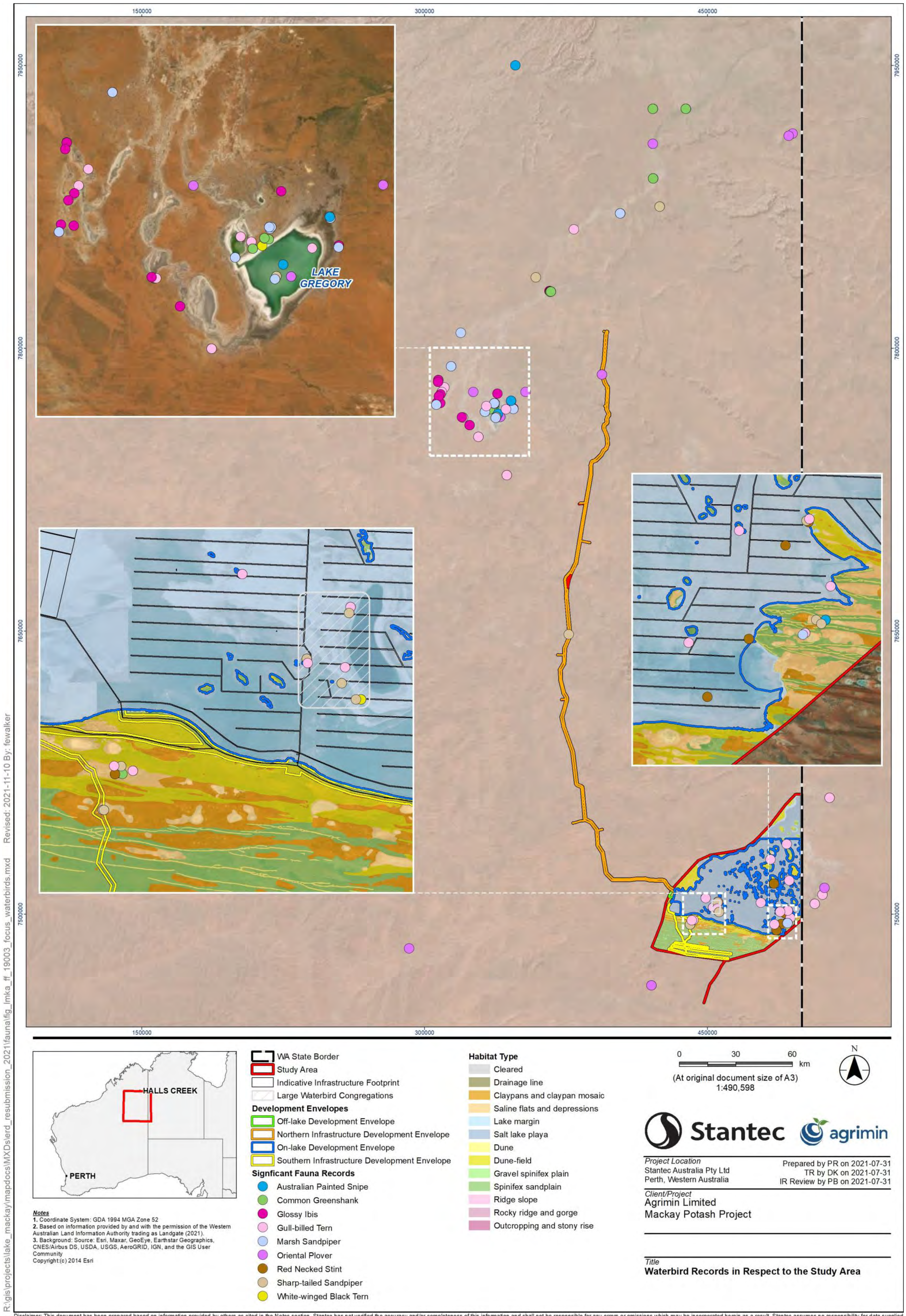

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Figure 7-20: Listed waterbird records with respect to the Proposal area and Lake Gregory for context (locations of Glossy Ibis are unavailable for Duguid et al. (2005))

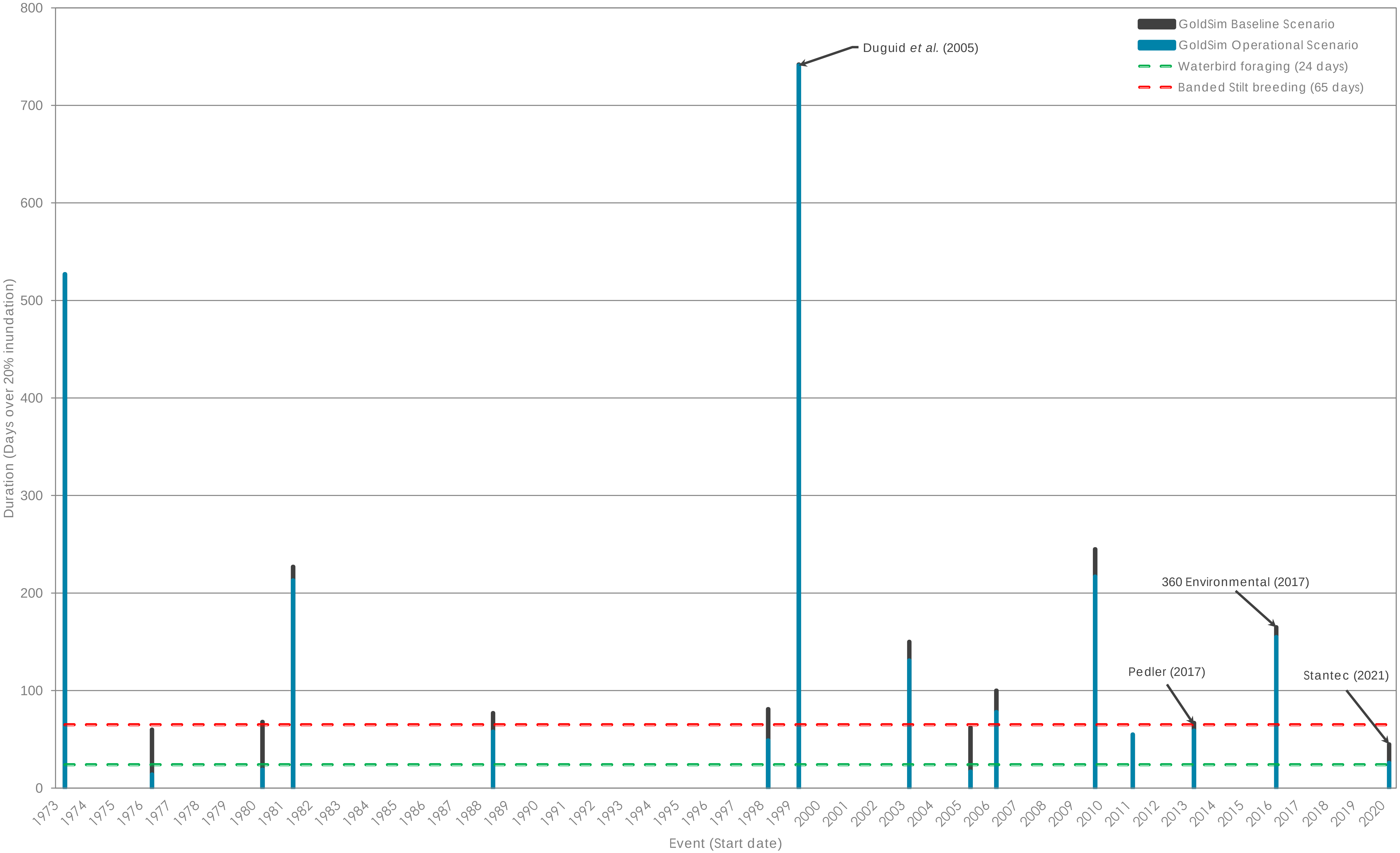

Figure 7-21: Inundation events: GoldSim modelling under baseline and operational scenarios with limits for potentially supporting waterbird foraging (green) and Banded Stilt Breeding (red).

7.6.5 Waterbirds – loss of breeding habitat

As summarised in Section 7.6.4, during flood events, inland salt lakes can provide an abundance of food resources for waterbirds including aquatic invertebrates and macrophytes. During these events, certain waterbirds may take the opportunity to breed on lake islands and claypans. In particular, Banded Stilts are an Australian resident of many inland salt lakes and nest on the islands of these salt-lakes after rain has initiated a boom in invertebrate prey (Menkhorst *et al.* 2019). However, due to the often brief ephemeral nature of inland salt lakes, not all breeding events are successful (Pedler 2017). While not feral, the Silver Gull is known to predate Banded Stilt chicks during breeding events and have considerable influence on breeding success (Pedler 2017). Silver Gull populations will potentially increase in response to the same foraging resources as feral predators, and as such mitigations are considered separately (Section 7.6.12).

Attempted breeding events of Banded Stilt were recorded during the previous waterbird surveys at Lake Mackay in 2001, 2017, and 2021 (Appendix G.1), as well as during 2014 from a targeted Banded Stilt assessment (Pedler 2017) (Figure 7-22; nesting sites not available for 2001 and 2017 events). The most notable breeding event was of the Banded Stilt in 2001 survey where 4,400 immature Banded Stilts were recorded on the islands. As the lake remained inundated for 398 days (greater than 20 % inundation), the 2001 inundation event likely resulted in several reproductive events over the duration of the inundation. The 2017 survey also recorded breeding of Banded Stilts; however, numbers were low with less than 10 fledged juveniles recorded. Small numbers of juvenile Red-kneed Dotterels, Silver Gull, Australian Gull-billed Tern (Mi), Red-necked Avocet and Black-winged Stilt were also observed which demonstrated breeding had occurred. However, the 2017 waterbird survey missed peak activity for breeding with the juveniles of Banded Stilt and other species likely to have dispersed. The success of attempted breeding events of Banded Stilts observed in 2014 (6,000 clutches observed) and 2021 (4,200 Banded Stilts observed on island with breeding behaviour) is unknown.

Based on available literature, Banded Stilts require inland salt lakes to be inundated for a minimum of 65 days for the species to successfully complete their breeding cycle and fledge their chicks (Appendix G.1). Based on the 33 years of available satellite imagery, six inundation events at Lake Mackay exceeded this minimum duration of inundation, however, three of those events were marginal (2007:66 days, 2014:69 days and 2015: 72 days) (Figure 7-11). Based on these inundation durations, the attempted breeding event in 2014 was potentially successful, while the event in 2021 was likely unsuccessful (Table 7-13; Appendix G.1). In summary, when inundated for a sufficient duration, Lake Mackay provides an important resource for foraging and breeding of waterbirds. These larger events are important as they are relatively rare and infrequent with the majority of inundation events lasting less than one month (Appendix I.21).

Table 7-13: Banded Stilt breeding evidence at Lake Mackay

Days of inundation	Breeding evidence observation	Date recorded	Likely success	Reference
398	12,070 adults, 4,400 juveniles	2001	Successful	Duguid et al. (2005)
69	~6,000 adult pairs, 6,500 clutches, >650 chicks (~2-4 weeks old)	2014	Potentially successful	Pedler (2017); Pedler *et al.* (2014)
66	257 adults, <10 fledged juveniles	14 to 17 April 2017	Successful	360 Environmental (2017b)
24	4,200 adults observed nesting No juveniles observed during the survey.	30 March to 2 April 2021	Unlikely successful due to rate of water recession	Appendix G.1

Potential impacts from the Proposal to waterbird breeding habitat could include direct and indirect impacts to the islands. Primarily this could occur through the construction of trenches and infrastructure on lake during operations. At closure the southern feeder trench will be breached and BMU trenches allowed to naturally infill, a process likely to occur within approximately 10 years (based on field observations of test trenches), aided by flooding, which will increase sedimentation into trenches. Potential indirect impacts could include changes to surface hydrology which could inadvertently result in the flooding of some breeding habitat alternatively groundwater drawdown could potentially impact upon riparian vegetation. However, the greater potential impact from groundwater drawdown could be the reduction in the duration of inundation events required for waterbirds, particularly Banded Stilts, to complete their lifecycle.

The potential direct impact on breeding habitat will primarily be mitigated through the exclusion of islands from the Proposal area. In total these islands excluded from the Proposal area make up 20,119 ha. Additionally, potential indirect impacts to breeding habitat associated with changes in surface hydrology and groundwater drawdown will be mitigated through the establishment of buffers around each of the islands (discussed in detail within Section 7.6.14). Islands on Lake Mackay have been categorised based on size, habitats and geology and subsequent ecological, hydrological and hydrogeological studies were used to develop suitable buffer zones (Appendix I.10). The sizes of the buffer zones and the number of islands in each category are summarised below and rational provided in Appendix I.10:

- Landform islands (3 islands in total) – buffer size will be 500 m.
- Intermediate and Large islands (52 islands in total) – buffer size will be 250 m.
- Small islands (216 islands in total) – buffer size will be 100 m.

To predict inundation scenarios under operational (drawdown) conditions, modelling has been completed using GoldSim over the 48 years of available data (1973-2021) (See Section 7.6.4)(Table 7-12)(Figure 7-21). The modelling indicates that the effects of drawdown during operations conditions will have some effect on the number of inundation events suitable for Banded Stilt breeding when considering the entire dataset (65 days inundation: 11→7 events). However, the modelling indicates that the reduction in the number of events would only affect the marginal events that are close to 65 days duration, while the long inundations important for large breeding events would be unaffected (Figure 7-21).

Additionally, when considering the most recent dataset from 2000 – 2020, the effects of drawdown on the number of potential breeding events are minimal (65 days: 6 → 5 events). The cause of this difference is that there is a greater number of inundation events occurred in the most recent 20 years of available data compared to the previous 25 years of available data, with this trend to continue (Table 7-12). Based on the drawdown modelling and the trend of recent inundation events, suitable conditions for breeding events of Banded Stilts, are predicted to continue during operations, particularly for long inundations which are important for large breeding events. Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions (Section 7.6.4).

In addition to the mitigation summarised above, Agrimin have developed a CEMP and a TFEMP to assist with the implementation of the mitigation hierarchy for the Proposal. Additionally, as anthropogenic disturbance can disrupt nesting waterbirds, including Banded Stiltsmitigation(Pedler 2017; Pedler *et al.* 2015) additional management will be implemented, including:

- To avoid disturbance to breeding waterbirds, no access will be permitted to islands used for breeding by banded stilts or other waterbirds.
- To avoid disturbance to breeding waterbirds, no access will be permitted to inundated portions of Lake Mackay when more than 20 % of the lake is inundated. Similarly, no access will be permitted to inundated claypans or salt pans with the exception of areas that coincide with the Indicative Footprint.

Based on the implementation of mitigation measures to limit the impacts to waterbird breeding habitat, the EPA objective for Terrestrial Fauna will be met.

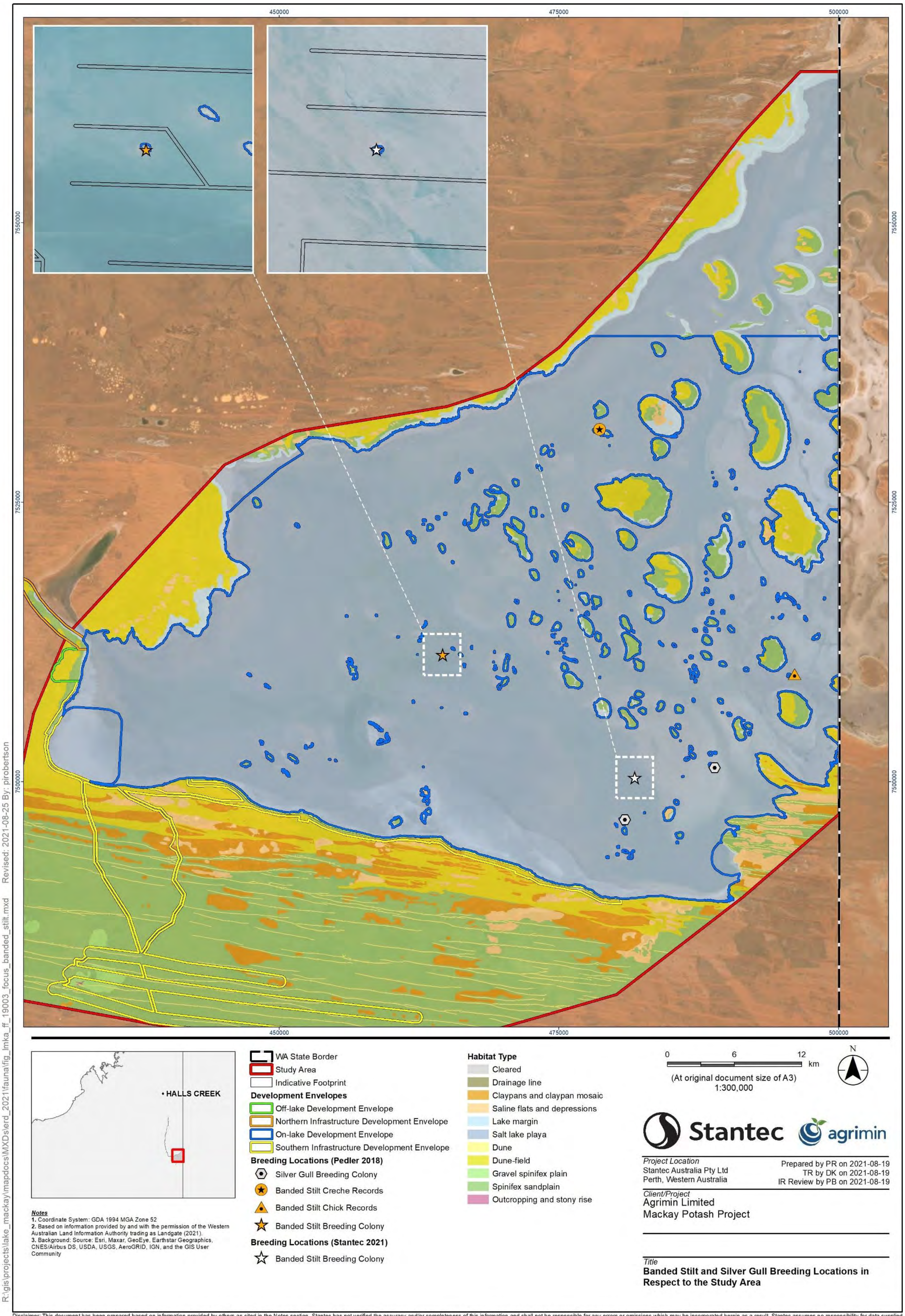

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Figure 7-22: Waterbird breeding records with respect to the Indicative Footprint, Proposal area and Study Area

7.6.6 Terrestrial SRE invertebrate fauna - Loss of population or species and/or habitat

Terrestrial SRE invertebrate fauna tend to share several ecological and life-history characteristics, such as poor powers of dispersal, confinement to discontinuous habitats, highly seasonal activity patterns and low fecundity (Harvey 2002). Given these characteristics, projects proposing to disturb discontinuous habitats have the potential to result in the loss of range-restricted taxa (EPA 2016g).

There has been a total of six terrestrial SRE invertebrate fauna surveys undertaken for the Proposal at Lake Mackay (Section 7.3; Appendix G.2). All specimens collected over previous surveys for the Proposal were compared and consolidated, with naming revised and aligned across the collection records. The combined surveys resulted in the collection of 48 taxa from target groups which were represented by 1,490 specimens. None of these taxa were identified as confirmed SRE species. However, of the 48 taxa, 40 taxa were identified as potential SRE species due to insufficient geographical context, or a lack of taxonomic resolution (Table 7-14). These comprised five salt lake specialist wolf spiders, one mesh-web spider, 10 mygalomorph spiders, six pseudoscorpions, 11 scorpions, five slaters, one snail, and four tiger beetles.

Of the 40 taxa recorded over the previous surveys, 34 were recorded within the Proposal area; however, 18 of these taxa were also recorded outside the Proposal area. Of the 34 taxa recorded from the Proposal area, only eight were recorded from inside the Indicative Footprint with all of these taxa also recorded outside the Indicative Footprint (Table 7-14, Figure 7-23). The eight taxa recorded from both inside and outside the Indicative Footprint were:

- Two wolf spiders:
  - *Hogna* 'FP-11090' (potential salt lake specialist);
  - *Venator* `sp. (VWF1177)` (potential salt lake specialist);
- One pseudoscorpion: *Indolpium* 'LM1' (likely widespread);
- Two scorpions:
  - *Lychas* 'annulatus complex' (likely widespread);
  - *Lychas* 'multipunctatus complex' (likely widespread);
- One slater: *Buddelundia* '10lm' (likely widespread);
- Two tiger beetles:
  - *Pseudotetracha* 'blackburni complex' (potential salt lake specialist); and
  - *Pseudotetracha* 'cf helmsi' (potential salt lake specialist).

All taxa recorded from the Indicative Footprint were able to be identified to species level and therefore these is confidence that all of these taxa are also represented outside the Indicative Footprint. No potential SRE taxa which could not be identified to species level have been recorded within the Indicative Footprint.

Of the eight taxa recorded from the Indicative Footprint, only four were collected solely from restricted habitats: the two wolf spiders *Hogna* 'FP-11090' and *Venator* `sp. (VWF1177)`and the two tiger beetles *Pseudotetracha* 'blackburni complex' and *Pseudotetracha* 'cf helmsi' (Figure 7-23). All four taxa are potentially salt lake specialists. The wolf spider *Venator* `sp. (VWF1177)` was collected from two locations in Lake margin habitat (Figure 7-23). The remaining three taxa were each collected from the Salt lake playa with the tiger beetles also collected from Claypan and claypan mosaic and/or Lake margin habitats (Table 7-14). These taxa are likely well distributed in association with these habitats at Lake Mackay. The remaining four taxa from the Indicative Footprint were recorded from multiple locations outside the Indicative Footprint in widespread habitats and are unlikely to restricted in their distribution.

Although the four potential salt lake specialists have potential to be impacted because their habitats occur within the Indicative Footprint, these habitats are also well represented outside the Indicative Footprint.

- Salt lake playa: A total of 243,271 ha occurs within the Study Area, of which 216,333 ha (88.93 %) occurs within the Proposal area and 13,363.1 ha (5.49 %) occurs within the Indicative Footprint.
- Lake margin: A total of 14,884 ha occurs within the Study Area, of which 1,341 ha (9.01 %) occurs within the Proposal area and 22.4 ha (0.15 %) occurs within the Indicative Footprint.
- Claypans and claypan mosaic: A total of 15,960 ha occurs within the Study Area, of which 1,457 ha (9.13 %) occurs within the Proposal area and 42.2 ha (0.26 %) occurs within the Indicative Footprint.

The proportion of each habitat within the Indicative Footprint comprises a minor proportion of the extent within the Proposal area and the Study Area. Additionally, each habitat is likely to be well distributed outside the Study Area in the local and regional surrounds. Even if the alignment of the Indicative Footprint is refined within the Proposal area, the proportions of each habitat within the Indicative Footprint will remain the same.

In addition to potential direct impacts, there exists the potential for indirect impacts, resulting from changes in surface hydrology, groundwater drawdown, impacts to island habitats and potential for fragmentation of the playa. Broadly, the Proposal has the potential to impact hydrology of the lake during inundation in two ways:

- Surface water: changing the areas of inundation through the construction of on lake infrastructure; and
- Groundwater: changing the depth and duration of inundation events through groundwater drawdown

These potential impacts are discussed in detail within Section 7.6.4 and 7.6.5 as they are of importance to waterbird foraging and breeding opportunities.

In summary with respect to SRE taxa and SRE habitat, potential impacts of changes in surface hydrology will be mitigated through the implementation of the CEMP which will include the following:

- where required, mitigate secondary impacts on the playa of changed surface hydrology through the installation of suitable drainage control features. These features should be designed to convey flow past On-LDE infrastructure and return flow to its natural path and area of inundation.
- where required, mitigate secondary impacts from changes in hydrology to claypans and claypan mosaics, and saline flats and depressions surrounding Lake Mackay that are dissected by the Indicative Footprint. These habitats comprise only a small portion of the Proposal area.

With respect to potential impacts from changes in groundwater, detailed modelling is presented within Section 9.5.4.1; however, a summary is provided below for context within this section. The hypersaline groundwater is typically approximately 250,000 mg/L and levels range from between 0.4 to 0.7 mbgl within the lake bed sediments, and from 3.4 to 4.0 mbgl beneath the larger islands.

Groundwater drawdown from brine abstraction within the lake bed sediments (up to 100 GL/a) will be progressive over the LoM. The construction of the BMUs will be staged over 17 years and allow for adaptive management of potential impacts. Generally, trench water levels within the BMUs will be drawn down to a sustained level of approximately 3 mbgl within two years after pumping begins, with an associated lowering of groundwater levels occurring laterally away from the trenches. After 10 years of abstraction, drawdown across the BMUs averages 0.52 m to 0.73 m. After 20 years of abstraction, drawdown across the BMUs averages 0.41 m to 0.74 m (Figure 7-24) (see detailed modelling within Section 9.5.4.1, Figure 9-31). The riparian zone is unlikely to be affected by the drawdown as root system of *Tecticornia* species is likely to be restricted to the upper horizon of the soil profile (<30 cm).

Groundwater drawdown during operation has the potential to reduce the depth and duration of flood events as a greater proportion of rainfall is required to infiltrate and saturate the lake bed sediments, prior to being expressed as inundation. Based on the drawdown modelling and the trend of recent inundation events, the duration of inundation events (greater than 24 days and greater than 65 days), are predicted to continue during operations (Table 7-12). Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions (Section 7.6.4).

With respect to island habitats, potential impacts are discussed separately within Section 7.6.14. This section includes mitigation specific to islands which includes buffer zones from disturbance to mitigate potential direct impacts as well as potential indirect impacts to habitats from changes in surface hydrology and groundwater drawdown.

With respect to fragmentation, it is acknowledged that the installation of on-lake infrastructure may result in some fragmentation of the salt lake playa habitat (trenches are spaced approximately 1 km apart). This in turn may reduce dispersal of taxa that inhabit the Salt lake playa and reduce dispersal between taxa that inhabit the islands and the lake margin. However, only one salt lake specialist (*Rivacindela* 'LM1') was restricted to the salt lake playa (single location outside of the Indicative Footprint) with all other salt lake taxa also being collected from fringing habitats which will have minimal impact from the Proposal. Additionally, the on-lake infrastructure will not form a permanent barrier to dispersal. At closure, pond bunds will be breached and the trenches left to naturally in-fill, a process likely to occur within approximately 10 years (based on field observations of test trenches), aided by flooding, which will increase sedimentation into trenches.

In summary, the potential impact of disturbance to SRE species and habitat will be mitigated through the implementation of the CEMP (Table 7-14) which will include the implementation of strict disturbance mitigation that avoids disturbance as a priority, and clearly demarcate and monitor disturbance boundaries. As no potential SRE taxa are restricted to the Indicative Footprint, and their habitats are well represented outside of the Indicative Footprint, the Proposal is not expected to result in the loss of a range-restricted taxon.

Based on current knowledge and the implementation of mitigation measures to limit the impacts to terrestrial SRE invertebrate species and habitat, the EPA objective for Terrestrial Fauna will be met.

Table 7-14: Potential SRE taxa locations recorded during surveys

Taxa	Potential SRE category: Geographic	Potential SRE category: Taxonomic	SA: Inside	SA: Outside	PA: Inside	PA: Outside	IF: Inside	IF: Outside	Fauna Habitat (# locations)(restricted habitats are highlighted): Claypans and claypan mosaic	Drainage Line	Dune	Dunefield	Gravel spinifex plain	Lake margin	Outcropping and stony rise	Rocky ridge and gorge	Saline flats and depressions	Salt lake playa	Spinifex sandplain	Grand Total (locations)	SRE potential: Only restricted habitats	SRE potential: Widespread habitats	SRE comment
Wolf Spiders																							
Hogna 'FP-11090'	✓		✓	×	✓	✓	✓	✓										7		7	✓		Potential Salt Lake Specialist: recorded inside & outside IF
Hogna sp.		✓	✓	×	×	✓	×	✓				1								1		✓	Likely widespread: only recorded outside IF
Tetralycosa sp.		✓	✓	×	✓	✓	×	✓						1				1		2	✓		Potential salt lake specialist(s): only recorded outside IF
Venator `sp. (VWF1176)`	✓		✓	×	✓	×	×	✓				1		1						2		✓	Likely widespread: only recorded outside IF
Venator `sp. (VWF1177)`	✓		✓	×	✓	×	✓	✓						2						2	✓		Potential Salt Lake Specialist: recorded inside & outside IF
Other Araneomorph Spiders																							
Dictynidae 'LM1'	✓		✓	×	✓	×	×	✓										1		1	✓		Potential Salt Lake Specialist: outside IF
Mygalomorph Spiders																							
Aname 'LM1'	✓		✓	×	✓	×	×	✓											2	2		✓	Likely widespread: only recorded outside IF
Aname 'LM2'	✓		✓	×	✓	×	×	✓											1	1		✓	Likely widespread: only recorded outside IF
Aname 'LM3'	✓		✓	×	✓	×	×	✓				1								1		✓	Likely widespread: only recorded outside IF
Aname 'MYG277'	✓		×	✓	×	✓	×	✓											2	2		✓	Likely widespread: only recorded outside IF
Aname 'MYG515'	✓		×	✓	×	✓	×	✓											1	1		✓	Likely widespread: only recorded outside IF
Anamidae sp.		✓	✓	×	✓	×	×	✓				1	2						4	7		✓	Likely widespread sp/spp: only recorded outside IF
Conothele 'LM1'	✓		✓	×	✓	×	×	✓					1							1		✓	Likely widespread: only recorded outside IF
Idiommata 'LM1'	✓		✓	×	✓	×	×	✓				1								1		✓	Likely widespread: only recorded outside IF
Kwonkan 'LM1'	✓		×	✓	×	✓	×	✓					1							1		✓	Likely widespread: only recorded outside IF
Kwonkan 'LM2'	✓		×	✓	×	✓	×	✓					1							1		✓	Likely widespread: only recorded outside IF
Pseudoscorpions																							
Austrohorus '05'		✓	✓	✓	×	✓	×	✓						1					1	2		✓	Likely widespread: only recorded outside IF
Beierolpium '8/2'		✓	✓	✓	✓	✓	×	✓	1		1	3			1					6		✓	Likely widespread: only recorded outside IF
Beierolpium '8/4'		✓	✓	✓	✓	✓	×	✓		1			4		2	2			2	11		✓	Likely widespread: only recorded outside IF
Beierolpium sp.		✓	✓	×	✓	✓	×	✓			1	1								2		✓	Likely widespread sp/spp: only recorded outside IF
Indolpium 'LM1'	✓		✓	✓	✓	✓	✓	✓	2	1		4	2	5	2	1	1		7	25		✓	Likely widespread: recorded inside & outside IF
Indolpium 'toothy'	✓		✓	✓	✓	✓	×	✓					2						3	5		✓	Likely widespread: only recorded outside IF

Taxa	Potential SRE category		SA		PA		IF		Fauna Habitat (# locations)(restricted habitats are highlighted)											Grand Total (locations)	SRE potential		SRE comment
	Geographic	Taxonomic	Inside	Outside	Inside	Outside	Inside	Outside	Claypans and claypan mosaic	Drainage Line	Dune	Dunefield	Gravel spinifex plain	Lake margin	Outcropping and stony rise	Rocky ridge and gorge	Saline flats and depressions	Salt lake playa	Spinifex sandplain		Only restricted habitats	Widespread habitats	
Scorpions																							
Isometroides 'LM1'	✓		✓	×	✓	×	×	✓					1							1		✓	Likely widespread: only recorded outside IF
Lychas 'aitkeni complex'		✓	✓	×	✓	×	×	✓				1								1		✓	Likely widespread: only recorded outside IF
Lychas 'annulatus complex'		✓	✓	✓	✓	✓	✓	✓	3	1	1	9	5	1	2				10	31		✓	Likely widespread: multiple records inside & outside IF
Lychas 'bituberculatus complex'		✓	✓	×	✓	×	×	✓				1	1			1			1	4		✓	Likely widespread: only recorded outside IF
Lychas 'harveyi complex'		✓	✓	×	✓	×	×	✓					1							1		✓	Likely widespread: only recorded outside IF
Lychas 'multipunctatus complex'		✓	✓	×	✓	✓	✓	✓	1			1	2			1			2	7		✓	Likely widespread: multiple recorded inside & outside IF
Lychas 'telfer'	✓		✓	✓	✓	✓	×	✓	1		3	1							1	6		✓	Likely widespread: only recorded outside IF
Urodacus 'armatus spp. group'	✓		✓	×	✓	×	×	✓	1				1							2		✓	Likely widespread: only recorded outside IF
Urodacus sp.		✓	✓	×	✓	✓	×	✓			1	2	1	1					1	6		✓	Likely widespread sp/spp: only recorded outside IF
Urodacus 'telfer'	✓		✓	×	✓	✓	×	✓			2	3								5		✓	Likely widespread: only recorded outside IF
Urodacus 'yaschenkoi complex'	✓		✓	×	✓	×	×	✓											1	1		✓	Likely widespread: only recorded outside IF
Slaters																							
Buddelundia '104'	✓		✓	×	✓	×	×	✓				1							2	3		✓	Likely widespread: only recorded outside IF
Buddelundia '10lm'	✓		✓	✓	✓	✓	✓	✓				7	3	1	1	1		2	4	19		✓	Likely widespread: multiple records inside & outside IF
Buddelundia '27lm'	✓		✓	✓	✓	✓	×	✓				1	2						2	5		✓	Likely widespread: only recorded outside IF
Buddelundia sp.		✓	✓	×	✓	×	×	✓					1		1				1	3		✓	Likely widespread sp/spp: only recorded outside IF
Buddelundiinae 'lakemackay'	✓		✓	✓	✓	✓	×	✓	2			1	1		1					5		✓	Likely widespread: only recorded outside IF
Snails																							
Leichhardtia cf. sisurnius		✓	✓	✓	×	✓	×	✓	2								1			3	✓		Likely restricted to claypans: only recorded outside IF
Insects																							
Australicapitona 'LM1'	✓		✓	×	×	✓	×	✓									1			1	✓		Potential Salt Lake Specialist: only recorded outside IF
Pseudotetracha 'blackburni complex'		✓	✓	×	✓	✓	✓	✓	1					3				9		13	✓		Potential Salt Lake Specialist: records inside & outside IF
Pseudotetracha 'cf helmsi'		✓	✓	×	✓	✓	✓	✓						1				2		3	✓		Potential Salt Lake Specialist: recorded inside & outside IF
Rivacindela 'LM1'			✓	×	✓	×	×	✓										1		1	✓		Potential Salt Lake Specialist: only recorded outside IF

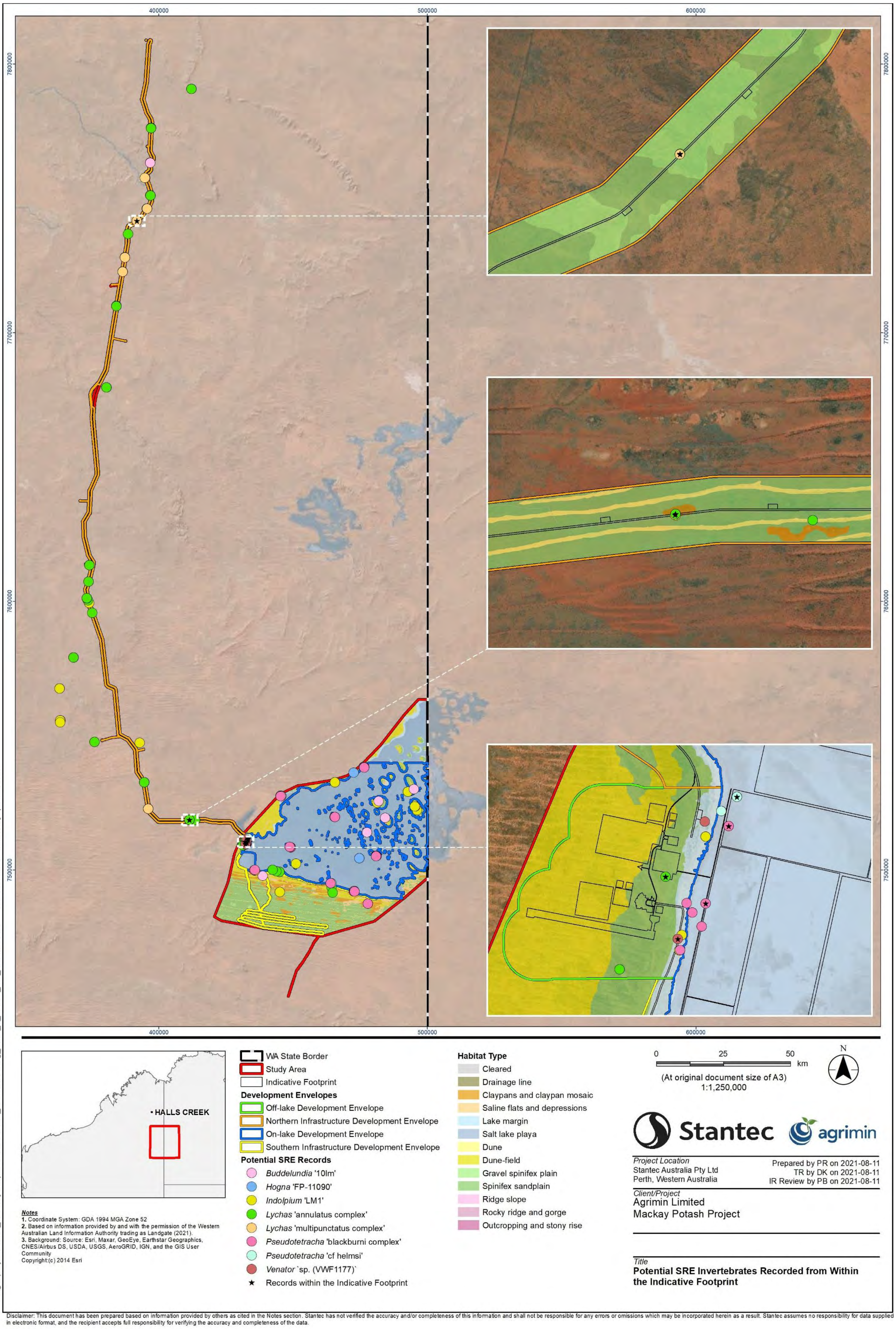

Figure 7-23: Potential SRE invertebrates recorded from the Indicative Footprint

7.6.7 Bird Strike – Wind Turbines

Birds and bats are susceptible to direct impacts (collisions with wind turbines and barotrauma for bats) and indirect impacts (changes in the use of habitats by birds and bats on or near a wind farm) (Clean Energy Council 2018). The following sections provide an assessment which follows the Best Practice Guidelines for Implementation of Wind Energy Projects in Australia (the Guidelines)(Clean Energy Council 2018). In line with the Guidelines this assessment has been broken down into the following sections:

- occurrence of listed bird and bat species at the site;
- occurrence of particular habitats (wetlands, caves, large trees with hollows) that may increase the concentration of specific birds and bats and subsequently increase the risk of collision; and
- occurrence of species that may be at higher risk of collision.

In total, five wind turbines are proposed to be established on the western margin of Lake Mackay. Two are proposed to be established south of the plant within the Off-LDE and three are proposed to be established within the SIDE along the access road to the borefield. Each turbine will have a power rating of 4.5 megawatt (MW), hub height of 130 m and sweep diameter of 155 m. This equals a rotor-sweep height of between 52.5 m and 207.5 m above ground level. A fire break of 70 m by 70 m will be cleared around each turbine to protect the infrastructure. In line with Civil Aviation Safety Authority (CASA) requirements, each turbine will be lit with medium intensity steady red obstacle lighting to maintain an acceptable level of safety to aircraft. Artificial water and foraging resources that might increase visitation by bird and bat species and subsequently increase potential for being struck by rotor blades, will be appropriately managed. Management of artificial fresh water sources are discussed within Section 7.6.9, management of foraging resources are discussed within 7.6.12. Additionally, artificial lighting in operational areas has the potential to attract insects which could subsequently increase visitation and therefore risk of blade strike to bat species as well as crepuscular and nocturnal bird species. To manage this risk, illumination will focus on operational areas and not the surrounding landscape.

7.6.7.1 Occurrence of listed bird and bat species at the site

A total of 14 significant bird species have been confirmed to occur within the Study Area and a further four significant bird species are considered likely to occur (Section 7.4.3, Appendix G.1). There are no significant species of bats expected to occur in the vicinity of the Proposal. Of these 18 bird species, 12 are waterbirds and would only be present near the wind turbines during inundation events (See Section 7.6.7.2). The other five species comprise:

- Night Parrot (Low risk): Species is extremely rare and has not been recorded in the SIDE or the Off-LDE. Additionally, the species tends to fly at low altitude (DotE 2016) and is unlikely to fly at rotor-sweep-height.
- Princess Parrot (Low risk): The species is rare and nomadic. The species has been recorded twice in the vicinity of the Proposal (15 km north and 47 km north-east of the proposed wind turbines in 2012 and 2021, respectively). The species may occasionally fly at rotor-sweep-height; however, given that it is rarely encountered, risk to the species is considered low.
- Grey Falcon (Low risk): The species is rare and nomadic. The species has been recorded once in the NIDE and is also known to occur in the surrounding region. The species is likely to soar at great height, presumably more than 2,000 m AGL (Schoenjahn 2013). Consequently, the species has potential to fly at rotor-sweep-height; however, given that it is rarely encountered, and uses a large range in altitude, the risk to the species is considered low.
- Fork-tailed Swift (Low risk): the species has been recorded once flying over Lake Mackay in 2017. The species flies anywhere from 1 to 300 m AGL and probably much higher (DAWE 2020a). Consequently, it has potential to fly at rotor-sweep-height; however, given that it is rarely encountered, risk to the species is considered low.
- Striated Grasswren (Low risk): Species has not been recorded in the SIDE but has potential to occur. However, the species tends to fly at low altitude and is unlikely to fly at rotor-sweep-height.

7.6.7.2 Occurrence of habitats in the vicinity of the Proposal that may increase the risk of collision

Habitats or features such as wetlands, caves and hollows may serve as a resource or breeding site for species of bats and birds (Clean Energy Council 2018). These features may increase the concentration of birds and bats in the area, resulting in higher risk of collision with turbines.

The Proposal is located on and adjacent to Lake Mackay which is predominantly a dry salt lake. However, during inundation events, Lake Mackay supports a high abundance of waterbirds including species that are listed as threatened or migratory (Section 7.4.1.2, Table 7-6; Appendix G.1).

Based on the analysis of available historical satellite imagery, Lake Mackay had 58 inundation events (with over 20 % inundation) over the last 33 years of available imagery (Appendix I.21) (Figure 7-11). Of the 58 events, 21 were equivalent or greater in duration to the event observed during the 2021 waterbird survey (24 days) while only two were greater in duration than the event observed during the 2017 waterbird survey (more than 400 mm of rainfall; 89 days duration). The event observed during the 2001 survey was the longest inundation event on available records and was nearly 30 times the average inundation duration.

During inundation events, the lake supports a high abundance of waterbirds including species that are listed as threatened or migratory (Section 7.4.1.2, Table 7-6; Appendix G.1). For waterbirds, due to the abundance (2001: 42,473 individuals and 2021: 42,194 individuals), diversity (34 species) and number of listed species (8 confirmed and 4 likely), the potential impact during flood events is considered high (Table 7-6).

7.6.7.3 Occurrence of species that may be at higher risk of collision

Monitoring surveys have found that certain birds and bats are more susceptible to being struck by the blades of wind turbines than others (Hull 2013) (Australian Ecological Research Services 2015) (Brett Lane & Associates Pty Ltd 2017). This is due to the flight behaviours of the species including the height that the species flies (many birds rarely reach the height of the blades) and the types of flight (hovering, circling, vertical and horizontal flights) which poses different risks of collision (Biosis Research Pty Ltd 2006). Currently there is a lack of data to clearly define which groups are at higher risk (Woehler and Belbin 2018) though there are likely to be differences in susceptibility for raptors, wading birds, nocturnal birds and bats (Biosis Research Pty Ltd 2006). It is assumed larger birds such as eagles, cranes, swans, geese and pelicans would likely be at a higher risk of collision due to their larger size and that they frequently fly at rotor-sweep-height (Biosis Research Pty Ltd 2006).

In line with CASA requirements, each turbine will be lit with medium intensity steady red obstacle lighting. Some studies have shown that insect aggregations do occur around wind turbines and that these aggregations can attract bats (Foo *et al.* 2017; Rydell *et al.* 2010). However, the aggregations do not seem to be as a result of the navigation lights with studies finding that mortality at towers with aviation lights is similar to or even less than mortality at towers without aviation lights (Bennett and Hale 2014; Bennett *et al.* 2017). Instead, there appears to be two other alternative reasons why insects may be attracted to wind turbines: the colours of the wind turbines themselves (Long *et al.* 2011) and the heat generated by the turbines (Jansson *et al.* 2019; Voigt 2021). Regardless of the cause for insects bring attracted to wind turbines, in general, the abundance of insects in the area is likely to be low. This is with the occasional exception of higher insect abundance after rainfall. Consequently, the potential for insect attraction leading to increased risk of blade strike to bats and crepuscular and nocturnal birds at the site is considered low.

Aside from the risk to waterbird species discussed above (Section 7.6.7.2), there exists some potential for impacts associated with raptors which may occasionally fly at rotor-sweep-height. However, given the low densities of these species anticipated to be in the vicinity of the five wind turbines, collisions are likely to be infrequent.

7.6.7.4 Wind turbine assessment

Based on this wind turbine assessment, the greatest risk to fauna is associated with the potential for bird strike during inundation events due to the large congregations of waterbirds on the lake, including species of significance. The potential impact of bird strike to waterbirds will be monitored initially to determine the level of impact caused by the turbines. Based on these findings, adaptive management will be implemented to refine the mitigation measures if required:

- Incident reporting of fauna mortalities in the vicinity of the wind turbines that could have been caused by wind turbine;
- Conduct opportunistic waterbird surveys in response to suitable conditions, if they occur, during construction/operation of the Proposal; and
- Implement adaptive management to refine mitigation measures.

In addition to the mitigation summarised above, Agrimin have developed a CEMP and a TFEMP to assist with the implementation of the mitigation hierarchy for the Proposal.

Based on the implementation of mitigation measures to limit the impacts of bird strike, the EPA objective for Terrestrial Fauna will be met.

7.6.8 Attraction of waterbirds to artificial water bodies - Loss of individuals including species of significance

Lake Mackay is known to support large numbers of waterbirds during inundation events however the lake is normally dry and does not provide suitable conditions for waterbirds (Section 7.4.1.2). Potential impacts from the Proposal include the creation of artificial water sources may attract waterbirds outside of normal timing. These individuals may lack the energy reserves or available resources (freshwater) to depart to more suitable locations. Additionally, the presence of artificial water sources, particularly hypersaline water, may impact on the health of individuals that are attracted to these water sources. In total, at year 20, the Proposal will result in the construction of up to approximately 2,917 ha of evaporation ponds and approximately 9,918 ha of open trenches. The evaporation ponds and trench network will be constructed progressively over the LoM and will take approximately 17 years to reach full size.

Within the trenches, salinity will reflect the groundwater of the lake bed sediments which are typically greater than 200,000 mg/L, with a maximum of approximately 340,000 mg/L (Section 9.4.2.1). Brine extraction will involve gravity drainage along the trenches. Brine will then be pumped into the evaporation ponds which will progressively increase salinities and precipitate out waste salts through a process of evapoconcentration (Section 2.5.2). The evaporation ponds and trench network will all be located on the salt lake within the On-LDE.

Potential impacts of the Proposal could occur if waterbirds are attracted to artificial saline bodies and these waterbodies could result in the loss of individuals including species of significance. Artificial water sources are used extensively by waterbirds in arid Australia including dams, sewage ponds, bore drains and mining waterbodies (Read 1999). However, waterbirds have been known to be attracted to water sources that can adversely impact their health and may lead to death (BHP Olympic Dam 2018;2019; DSEWPC 2011a; Read 1999; United States Fish and Wildlife Service 2009). An increase in the frequency of birds being attracted to these artificial water sources in the arid zone has been correlated with summer rains (BHP Olympic Dam 2018;2019). Although artificial water sources can vary in their suitability to waterbirds, high brine concentrations associated with historic potash projects are known to be toxic to some waterbird species.

In WA's arid interior, salt lakes are typically dry. During inundation events, the salts naturally dissolve and disperse into the water column. Larger rainfall events may result in lower salinities in surface water, however, as the hydroperiod progresses, the water levels will recede and salinity concentrations will reach saturation point, prior to entering the drying phase. Salt lakes in WA have been found to have salinities that range from 1,000 to 390,000 mg/L (TDS) (Gregory 2008). A number of these lakes were subject to dewatering discharge from adjacent mining operations, to allow safe mining below the water table. Typically, groundwater discharged ranged from 100,000 to 300,000 mg/L (TDS) (Gregory 2008).

On Lake Lefroy, dewatering discharge has occurred since 1965 and there are currently 18 approved discharge points onto the playa (Stantec 2018). Monitoring, including annual and opportunistic waterbird surveys, is undertaken to meet environmental compliance. Previous studies have found no evidence of migratory birds or waterbirds utilising the lake during flooding, due to the extremely hypersaline conditions. This is because the lake lacks a low salinity phase (due to discharge and salt accumulation) and even in major flood events exhibits a salinity of more than 260,000 mg/L. There is no evidence of waterbirds being attracted to the hypersaline discharge water on the lake, and no records of waterbird mortality during flooded or dry conditions.

Additionally, salt works in Australia concentrate brine using trenches and evaporation ponds to extract salts. There are a number of sites producing salt in Australia, including 4000 ha pond network at the Dry Creek salt works (first established in 1936). These salt works are documented as an important habitat for shorebirds and waterbirds (Purnell *et al.* 2017). Salt works in operation in WA include Shark Bay Salt, WA Salt Koolyanobbing, Onslow Salt, Dampier Salt. These projects are not known to result in mortality of waterbirds within evaporation ponds.

During operations of the Proposal, waterbirds will visit the lake during inundation events. As the hydroperiod progresses into the drying phase of the hydroperiod, salinity on the playa will naturally increase to levels similar to the trenches and evaporation ponds. At this point, the waterbirds are likely to move to nearby freshwater claypans or depart Lake Mackay rather than move into the hypersaline ponds or trenches. However, given the lack of studies on potential impacts to waterbirds as a result of hypersaline water sources at potash projects, a conservative approach has been taken for this Proposal. The TFEMP includes commitment to an iterative approach of mitigation and monitoring. If required, mitigation options may include the implementation of bird deterrents which have been implemented at other operations. Given the large scale of the Proposal, monitoring will focus on the evaporation ponds and a representative portion of the trench network. Given that the Proposal will initially start at a small scale, monitoring from inception will allow the Proposal to implement adaptive management and corrective actions progressively as required.

In addition to the mitigation summarised above, Agrimin have developed a CEMP and a TFEMP to assist with the implementation of the mitigation hierarchy for the Proposal.

Based on the implementation of mitigation measures to limit the potential impacts of exposure of high brine concentrations on waterbirds, the EPA objective for Terrestrial Fauna will be met. Monitoring will be conducted from the inception of the Proposal and corrective actions implemented if required.

7.6.9 Fauna entrapment in ponds/trenches - Loss of individuals including species of significance

Terrestrial fauna, particularly larger animals such as kangaroos, have the potential to become entrapped in trenches or water storage dams. Although terrestrial fauna species do not reside on the playa, there is potential they could be attracted to the water in the trenches or fall into the trenches when traversing the playa. In total, at year 20, there will be approximately 9,918 ha of open trenches. Each trench will be approximately 6 m in width and approximately 4.5 m in depth below ground surface. Water levels in the trenches will range during operations from approximately 0.5 m to 3 m below ground surface. Spoil will form bunds either side of the trenches to a height of approximately 1.5 m as a deterrent. The trench network and evaporation ponds will be constructed progressively over the LoM. The closest trenches will be approximately 250 m from the lake margin with the majority forming a network across the centre of the lake away from terrestrial fauna habitats.

Given the paucity of information regarding fauna entrapment in the trench networks at potash projects, a conservative approach has been taken for this Proposal. The TFEMP includes commitment for an iterative approach of mitigation and monitoring. Given the large scale of the Proposal, monitoring will focus on a representative portion of the trench network. The construction of the Proposal will take approximately 17 years to reach full size. Given that the Proposal will initially start at a small scale, monitoring from inception will allow the Proposal to implement adaptive management, if required.

Mitigation measures will include the following:

- bunding of approximately 1.5 m will be established along all trenches as a deterrent to fauna;
- the TFEMP includes commitment for an iterative approach of monitoring and adaptive management if required. Given the large scale of the Proposal, monitoring will focus on the evaporation ponds and a representative portion of the trench network.
- at closure, strategic breaching of the southern feeder of trench bunding canal to maintain hydrology, based on hydrological modelling results; and
- at closure, trenches to infill naturally, a process likely to occur within approximately 10 years (based on field observations of test trenches), aided by flooding, which will increase sedimentation into trenches.

Although the Proposal will primarily result in open hypersaline waterbodies, there will also be some freshwater sources at site that may also attract terrestrial fauna and waterbirds. During construction of the haul road within the NIDE, freshwater will be abstracted via bores and stored in transportable containers. Any associated infrastructure or disturbance will be decommissioned and rehabilitated at the completion of construction of the sealed road. Additionally, a freshwater storage dam will be established within the Off-LDE for use in the village and facilities over the duration of operations. Sewage will be treated within a sealed wastewater treatment plant and treated effluent will be discharged of via sprinkler system. Mitigation measures will include the following:

- any open water storage (temporary features): fauna egress will be provided; and
- freshwater storage dam (duration of operations): fencing will be installed around the perimeter of the storage dam within the Off-LDE. Waterbird deterrents will be considered if required.

Based on the implementation of mitigation measures to limit the potential impacts of fauna entrapment, the EPA objective for Terrestrial Fauna will be met. Monitoring will be conducted from the inception of the Proposal and corrective actions implemented if required.

7.6.10 Road strike - Loss of individuals including species of significance

The Proposal will involve the construction of roads which will lead to the potential for road strike of fauna. Road strike is related to behaviour of species, traffic volume and vehicle speed (van der Ree *et al.* 2008). Although there is the potential for road strike to occur anywhere where vehicles will be in operation, the primary activity with potential to lead to road strike is along the proposed haul road within the NIDE.

Road strike typically only involves individuals; however, the cumulative effect over time can be considerable (Gleeson and Gleeson 2012). Additionally, fauna deaths can lead to increased activity of scavenging predators (primarily introduced species) which may have indirect impacts on fauna and species of significance (Dickman 1996) (discussed separately under Section 7.6.12). Collisions with animals are more likely to occur at night (Rowden *et al.* 2008). A number of significant fauna species occupy the NIDE and are vulnerable to road strike, in particular the Night Parrot, Great Desert Skink and the Greater Bilby which are all nocturnal species. These species have potential to be struck by operational vehicles and local traffic.

The potential loss of individuals will primarily be mitigated through restricting haulage operations to daylight hours; however, it is acknowledged that local traffic may still result in road strike, including significant fauna. Road access be restricted to operational traffic and local aboriginal communities.

In addition to the mitigation summarised above, Agrimin have developed a CEMP and a TFEMP to assist with the implementation of the mitigation hierarchy for the Proposal.

Based on the implementation of mitigation measures to limit the impacts of road strike on fauna, the EPA objective for Terrestrial Fauna will be met.

7.6.11 Altered fire regimes - Loss of important habitat for significant fauna

Fire may impact fauna via direct contact, or indirectly by long-term habitat modification brought about by altered fire frequency and intensity (Woinarski *et al.* 2014). Values associated with many habitats lies in the mosaic vegetation structures of fire ages. Too frequent, hot, or extensive fires during hot, dry times of the year can eliminate this mosaic, and reduce the capacity of these habitats to support diverse assemblages of fauna.

Altered fire regimes is listed as a key threatening process for seven of the significant species that have been recorded in the Study Area and have the potential to be impacted by unplanned fire associated with the Proposal. The significant species are:

- Greater Bilby (*Macrotis lagotis*) (Vu, Vu)
- Brush-tailed Mulgara (*Dasycercus blythi*) (P4)
- Night Parrot (*Pezoporus occidentalis*) (En, CR)
- Princess Parrot (*Polytelis alexandrae*) (Vu, P4)
- Striated Grasswren (inland) (*Amytornis striatus striatus*) (P4)
- Australian Painted Snipe (*Rostratula benghalensis*) (En, IA)
- Great Desert Skink (*Liopholis kintorei*) (Vu, Vu)

The development and ongoing operation of the Proposal has the potential to introduce unplanned fire via vehicle movements and/or other Proposal activities such as hot work. Increased access along the NIDE will increase the frequency of other road users and this is likely to increase the incidence of fires.

It is acknowledged that altered fire regimes is a key threatening process for a number of significant species that have been recorded in relatively high abundance in the vicinity of the Proposal. The potential impact of unplanned fires as a result of the Proposal will be mitigated through the implementation of the CEMP and the TFEMP which will primarily include the implementation of an FMP to limit any potential increase in unplanned fires as a result of the Proposal.

In addition to the mitigation summarised above, Agrimin have developed a CEMP and a TFEMP to assist with the implementation of the mitigation hierarchy for the Proposal.

Based on the implementation of mitigation measures to limit the potential for unplanned fires as a result of the Proposal, the EPA objective for Terrestrial Fauna will be met.

7.6.12 Feral predators (cats & foxes) - Increased predation on significant fauna

Feral predators, especially the feral cats and Red Foxes have contributed to the decline and extinction of many species in Australia (Abbott 2002; Burbidge and McKenzie 1989; Ford *et al.* 2001; Short and Smith 1994; Woinarski *et al.* 2014;2015). Feral predators are also likely to negatively impact upon fauna assemblages, in particular on small and medium-sized native vertebrates in Australia (Dickman 1996). With respect to the Proposal, predation by feral animals is listed as a key threatening process for the following significant species that have been recorded in the within the vicinity of the Proposal:

- Greater Bilby (*Macrotis lagotis*) (Vu, Vu)
- Brush-tailed Mulgara (*Dasycercus blythi*) (P4)
- Night Parrot (*Pezoporus occidentalis*) (En, CR)
- Princess Parrot (*Polytelis alexandrae*) (Vu, P4)
- Striated Grasswren (inland) (*Amytornis striatus striatus*) (P4)
- Australian Painted Snipe (*Rostratula benghalensis*) (En, IA)

- Great Desert Skink (*Liopholis kintorei*) (Vu, Vu)
- Northern Marsupial Mole (Notoryctes *typhlops*) (P4)
- Southern Marsupial Mole (*Notoryctes*) (P4)
- Gull-billed Tern (*Sterna nilotica*^) (Mi, IA)

Additionally, when the lake is in flood, the islands on Lake Mackay provide suitable breeding habitat for waterbirds such as the Banded Silt. During these waterbird breeding events, the eggs and chicks are particularly vulnerable to predation.

Feral predators, particularly feral cats are already known to occur within the Proposal area and surrounding region. However, the operation of the Proposal could attract and lead to an increased abundance of feral predators in the vicinity of the Proposal through an increase of available foraging resources. Foraging resources may include access to putrescible wastes and landfill, freshwater sources but may also result from access to carcasses from road strike. While not feral, the Silver Gull is known to predate Banded Stilt chicks during breeding events and have considerable influence on breeding success (Pedler 2017). Silver Gull populations will potentially increase in response to the same foraging resources as feral predators.

The potential impact of an increase in feral predators as a result of the Proposal will be mitigated through the implementation of the CEMP and TFEMP which will include the following measures:

- management of potential feral predator foraging resources (i.e. site landfill);
- implement a feral predator control program manage any potential increase in the prevalence of feral predators as a result of the Proposal; and
- during waterbird surveys, include monitoring of the Silver Gull population and implement management actions if required.

A decision framework for management of Silver Gull predation at banded stilt nesting colonies has been developed by the South Australian Government (DEWNR 2014). In addition to the mitigation summarised above, Agrimin have developed a CEMP and a TFEMP to assist with the implementation of the mitigation hierarchy for the Proposal.

Based on the implementation of mitigation measures to limit an increase in feral predators because of the Proposal, the EPA objective for Terrestrial Fauna will be met.

7.6.13 Weed spread - Increased risk of fire, reduced native vegetation cover/ alteration of fauna habitat

Weed invasion is widely recognised as having a negative impact on fauna species, as it can fundamentally alter the composition and structure of native vegetation communities (Cowie and Werner 1993; Gordon 1998). In the extreme, entire ecosystems can be modified directly (Sodhi and Ehrlich 2010), and indirectly through increase fuel loads which in-turn alter the local fire regime (Miller *et al.* 2010).

Habitats within the Proposal area are currently not heavily affected by weed invasion, with no recorded invasive species in all areas aside from the NIDE. Some scattered weeds with restricted spread occur in the NIDE, and Buffel Grass currently occurs along the Tanami track; these may become a source of proliferation. Weed species may be spread within the Proposal area via machinery/ mobile equipment during construction and during operations.

The potential indirect impact on fauna through the potential introduction and spread of weed species as a result of the Proposal will be mitigated through the implementation of the CEMP and the TFEMP which will primarily include the following:

- implement a weed management strategy to prevent the spread of existing weed species and the establishment of new weeds;
- eradicate weed infestations detected during inspections; and
- avoid the introduction/spread of weeds by conducting quarantine/inspections/hygiene measures of any machinery (particularly for earthworks) entering the Proposal area.

Based on the implementation of mitigation measures to limit the potential for the introduction and spread of weeds because of the Proposal, the EPA objective for Terrestrial Fauna will be met.

7.6.14 Island habitats – direct and indirect impacts

There are 271 islands on the lake, ranging from small (<100 ha, dominated by chenopods) to landscape scale (>2,000 ha, with dunes, spinifex shrubland and woodland plains, chenopod margins and claypans/drainage features) (Stantec 2021b). The habitats on the islands have been described and delineated as comprising four fauna habitats: Lake margin, Spinifex sandplain, Dunefield, and Saline flats and depressions (Appendix G.1). All of these habitats are well represented in the vicinity of Lake Mackay (Section 7.6.1): Lake margin habitat is present around most islands and around the perimeter of Lake Mackay, Saline flats and depressions occur on the islands and south of the lake in the swales between dunes, while both the Spinifex sandplain and Dunefield are well represented throughout the Study Area and regional surrounds.

Development of the Proposal has the potential to result in direct and indirect impacts to fauna and fauna habitats on the islands (See Section 7.6.5 for separate discussion on waterbird breeding habitat). Potential direct impacts could occur through the construction of trenches and infrastructure on lake during operations. At closure the southern feeder trench will be breached and BMU trenches allowed to naturally infill, a process likely to occur within approximately 10 years (based on field observations of test trenches). These potential direct impacts will be mitigated through the exclusion of islands from the Proposal area. In total these islands excluded from the Proposal area make up 20,119 ha.

Development of the Proposal also has the potential to result in indirect impacts such as changes to hydrology which could inadvertently result in the flooding of some island habitat or drawdown which could impact riparian vegetation. These potential impacts to habitats as a result of changes in hydrology and drawdown will be mitigated through the establishment of buffers around each of the islands (in addition to exclusion from the Proposal area). The sizes of the buffer zones and the number of islands in each category are summarised below and rational provided within Appendix I.10:

- Landform islands (3 islands in total) – buffer size will be 500 m.
- Intermediate and Large islands (52 islands in total) – buffer size will be 250 m.
- Small islands (216 islands in total) – buffer size will be 100 m.

Details on the interaction of groundwater drawdown within the lake sediment and the area of influence is provided within the groundwater section of Inland Waters (Section 9). However, a brief summary is provided below to provide context within this section. Groundwater salinity within the lake sediment is hypersaline, typically ~250,000 mg/L. Baseline groundwater levels range from 0.4 to 0.7 mbgl within the lake bed sediments, and from 3.4 to 4.0 mbgl beneath the larger islands. During prolonged dry conditions, a decrease of up to 0.2 mbgl was recorded within the lake bed sediments, while a reduction of up to 0.6 mbgl was observed beneath the larger islands. Potential groundwater-dependent vegetation is not anticipated to be dependent upon the hypersaline groundwater; however, there may be some interaction with lower salinity water, that overlay the hypersaline layer (Section 9). Potentially groundwater-dependent vegetation known to occur on the islands includes *Allocasuarina decaisneana* and *Melaleuca glomerata*.

Groundwater drawdown from brine abstraction within the lake bed sediments (up to 100 GL/a) will be progressive over the LoM. The construction of the BMUs will be staged over 17 years and allow for adaptive management of potential impacts. Generally, trench water levels within the BMUs will be drawn down to a sustained level of approximately 3 mbgl within two years after pumping begins, with an associated lowering of groundwater levels occurring laterally away from the trenches. After 10 years of abstraction, drawdown across the BMUs averages 0.52 m to 0.73 m. After 20 years of abstraction, drawdown across the BMUs averages 0.41 m to 0.74 m (Figure 7-24). Detailed modelling is provided within Section 9 (Figure 9-31).

Maximum drawdown of the lake bed sediments beneath the landform islands is expected to range from 1.25 m on the island fringes to less than 0.25 m in the centre of the islands. Most of the islands are subject to drawdown of less than 0.75 m (Figure 7-24; Section 9). Based on this modelling, with buffers in place, drawdown is likely to be minimal at the margins of the islands and negligible beneath the islands (i.e. likely within range of natural variation). Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions. Consequently, based on modelling, vegetation and therefore fauna habitats and dependent fauna should not be impacted by the operation of the Proposal due to groundwater drawdown.

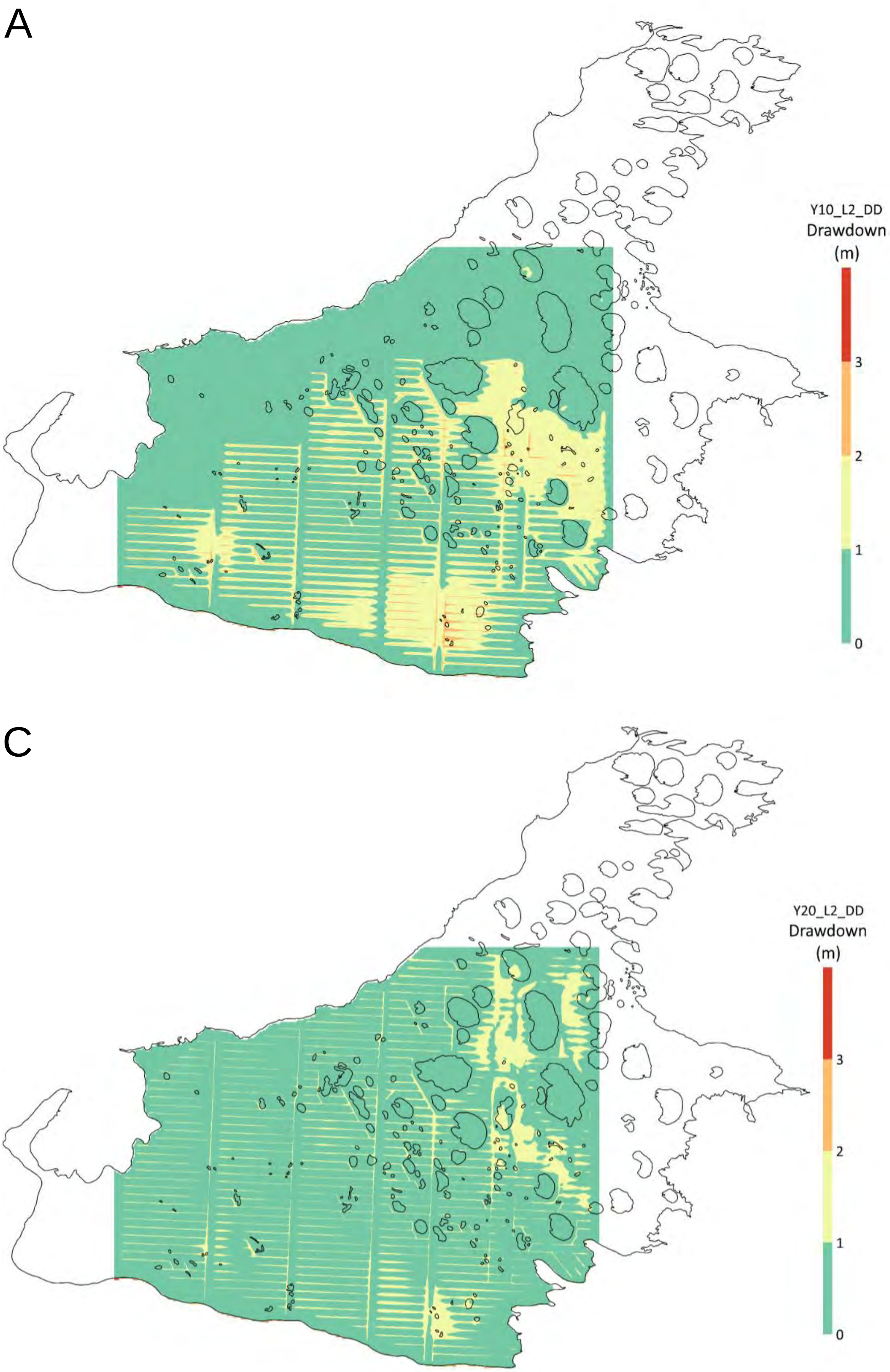

Figure 7-24: (A) 10 years LoM drawdown, (B) 20 years LoM drawdown

Additionally, riparian vegetation, analogues with the Lake margin fauna habitat which fringes the islands and lake margin, is largely dominated by *Tecticornia* species. A recent study by Botanica (2018), has found that the root system of *Tecticornia* species was restricted to the upper horizon of the soil profile (<30 cm). These findings suggest that this vegetation is unlikely to represent groundwater-dependent vegetation and therefore would be unlikely to be impacted from any drawdown that results from the development of the Proposal.

Potential impacts to islands habitats through altered hydrology or significant alteration of groundwater due to Proposal activities shall be mitigated via adaptive management and corrective actions over the staged LoM. Mitigation measures will include:

- compliance with a FVEMP and CEMP;
- development of, and compliance with an IWEMP; and
- development and implementation of a Groundwater Monitoring Procedure.

Based on the implementation of mitigation measures to limit the impacts to island habitats, the EPA objective for Terrestrial Fauna will be met.

7.6.15 Altered Hydrology (excluding lake operations)

Water sources are a limiting factor in arid environments (James et al. 1995). The vast majority of ecosystems in the Great Sandy Desert region do not feature accessible water for any length of time. Areas containing permanent/semi-permanent water sources are comparatively more productive ecosystems which has a direct and indirect benefit to the terrestrial fauna (Murray et al. 2003). Availability of water and nutrients is the primary limiting factor in arid and semi-arid environments with floodplains, flood-outs and riparian fringes being the most productive habitats in the landscape (James et al. 1995).

A total of 11 temporary water sources were identified in the Study Area (Section 7.4.1.4). Most were pools in exposed bedrock, associated with rocky substrates in rocky ridge and gorge (5), minor drainage line (3), and outcropping and stony rise (2) habitats. Three were identified in claypans and claypan mosaic habitat; these comprised large claypans and a soak. Additionally, one permanent water source is located approximately ~250 m west and downstream of the NIDE. Additionally, broad drainage features were found to support the foraging of the Night Parrot presumably due to the presence of the diversity of ephemeral grasses and herbs after periods of rainfall.

Development for the Proposal has the potential to directly impact upon water sources. Additionally, the Proposal has the potential to indirectly affect surface hydrology that could impact upon the availability and quality of water at water sources and / or change the availability of water to drainage habitats.

In total, all 11 temporary water sources occur within the Proposal area; however, none are likely to be directly impacted as they all occur outside the Indicative Footprint. Changes to surface hydrology primarily has potential to occur during construction of the haul road within the NIDE. The haul road is proposed to cross a number of drainage features and could therefore impact upon surface hydrology and affect the quality and availability of water.

The potential indirect impact to surface hydrology as a result of the Proposal will be mitigated through the implementation of the CEMP and the TFEMP which will primarily include the following:

- limit disturbance to the IF and avoiding impacts to the broader DE;
- avoid clearing within drainage features and drainage lines where possible; and
- minimise and manage impacts to natural surface hydrology. In particular, minimise impacts on surface water flows to areas confirmed or with potential to support intermittent water sources (drainage line, saline flats and depressions, claypans and claypan mosaic).

Based on the implementation of mitigation measures to limit the potential for altered hydrology as a result of the Proposal, the EPA objective for Terrestrial Fauna will be met.

7.6.16 Noise and vibration exposure

Noise and vibration can interrupt fauna behaviour (resting, breeding, foraging), lead to area abandonment (e.g. nest or roost sites, reduced population density), interfere with fauna communication if constant (Newport *et al.* 2014).

The development and ongoing operation of the Proposal is likely to generate noise and vibration due to general operation of haul trucks, heavy machinery and vehicles, power generation and the presence of personnel. Some fauna species have greater potential to be affected by noise and vibration. Great Desert Skink may abandon burrows in close proximity to the haul road; however, the only active population known from the Study Area has been avoided through the realignment of the NIDE (Section 7.6.3.3). Other species that may move away from noise and vibration include the Greater Bilby and the Brush-tailed Mulgara. Most species with potential to be impacted by noise and vibration are nocturnal or active at dawn/dusk.

The potential indirect impact of noise and vibration as a result of the Proposal will be mitigated through the implementation of the CEMP and the TFEMP which will primarily include the following:

- implement and enforce speed limits for all traffic, particularly at dawn/dusk and night time in habitats and areas of importance to significant species;
- restrict operations on the haul road to daylight hours. It is acknowledged that there will be an increase in road use by local traffic at all hours; and
- the haul road will initially be unsealed; however, Agrimin plan to bituminise the haul road and this will subsequently reduce noise and vibration.

7.6.17 Cumulative impacts

The cumulative impacts of the Proposal in conjunction with other existing or reasonably foreseeable activities, developments and land uses is recognised as an important consideration for EIA (EPA 2021d).

For context, the Proposal is located in a remote and undeveloped region of WA. The majority of land within the GSD2 sub-bioregion is unallocated crown land, with areas of conservation, mining leases, and Aboriginal lands and reserves, and several small areas of urban development (DotE 2008; Kendrick 2001). Approximately 7% of the Great Sandy Desert bioregion is used for grazing (DotE 2008; Kendrick 2001). Within WA, TAN1 is dominated by unallocated crown land and crown reserves (Graham 2001).

Within the vicinity of the Proposal, existing impacts in the region are largely confined to development associated with the remote Indigenous communities, historical resources exploration and access roads. Land use is predominantly restricted to Indigenous land practices within the respective determinations.

The main impact associated with the Proposal comprises the clearing of fauna habitat. The majority of habitats proposed to be cleared are widely distributed in the broader landscape and bioregion (Section 7.6.1). The only habitat that is not widely distributed outside the Proposal area is the salt lake playa of Lake Mackay. There are no other proposed developments of salt lakes in the Great Sandy Desert or the Tanami bioregions and all other salt lakes in these bioregions are almost completely untouched.

Within WA, impacts from potash projects to ephemeral salt lakes of the arid zone were cumulatively assessed. This was undertaken by intersecting disturbance areas from approved potash projects with areas mapped as lake systems by Geoscience Australia (Geoscience Australia 2006). Features delineated as 'lakes' within the Geoscience Australia layer were filtered to only include features similar to Lake Mackay:

- non-perennial lakes: only ephemeral lakes which have a boom/bust hydroperiod typical of inland salt lakes were included. Permanent lakes were excluded;
- salt lake land systems: only lakes that coincided with salt lake land systems were included. Freshwater lake systems were excluded; and
- Eremaean and South-Western Interzone: only lake systems that occur within the Eremaean and South-Western Interzone botanical provinces were included. These lakes are more likely to have hydroperiods typical of the arid zone which experience irregular and infrequent inundation events similar to Lake Mackay. Lake systems from the southwest and northern interzones were excluded as they would be more likely to have regular seasonal inundation events.

In total, within the Great Sandy Desert, a total of 508,430 ha of lakes meets the criteria outlined above, of which, the proposed disturbance to Lake Mackay comprises 2.6 % (Table 7-15). Within WA, a total of 2,853,793 ha of lakes meets these criteria (Table 7-15). These salt lakes vary from pristine to disturbed with disturbance primarily from agriculture within the Avon Wheatbelt (lakes excluded from analysis as they occur within the southwest botanical zone) and dewatering from resource projects in the Goldfields regions (Timms 2005).

With respect to potash projects, four salt lake projects have been granted formal approval for development. These are:

- Beyondie Sulphate of Potash Project (Kalium Lakes Potash): Approval June 2019;
- Lake Disappointment Potash Project (Reward Minerals): Approval June 2020;
- Lake Wells Potash Project (Australian Potash Limited): Approval February 2021; and
- Lake Way Sulphate of Potash Project (Salt Lake Potash): Approval April 2021.

Within WA, the proposed disturbance from this Proposal comprises 0.5 % of the extent of salt lakes. The portion of Lake Mackay within the Proposal area comprises 7.6% of the extent of salt lakes by area in WA. Cumulative impacts from all approved salt lake potash projects and this Proposal will result in a disturbance comprising 0.9 % of the total extent of salt lake habitat within WA (Table 7-15, Figure 7-25). This will result in potash projects (based on proposal area) operating on 9.5 % of salt lakes by area within WA.

There are no other salt lake projects in the Great Sandy Desert or Tanami bioregions and the region is relatively unimpacted from human development. Consequently, any cumulative impacts in the region beyond those outlined for the Proposal are anticipated to be minimal. Additionally, within the broader context, disturbance from potash projects comprise only a small proportion of salt lakes by area in WA.

Table 7-15: Ephemeral salt lakes of the arid zone and their extent within WA with respect to this Proposal and other approved potash proposals.

Bioregion	Bioregion Code	Extent (ha)	Salt Lake Potash Proposals*	Extent within the Study Area		Extent within Proposal Area		Extent within the Indicative Footprint	
				hectares	%	hectares	%	hectares	%
Carnegie	CAR	203,655							
Central Ranges	CER	4,988							
Coolgardie	COO	502,958							
Gascoyne	GAS	235,007							
Gibson Desert	GID	70,165							
Great Sandy Desert	GSD	508,430	Mackay Sulphate of Potash Project (this Proposal)	243,271	47.8%	216,333	42.5%	13,363	2.6%
Great Victoria Desert	GVD	191,907	Lake Wells Potash Project	10,301	5.4%	4,100	2.1%	2,180	1.1%
Hampton	HAM	98							
Little Sandy Desert	LSD	199,150	Beyondie Sulphate of Potash Project	3,225**	1.6%	^	^	197**	0.1%
			Lake Disappointment Potash Project	134,521	67.5%	35,934	18.0%	7,198	3.6%
Murchison	MUR	758,362	Lake Way Sulphate of Potash Project	16,867	2.2%	13,422	1.8%	2,549	0.3%
Nullarbor	NUL	43,914							
Pilbara	PIL	3,070							
Tanami	TAN	8,263							
Yalgoo	YAL	123,826							
Total		2,853,793	-	408,185	14.3%	269,789	9.5%	25,487	0.9%

*Note: * indicates salt lake habitat extent as presented within each respective ERD; ** inidfctes combined 'salt lake playa' and 'lake margin' habitat; ^ indicaytes not provided.*

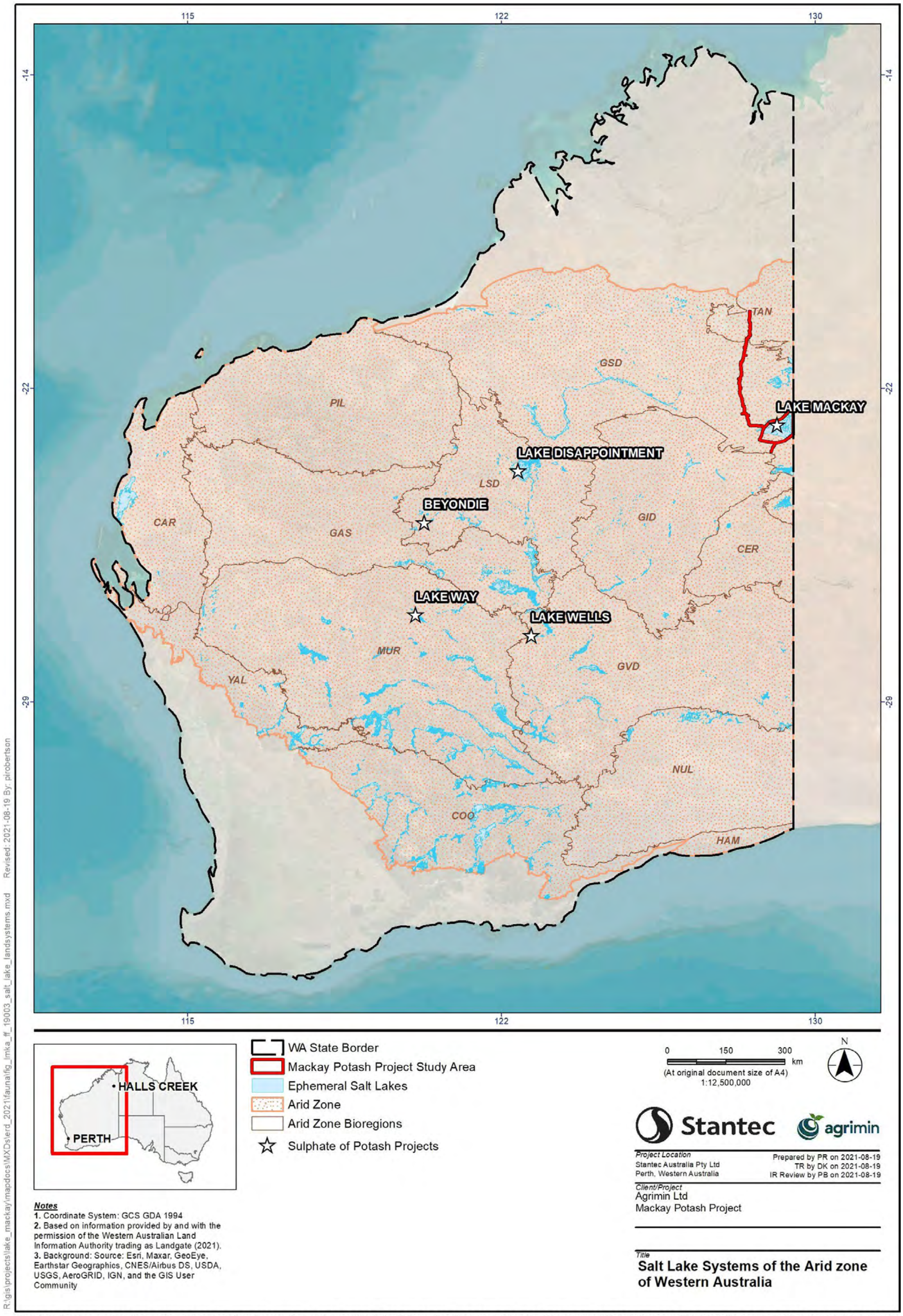

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Figure 7-25: : Ephemeral salt lakes of the arid zone and their extent within WA

7.7 Predicted Outcome

The Proposal is expected to result in the unavoidable loss of potential fauna habitat for significant fauna species as a result of clearing activities. Agrimin considers that scale of direct impacts to habitat types for significant fauna species including migratory waterbirds, are unlikely to be of high significance. In total, a relatively small percentage of the identified habitats for significance fauna species and waterbirds will be impacted by the Proposal.

The Proposal is expected to result in the unavoidable loss of significant fauna species in particular key habitat features such as that support individuals of Greater Bilby through the direct removal of burrows and foraging habitats. Although a number of burrows for the Greater Bilby will be directly impacted, burrows and foraging habitats are known to occur extensively throughout the Proposal area and surrounds. The species high mobility, low site fidelity and the ability to traverse large areas within a 24-hour period, supports Agrimin's view that any loss of burrow habitat is not expected to affect the conservation status of the species or result in permanent or irreversible impacts to the viability, or decline of the species at a local or population level.

Potential impacts to the Yagga Yagga population of Great Desert Skink were able to be mitigated by proponent-led avoidance measures including realigning the NIDE corridor. The population which exceeds 64 active burrows was better defined through additional targeted survey work, and the NIDE was realigned so that all active burrows associated with the population were avoided with a buffer of 300 m.

Additionally, to minimise the direct, indirect, and cumulative impacts to acceptable levels, Agrimin has prepared a CEMP and TFEMP to address these potential impacts, which includes the following key management actions:

- pre-clearance surveys of prospective habitat for the Great Desert Skink and Greater Bilby, to ensure that burrows abandoned and/or avoided where practicable;
- speed limits and rrestrict road haulage operations to daylight hours; and
- develop a Feral Predator Control Program and Fire Management Procedure and collaborate with Traditional Owners to implement these management measure.

Restricting construction and operation activities to daylight hours along the haul road within the NIDE contributes to reducing the potential likelihood of vehicles strikes and other indirect impacts (i.e. noise, vibration, artificial light) on nocturnal species such as the Great Desert Skink, Night Parrot and Greater Bilby.

A total of 24 migratory bird species (waterbirds and shorebirds) have been recorded regionally within 100 km of the Proposal area. Of these, seven migratory bird species were confirmed from field studies as occurring within the Proposal area and an additional five species was assessed as being likely to occur. However, as impacts from the Proposal will only comprise a small proportion of the habitat (less than 5.5% of the lake playa) for these migratory species during infrequent flood conditions. Therefore, the Proposal is unlikely to have significant residual impact to the ecological functional of Lake Mackay to support these EPBC Act listed migratory bird and migratory shorebird species.

Potential impacts on terrestrial fauna and proposed mitigation measures are outlined in Table 7-10. These potential direct and indirect impacts on terrestrial fauna habitats and populations, are able to be effectively mitigated to meet the EPA objective for the Terrestrial Fauna Factor and are unlikely to result in long term, or significant residual environmental impacts. Some impacts may require monitoring during the early stages of construction/operation to ensure mitigation measures are sufficient.

While no significant residual impact to terrestrial fauna was identified, there is potential for significant residual impact to critical and supporting habitat of the EPBC Act-listed Greater Bilby, Night Parrot and Great Desert Skink as a result of the Proposal. Agrimin are committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).mitigationAgrimin are committed to supporting the conservation of the Night Parrot, and survey work and analysis undertaken as part of the EIA for the Proposal have substantially contributed to understanding the ecology of this species. However, it is acknowledged that there are remaining knowledge gaps, which may better inform conservation management of the Night Parrot across its range. As a result, Agrimin have provisioned two packages of voluntary indirect offsets that have potential for meaningful conservation outcomes for this species, while concurrently supporting Indigenous groups on the associated IPAs. These voluntary indirect offsets are summarised in Section 13 and detailed within Appendix N.

Based on the implementation of all mitigation measures to limit the impact of the Proposal on the environment, the EPA objective for Terrestrial Fauna will be met.

8. Subterranean Fauna

8.1 EPA Objectives

The EPA's environmental objective for subterranean fauna is "*To protect subterranean fauna so that biological diversity and ecological integrity are maintained*' (EPA 2016d).

8.2 Policy and Guidance

The State and Commonwealth legislative instruments, policy, guidelines, and advice relevant to the Proposal and their application are presented below. Table 8-1 also summarises the scope of each guide as relevant to the Proposal.

Table 8-1: Legislative instruments, policies and guidelines relevant to subterranean fauna impact assessment

Legislative instrument	
Biodiversity Conservation Act 2016	
Biosecurity and Agricultural Management Act 2007	
Environment Protection and Biodiversity Conservation Act 1999	
Environmental Protection Act 1986	
EPA policy or guidance	**Considerations**
Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA.	This Statement provides guidance to ensure that a Proposal addresses the holistic view of its environmental impact relevant to the EP Act.
Environmental Protection Authority. (EPA 2016d). Environmental Factor Guideline – Subterranean Fauna.	Surveys and information provided for the Proposal were carried out in accordance with the requirements as set out in this guideline.
Environmental Protection Authority. (EPA 2021e). Technical guidance – Subterranean fauna surveys for environmental impact assessment	The EPA's advice for conducting surveys, particularly focusing on the design and methodology, for subterranean fauna.
Environmental Protection Authority. (EPA 2021c). How to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans: Instructions.	A guide for preparing Environmental Management Plans that may be required in conjunction with the Proposal.
Other policy or guidance	**Considerations**
ANZECC & ARMCANZ. (ANZECC & ARMCANZ 2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1, The Guidelines (Chapters 1-7).	Used to assess and subsequently manage ambient water quality in natural and semi-natural water resources.
Water Quality Australia. (Water Quality Australia 2018). Australian & New Zealand Guidelines (ANZG) for Fresh & Marine Water Quality.	Detailed guidelines for implementing adequate management of water quality in natural and semi-natural water resources.

8.3 Overview of studies

Numerous studies (more than 30) have been undertaken to understand the Subterranean Fauna factor for the Proposal, across the geology, groundwater and subterranean fauna disciplines (Table 8-2). The studies span from 2017 to 2021 and have included sampling of the lake and islands (On-LDE) and the SIDE, the results of which have been collated into technical reports and memorandums (Appendix H, Appendix I). Groundwater and subterranean fauna sampling sites are presented in Figure 8-1.

The remoteness of the Proposal area has involved significant logistical challenges associated with mobilising heavy equipment across the lake and islands for drilling programs. The subsequent sections provide detailed information on the studies undertaken for each discipline relating to the receiving environment and summarise the key findings in order to understand the Subterranean Fauna factor for the Proposal.

Table 8-2: Summary of studies relating to Subterranean Fauna

Receiving Environment	Number of Reports/Memos	Description
Geology	10*	Technical studies characterising lake and regional scale geology
Groundwater	21*	Technical studies characterising lake bed sediments, off-LDE and regional hydrogeology
Subterranean Fauna	3	Technical studies characterising subterranean fauna communities of the Proposal area, detailed in Table 8-9.

*Note: * indicates some reports and technical memorandums overlap.*

8.3.1 Survey Limitations

Several subterranean fauna field surveys have been undertaken at Lake Mackay, targeting the lake, islands and SIDE. While most of the habitat associated with these areas is not prospective for subterranean fauna, calcareous geology, predominantly on the landform islands, appears to support stygal and potentially troglofauna communities. For stygofauna, the total survey effort of 79 samples in the Study Area, which includes the Proposal area and Southern Regional area, exceeded the guidance for Level 2 surveys (40 samples). The troglofauna survey effort approached or exceeded the guidance for pilot studies (10 to 15 troglofauna samples) in the two areas sampled.

Survey efforts in 2020 were also hindered by COVID-19 travel restrictions, delaying the retrieval of troglofauna traps and preventing additional subterranean fauna survey work from being undertaken in the early part of the year. Specialist taxonomic identification of specimens was also affected by the travel restrictions However, every effort was made to access suitably qualified local specialists to complete morphological identification.

There has also been no survey work completed in the NIDE. While there will be minor, temporary water abstraction during construction of the haul road, minor abstraction will occur from a limited number of bores along the haul road. However, this is not expected to be significant enough to warrant subterranean fauna surveys and therefore is not discussed further in this section.

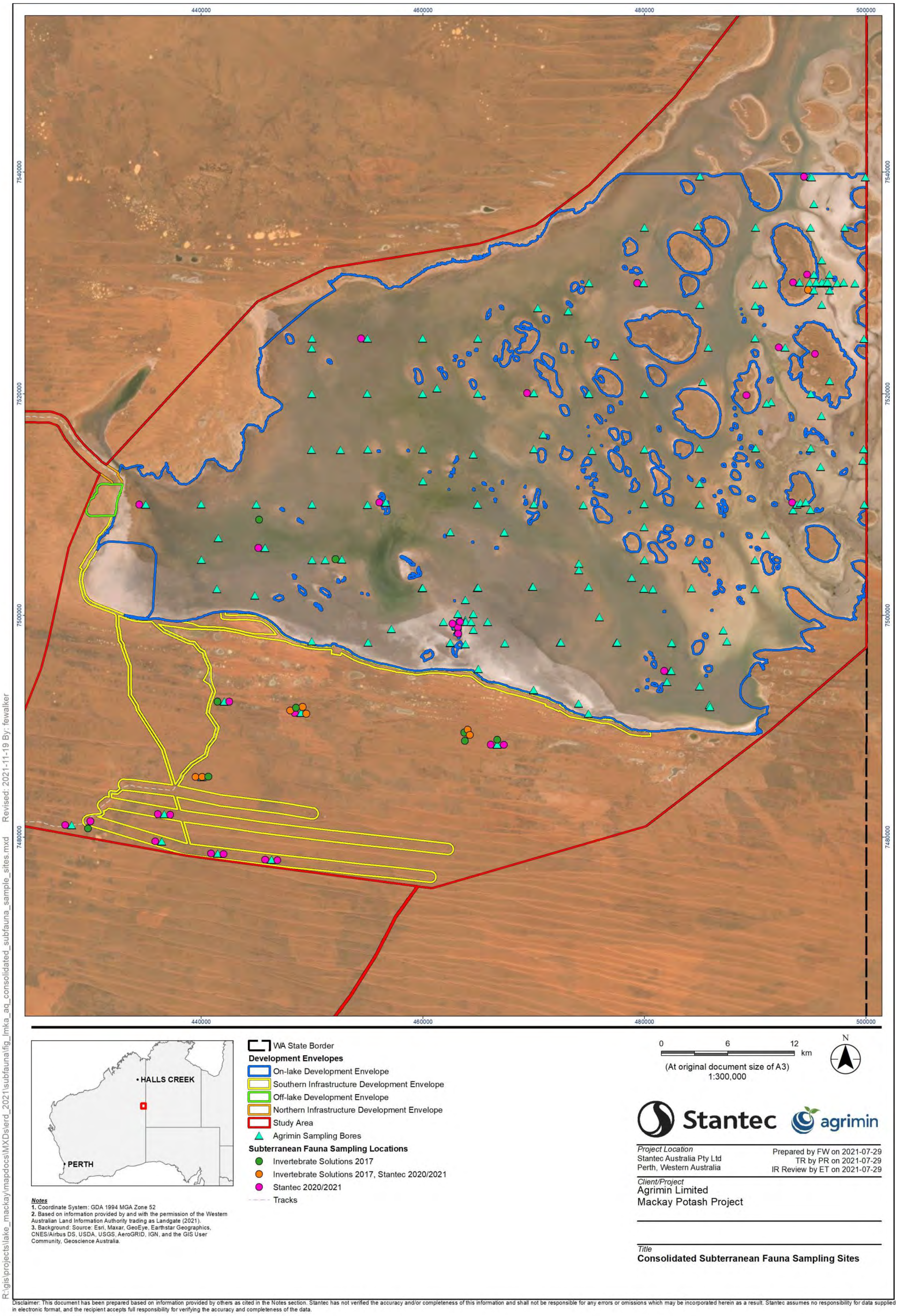

Figure 8-1: Location of groundwater and subterranean fauna sampling bores on Lake Mackay and islands (On-LDE), and within the southern region (SIDE)

8.4 Receiving environment

8.4.1 Geology

Numerous exploration field work programs have been carried out between 2011 and 2020, to investigate and characterise the geology of the Proposal area. The technical memorandums and reports based on these programs are summarised in Table 8-3 and, where available, are presented in Appendix I.12 to Appendix I.20. Initial exploration work on the lake comprised shallow drilling programs carried out between 2011 and 2015. Following Agrimin's acquisition in 2015, extensive exploration has been undertaken focusing on the geology of the lake bed sediments, with targeted island drilling in 2019. In 2017 and 2019, exploration activities targeted potential process water supply south of the lake (SIDE), which followed a review of historic regional drilling data. Geology of the Proposal area and Study Area more broadly, is presented in Figure 8-2.

Table 8-3: Summary of geological data and studies

Reference	Area	Title
Groundwater Exploration Services 2016	On-LDE	Lake Mackay Preliminary Groundwater Modelling Study
Hydrominex Geoscience 2017	On-LDE	Technical Report on the Lake Mackay Potash Project Western Australia
Advisian 2018	On-LDE	Prefeasibility Study Chapter 6: Hydrological and Hydrogeological Modelling
Knight Piesold 2018	On-LDE	Hydrogeological Modelling for the Mackay SOP Proposal Prefeasibility Study
Agrimin 2020	On-LDE, Off-LDE	Definitive Feasibility Study
Agrimin 2020	On-LDE	Island Drilling Memorandum
Agrimin 2020	On-LDE	Infill Drilling Memorandum
CDM Smith 2020	SIDE	Water Supply Assessment for Mackay SOP Project
Stantec 2020	On-LDE	Islands Characterisation Memorandum
Agrimin 2020	On-LDE	Shelby Tube Sampler Memorandum

8.4.1.1 Lake geology

The surface of Lake Mackay typically comprises a thin crust (<5 mm), of evaporitic material, predominantly halite. In the west of the lake halite coverage is more extensive than in the east, where it becomes patchy and interspersed with increasing proportions of gypsum and windblown quartz sands. The western halite crust typically forms a near horizontal surface, whereas the lake bed surface in the east is noticeably more undulating, and contains air filled vugs/void spaces. The halite crust has been observed to dissolve rapidly after rainfall and reprecipitate when flood water evaporates.

Across much of the lake surface, the halite crust is underlain by variably decomposed organic material, which can be up to several cm thick and typically occurs at surface or within approximately 5 cm of surface. This organic layer is often exposed in patches where surficial halite is not present. This organic material typically has a high moisture content and is black in colour. The relatively thin crust of halite and organics is underlain by a variable lake bed sequence which displays distinct characteristics east-west across the lake area.

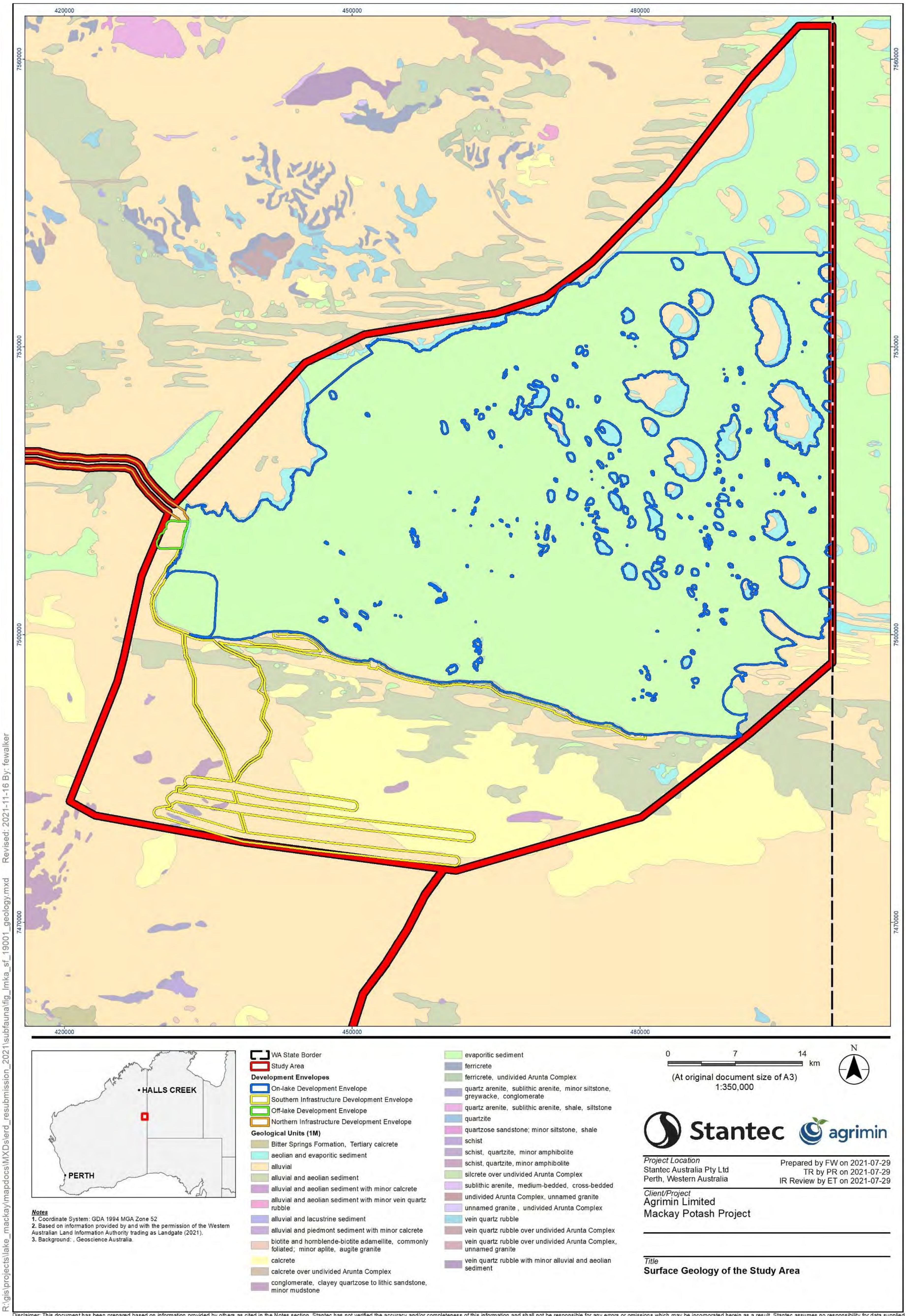

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Figure 8-2: Surface geology of the Study Area

The remaining lacustrine or lake bed sediments sequence of Lake Mackay is characterised into three broad lithological units, including:

- fine to coarse grained gypsum sand, with an approximate thickness of 1 m that varies laterally east-west across the lake. Gypsum sand horizons are noticeably thicker in the east. This unit progressively grades downward into clayey and silty sand approximately 3 m below ground level (mbgl);
- sandy and silty clay, containing discrete interbedded layers of evaporites (including granular/crystalline gypsum, halite and calcite), and organics continues to around 150 mbgl. The density of the clays increases with depth; and
- a palaeochannel unit in the southern section of the lake, comprising sands and gravels, with minor silt and clay continues to a known depth of 211 mbgl. The upper part of this unit contains discrete detrital iron, lignites and evaporite horizons. The lake bed sediments are unconformably underlain by what is interpreted to be a highly weathered pelitic bedrock.

The shallow lake bed sediments are the primary geological unit of interest within the On-LDE and vary in composition from east to west due to varying depositional processes (Table 8-4). Island and SIDE geologies are described separately in Section 8.4.1.2 and Section 8.4.1.3, respectively, due to their unique characteristics.

Table 8-4: Lake lithology descriptions

Lithology	Description
Surficial Halite	Surficial halite layer occurs as either; <5mm white crystalline evaporite layer in the western and central areas of the lake. In the east the surficial halite is intermixed with pale brown fine to medium gypsum sand and forms a brittle crust with many voids and vugs.
Organic Material	A dark grey organic layer (preserved material) ranges in thickness from 3 mm to 30 mm. This layer lies immediately below the salt crust in the western and central areas of the lake and is exposed at the surface in depressions where the surficial halite crust has been dissolved. In the east, this layer occurs at variable depths immediately above the water table and first occurrence of clay.
Gypsum Sand	Gypsum sand is widespread across the lake and occurs in the western and central areas as interbedded layers in silt and clay layers. Gypsum sand in the eastern region of the lake immediately underlies the brittle crust makes up a major portion of the sediment profile. It varies from fine to coarse and is friable and unconsolidated.
Red Brown Clay	Red brown clay with interspersed bands of crystalline gypsum sand is the dominant lithology on the lake. It occurs within 0.1m of the surface in the west and up to 1.0 m from the surface in the east.
Crystalline Gypsum	Crystalline gypsum occurs as both interspersed crystals <50 mm in size at the lake water table and large laterally continuous horizons of consolidated crystal growths >100 mm at between 3 to 6 m depth, primarily encountered in the eastern region of the lake.

8.4.1.2 Island geology

Lake Mackay is host to more than 270 islands within the On-LDE. These range from small unvegetated formations to large formations that host extensive sand dunes. The islands range from less than 1 m in height to more than 13.5 m, with the larger islands providing the greatest topographic relief (Appendix 1.10). Drilling investigations completed on six lake islands (Appendix 1.10) confirmed that they are surficial features of variable thickness underlain by lake bed sediments and are not linked to another subsurface geologic feature.

The lake islands are composed of unconsolidated aeolian sand at surface which is underlain by calcrete and gypsiferous sand. Clay content increases with depth and typically marks the transition from island sediment to the lake bed sediments. The thickness of the island sequences varies depending on the size of the island and topographical elevation.

8.4.1.3 Southern Regional geology

Within the SIDE, south of Lake Mackay, exploration has focussed on identifying a processing water supply. The geology in this region comprises rocks of the Amadeus Basin. The western portion of the SIDE is dominated by the Angas Hills Formation consists of interbedded pebble and cobble conglomerate, sandstone, pebbly sandstone and siltstone with a matrix of clayey sandstone and minor mudstone. The eastern portion of the SIDE hosts a sequence of sandstone, siltstone and shale and is consistent with the Carnegie/Pertatataka Formation.

These are overlain by tertiary palaeochannel deposits of silty clay and clay over sand in some areas, and broad alluvial cover of Neogene age predominantly comprising a clayey sandstone, sand, quartz and silt/clay matrix. Historic logs from exploration targeting uranium and iron oxide copper gold mineralisation immediately east of the SIDE (Southern Regional area) identified clay and sand sequences overlain by a laterally extensive silcrete layer at 40 m and a similarly extensive calcrete layer at the surface (Brooker and Fulton 2016).

8.4.2 Groundwater

A summary of the main groundwater related investigations completed across the On-LDE, Off-LDE, SIDE and Southern Regional area are presented in Table 8-5. Numerous field programs have targeted the surficial lake bed sediments to determine the hydrogeological properties. As part of this, drilling, utilising various methods, has been completed across the lake, with over 250 bores installed, many of which are used for groundwater monitoring. Several bores have been equipped with data loggers, collecting up to five years of continuous water level data. In addition, trial trenches (up to 6 m in depth) have been excavated at 23 locations across the On-LDE, to understand groundwater properties, including hydraulic ranges, groundwater quality, groundwater drawdown and potential pumping rates from the lake bed sediments. Groundwater sampling and monitoring was also completed as part of drilling programs on the islands and for the SIDE (process water supply), while Southern Regional bore data was collected as part of subterranean fauna surveys.

The results of these extensive investigations were used to develop an integrated groundwater flow and solute transport model for Lake Mackay, and a conceptual schematic cross section of groundwater associated with the playa and islands (Figure 8-3). Recharge, a key parameter investigated, is predominantly from direct rainfall onto the lake surface. Surface water contributions from the immediate catchment areas surrounding the lake are infrequent and only occur as a result of major rainfall events. As the lake is a terminal drainage point for the surrounding watershed, discharge is solely from evaporation and evapotranspiration.

Table 8-5: Summary of key groundwater data and studies

Reference	Area	Title
Groundwater Exploration Services 2016	On-LDE	Lake Mackay Preliminary Groundwater Modelling Study
Hydrorminex Geoscience 2017	On-LDE	Technical Report on the Lake Mackay Potash Project Western Australia
Advisian 2018	On-LDE	Prefeasibility Study Chapter 6: Hydrological and Hydrogeological Modelling
Knight Piesold 2018	On-LDE	Hydrogeological Modelling for the Mackay SOP Proposal Prefeasibility Study
Agrimin 2020	On-LDE	Closed Lysimeter Testing Memorandum
Agrimin 2020	On-LDE, Off-LDE	Definitive Feasibility Study
Agrimin 2020	On-LDE	Infill Drilling Memorandum
Agrimin 2020	On-LDE	Infiltration Testing Memorandum
Agrimin 2020	On-LDE	Island Drilling Memorandum
Agrimin 2020	On-LDE	Regional Lake Groundwater Levels Memorandum
Agrimin 2020	On-LDE	Shelby Tube Sampler Memorandum
CDM Smith 2020	SIDE	Water Supply Assessment for Mackay SOP Project
Stantec 2020	On-LDE	Trench Pump Test Analysis Report

Reference	Area	Title
Agrimin 2020	On-LDE	Island Impacts Groundwater Memorandum
Stantec 2020	On-LDE	Integrated Groundwater Flow and Solute Transport Model Report
Agrimin 2020	On-LDE	Long Term Pump Test Memorandum
Stantec 2020	On-LDE	Lake Mackay Stage 1 and Stage 2 Surface Water Assessment
Stantec 2020	On-LDE	Islands Characterisation Memorandum
Stantec 2020	On-LDE	Recharge Assessment Memorandum
Stantec 2020	On-LDE	Recharge Lab Assessment Memorandum
Agrimin 2021	On-LDE, SIDE	Groundwater Sampling and Analysis Memorandum

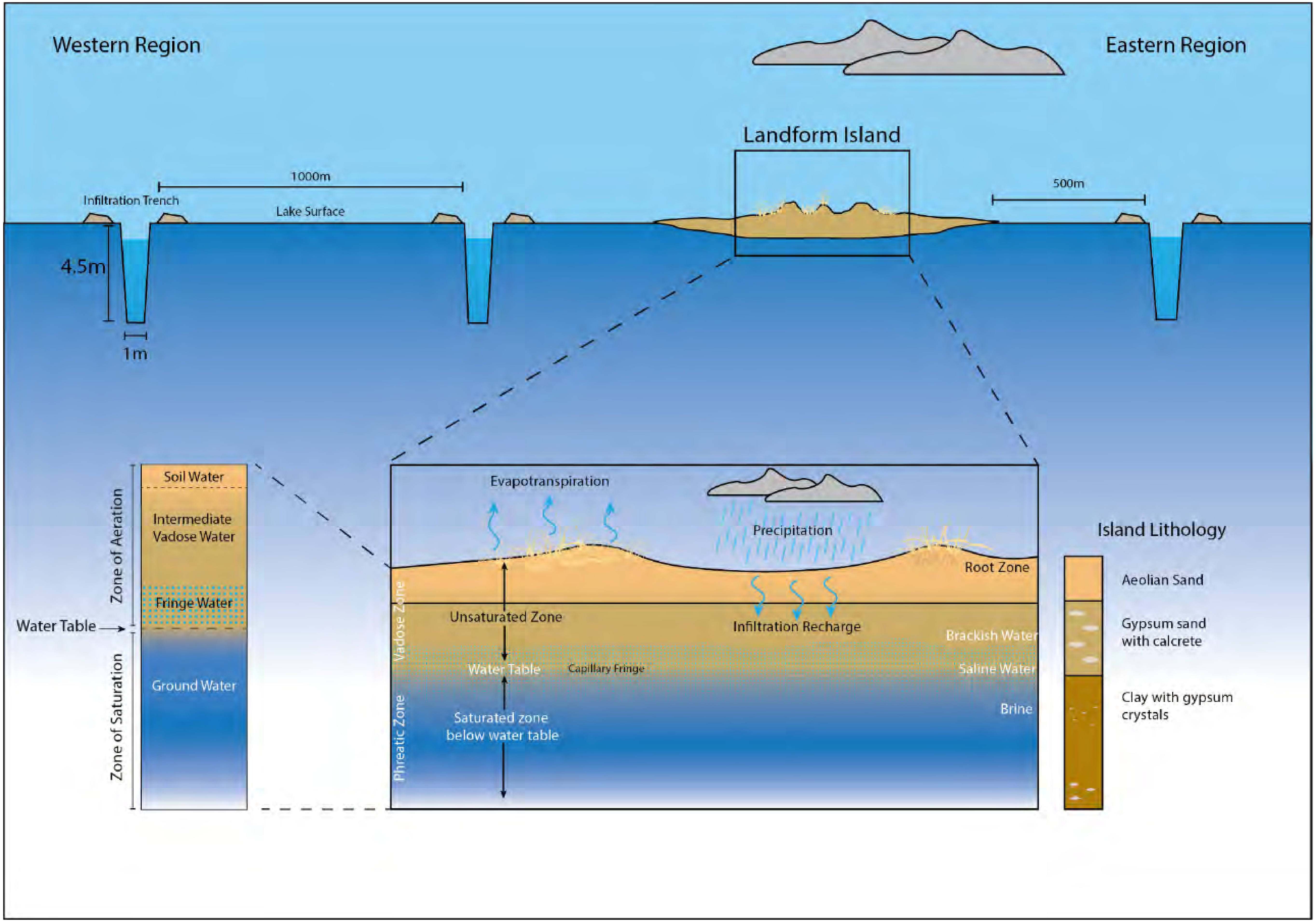

Figure 8-3: Conceptual schematic cross section of Lake Mackay and islands

8.4.2.1 Lake groundwater

Groundwater level monitoring across Lake Mackay, including monitoring of test trenches and piezometers, shows seasonal fluctuations ranging from 0.4 to 0.7 mbgl, with an average fluctuation of 0.3 m. Groundwater levels at monitoring bores also tend to increase rapidly in response to the first major rainfall event of the wet season. Levels subsequently decrease, and during extended dry conditions show an overall reduction across the lake (Appendix I.16).

Groundwater sampling and monitoring at Lake Mackay (Appendix I.20) indicates the lake bed sediments is characterised by circumneutral pH (mean of 6.6), with naturally elevated nitrate concentrations (Table 8-6). Groundwater salinity of the lake bed sediments varies across the lake, although is typically greater than 200,000 mg/L, with a maximum of approximately 340,000 mg/L (Table 8-6). In contrast, the major ionic constituents of the lake bed sediments are consistent, comprising a cation dominance of Na>K>Mg>Ca, and an anion sequence of $Cl>SO_4>HCO_3$ (Table 8-6). Background concentrations of Na and Cl are approximately 100,000 mg/L and 145,000 mg/L, respectively, while potassium concentrations range from 3,000 mg/L to 3,350 mg/L (Appendix I.13).

Table 8-6: Summary of groundwater quality from lake bed sediments from monitoring bores and trenches.

Parameter	Records	Min.	Mean	Median	Max.
pH (units)	32	5.34	6.63	6.68	7.22
Salinity (TDS)	349	6,569	214,678	228,456	339,995
Magnesium	213	57	2,551	2,240	6,790
Calcium	213	140	598	602	1,220
Sodium	213	6,823	88,786	89,062	134,348
Potassium	213	390	3,088	3,080	9,640
Chloride	213	164	131,987	132,050	186,950
Sulphate	213	3,870	19,688	19,325	60,900
Bicarbonate	28	10	37	20	210
Nitrates	32	4	31	11	151

Note: all parameters are mg/L, except where shown.

8.4.2.2 Island groundwater

The depth to groundwater on the islands of Lake Mackay varies, depending on immediate topography, however, is typically less than 5 mbgl (Appendix I.15). Groundwater levels are influenced by a dynamic equilibrium between precipitation, evaporation and evapotranspiration.

The largest landform islands in the eastern portion of the lake also appear to host a lower salinity water, within the porous gypsiferous sands that overlay the clay dominant lake bed sediments (brine). The pH is typically circumneutral (mean 6.9), with naturally elevated nitrate concentrations (Table 8-7). Salinities are typically below 60,0000 mg/L, with an ionic composition dominated by Na and Cl (Table 8-7).

The lower salinity groundwater is likely associated with the infiltration of rainfall into the shallow, permeable aeolian sediment and where present, calcrete outcrops. Seasonal fluctuations in water levels are expected on the islands, associated with both temporal water level changes within the aeolian sands and the deeper lake bed sediments.

Data from two bores located on two lake islands do not show the same rapid increase following rainfall. This is attributed to the increased topographical elevation of the islands. Initial data collected from field investigations on one of the landform islands indicate that the island features act as recharge zones to the lake bed sediments below them. Above average rainfall events (>300 mm in one month) are likely to result in significant recharge, saturating the vadose zone and increasing groundwater levels to within 0.6 m of the surface (Appendix I.4). Further studies are planned to characterise the groundwater occurrence of the lake islands.

Table 8-7: Summary of groundwater quality from the islands during drilling

Parameter	Records	Min.	Mean	Median	Max.
pH (units)	2	6.83	6.87	6.87	6.90
Salinity (TDS)	2	41,864	48,988	48,989	56,113
Magnesium	2	373	446	446	520
Calcium	2	1,080	1,135	1,135	1,190
Sodium	2	12,450	14,675	14,675	16,900
Potassium	2	325	418	418	510
Chloride	2	20,425	24,738	24,738	29,050
Sulphate	2	5,295	5,573	5,573	5,850
Bicarbonate	2	40	105	105	170
Nitrates	2	8	38	38	68

Note: all parameters are mg/L, except where shown.

8.4.2.3 Southern Regional groundwater

Groundwater modelling was undertaken within the Southern Regional area, targeting the SIDE, to assess the prospectivity of aquifer units to meet processing water requirements for the Proposal (Appendix I.12). The aquifer units in the area include the alluvial Neogene deposits, Angas Hills Formation and Carnegie Formation. Tertiary palaeochannel clay forms an aquitard, and where present separates aquifers within the Neogene Deposits and Angas Hills Formation. The Carnegie/Pertatataka Formation is an aquitard forming a basement to the overlying effective aquifers (Appendix I.12).

Two prospective aquifer units have been identified in the SIDE between 5.8 and 8.2 mbgl, primarily intercepting the aquifer hosted within the shallow Neogene alluvials. Depth to water table corresponds, ranging between 5.8 m bgl and 8.2 m bgl (Appendix I.12). The units host groundwater characterised by circumneutral pH (mean 7.3), with salinity concentrations ranging from approximately 1,600 mg/L to 6,300 mg/L (Table 8-8). In comparison, bores in the surrounding Southern Regional area range from less than 5,000 mg/L to approximately 47,000 mg/L, with concentrations decreasing with distance from the lake.

Table 8-8: Summary of groundwater quality from the SIDE/Southern Regional area during drilling.

Parameter	Records	Min.	Mean	Median	Max.
pH (units)	3	7.2	7.27	7.3	7.30
Salinity (TDS)	3	1,567	3,465	2,528	6,300
Magnesium	7	35	69	55	180
Calcium	7	55	118	95	264
Sodium	7	350	695	600	1,622
Potassium	7	30	49	40	124
Chloride	7	326	867	950	1,290
Sulphate	7	240	503	390	1,312
Bicarbonate	3	296	345	315	424

Note: all parameters are mg/L, except where shown.

8.4.3 Subterranean Fauna

8.4.3.1 Overview of Studies

There have been three subterranean fauna studies undertaken for the Proposal, which have investigated subterranean fauna values within the Study Area, incorporating the Proposal area and Southern Regional area, aligning with regulatory guidance. A summary of these studies is provided in Table 8-9, with technical reports provided in Appendix H. An overview of the subterranean fauna sampling sites (bores) is shown in Figure 8-4. An initial pilot study was undertaken in 2017, focusing on stygofauna within the surficial calcareous deposit in the Southern Regional area (Table 8-9). This was followed by a Level 1 study, also in 2017, which targeted sites in the Southern Regional area and the playa and islands of Lake Mackay (On-LDE). A third study was undertaken in 2020 and 2021, incorporating five additional subterranean fauna field surveys. This study included sites on the playa and islands of Lake Mackay (On-LDE), within the SIDE Borefield, and Southern Regional area (Table 8-9).

8.4.3.2 Habitat characterisation

8.4.3.2.1 Lake habitat

Low porosity lacustrine deposits such as clay and silt, which host hypersaline groundwater (>100,000 mg/L), comprising the lake bed sediments of Lake Mackay, are considered to have a low prospectivity for subterranean fauna. Although stygofauna and troglofauna can occupy a diverse range of geologies, such as karst, fractured rock, vuggy pisolites and unconsolidated alluvial sediment, their presence is typically dependent on the occurrence of interconnected of sub-surface crevices, fractures and voids, which are absent from low porosity lacustrine sediment (Subterranean Ecology 2010a). This is evident in the core photos of the lake bed sediments at Lake Mackay (Plate 8-1).

In addition to restricting movement, inadequate interconnected void spaces and associated low permeability limit pathways for the infiltration of resources such as oxygen and carbon, key factors influencing subterranean fauna persistence and distribution (Subterranean Ecology 2010a). While stygofauna are known to occur in hypersaline groundwater up to 100,000 mg/L in the northern Yilgarn region, and some species are known to be salt tolerant, the majority of stygofauna appear to be restricted to salinities below 25,000 mg/L (Halse 2018).

8.4.3.2.2 Island habitat

The most prospective subterranean habitat exists on the larger landform islands of Lake Mackay, where calcareous material intercepts the low salinity capillary fringe, although calcrete is not immediately evident in the core photos (Plate 8-2). Calcrete aquifer systems are recognised as providing optimal habitat for stygofauna in the Pilbara and Yilgarn regions of WA, typically hosting more diverse assemblages than regolith or fractured rock aquifers (Halse *et al.* 2004; Humphreys 2006; Humphreys 2008; MWH 2016a;b; Outback Ecology 2014).

The vadose (unsaturated) zone of calcrete units is similarly recognised as important habitat for troglofauna, providing suitably sized and extensively connected crevices and cavities, that remain relatively humid. The latter is an important condition considered to be a key requirement for troglofauna existence (Barranco and Harvey 2008; Bennelongia 2009; Halse *et al.* 2002; MWH 2014; Outback Ecology 2011a; Subterranean Ecology 2008).

8.4.3.2.3 Southern Regional area and SIDE habitat

In WA, studies have shown that alluvial aquifers associated with palaeodrainage channels of the arid and semi-arid zones can contain rich stygofauna (Halse *et al.* 2004; Humphreys 2006; Humphreys 2008; MWH 2016a;b; Outback Ecology 2014) and troglofauna communities (MWH 2014; Outback Ecology 2011; Subterranean Ecology 2008). As opposed to calcrete units, unconsolidated alluvial aquifers provide interstitial habitats between clastic sediment (primary porosity), with coarser sediment supporting a more diverse range of fauna. Greater hydraulic connectivity also increases supply rates of organic carbon, oxygen, and nitrogen, essential for the subterranean lifecycle (Subterranean Ecology 2010).

While the SIDE borefield occurs in the saturated Neogene alluvials hosting fresh to low salinity groundwater, the relatively fine textured lithology is likely to restrict subterranean fauna (Plate 8-3). However, to the northeast of the SIDE and within the Southern Regional area, more prospective subterranean fauna habitat exists within unconfined calcrete and unconsolidated sediment hosting brackish groundwater.

Table 8-9: Summary of subterranean fauna studies for the Proposal

Reference	Title	Date	Survey Effort	Subterranean Fauna Records	Key Findings
Invertebrate Solutions (2017a)	Mackay Potash Project – Pilot Survey for Subterranean Fauna	• May 2017	• Five stygofauna haul samples collected from five sites (bores) in the Southern Regional area • Sampling targeted a surficial calcrete aquifer	• 121 individual stygofauna collected, represented by 10 species from the higher-level taxonomic groups Oligochaeta, Bathynellacea, Ostracoda, Harpacticoida, Cyclopoida and Coleoptera	• Undescribed genera and species (Southern Regional area): ○ *'Mackaynitocrella mouldsi'* ○ *'Mackaycyclops mouldsi'* • Undescribed species (Southern Regional area): ○ *Parapsuedoleptomesochra 'mackay'* ○ *Schizopera 'mackay'* ○ *Atopobathynella* sp. *'mackay'* ○ *Abcandonopsis 'mackay'* ○ *Halicyclops 'mackay'* ○ *Paroster* sp. *'mackay'*
Invertebrate Solutions (2018a)	Mackay Potash Project – Phase 1 Survey for Subterranean Fauna	• November 2017	• Stygofauna ○ Total of 15 stygofauna haul samples collected from 15 sites (bores) ○ 12 samples collected from the Southern Regional area; seven from the surficial calcrete aquifer and five from the deep alluvial aquifer ○ One sample collected from On-LDE islands ○ Two samples collected from the On-LDE playa • Troglofauna ○ Two troglofauna scrapes collected from sites to the south of the lake ○ Six troglofauna litter traps deployed (four retrieved)	• Southern Regional area surficial calcrete ○ 222 individual stygofauna collected, represented by 16 species and four higher level taxonomic groups • On-LDE islands ○ Two species of stygofauna collected from two orders of Copepoda	• Undescribed genera and species (Southern Regional area): ○ *'Mackaycyclops bradleyi'* • Undescribed species (Southern Regional area): ○ *Schizopera 'medifurca'* ○ *Schizopera 'paracooperi'* ○ *Paroster* sp. *'mackay medium'* ○ *Paroster?* sp. *'mackay small'* • Undescribed species (Islands): ○ *Schizopera 'bradleyi'* • No stygofauna recorded from playa or deep alluvial aquifer within the Southern Regional area. No troglofauna recorded.
Appendix H	Mackay Potash Project -Subterranean Fauna Study 2021	• January 2020 (stygofauna and troglofauna litter trap deployment) • May/June 2020 (stygofauna only) • August 2020 (stygofauna and troglofauna litter trap deployment) • October 2020 (stygofauna only) • April 2021 (stygofauna only)	• Stygofauna ○ Total of 59 stygofauna samples (58 haul samples and one hand auger sample) collected from 28 sites (bores) ○ 24 samples collected from 11 sites (bores) On-LDE (islands) ○ Nine samples collected from eight sites (bores) within the On-LDE (playa) ○ 12 samples collected from four sites (bores) within the SIDE ○ 14 samples collected from five sites (bores) within the Southern Regional area • Troglofauna ○ Seven litter traps deployed at four sites in the SIDE ○ 13 litter traps deployed at seven sites in the Southern Regional area	• Southern Regional area surficial calcrete ○ 35 individual stygofauna collected, represented by at least two species from two higher level taxonomic groups • SIDE ○ One species of potential stygofauna taxon Enchytraeidae sp. (two individuals) • Islands ○ Three stygofauna species (Copepoda; *Halicyclops kieferi, Schizopera* ?'bradleyi') and one potential stygofauna (Enchytraeidae sp.) collected ○ One potential troglofauna, Projapygidae-OES3	• Confirmation of diverse and unique stygofauna community present within Southern Regional area (surficial calcrete) • Stygofauna confirmed from four islands (low to moderate abundance and low diversity) • Potential troglofauna recorded from one landform island • One potential stygofauna recorded from the SIDE, though not considered to represent a significant stygofauna community • No stygofauna recorded from On-LDE playa

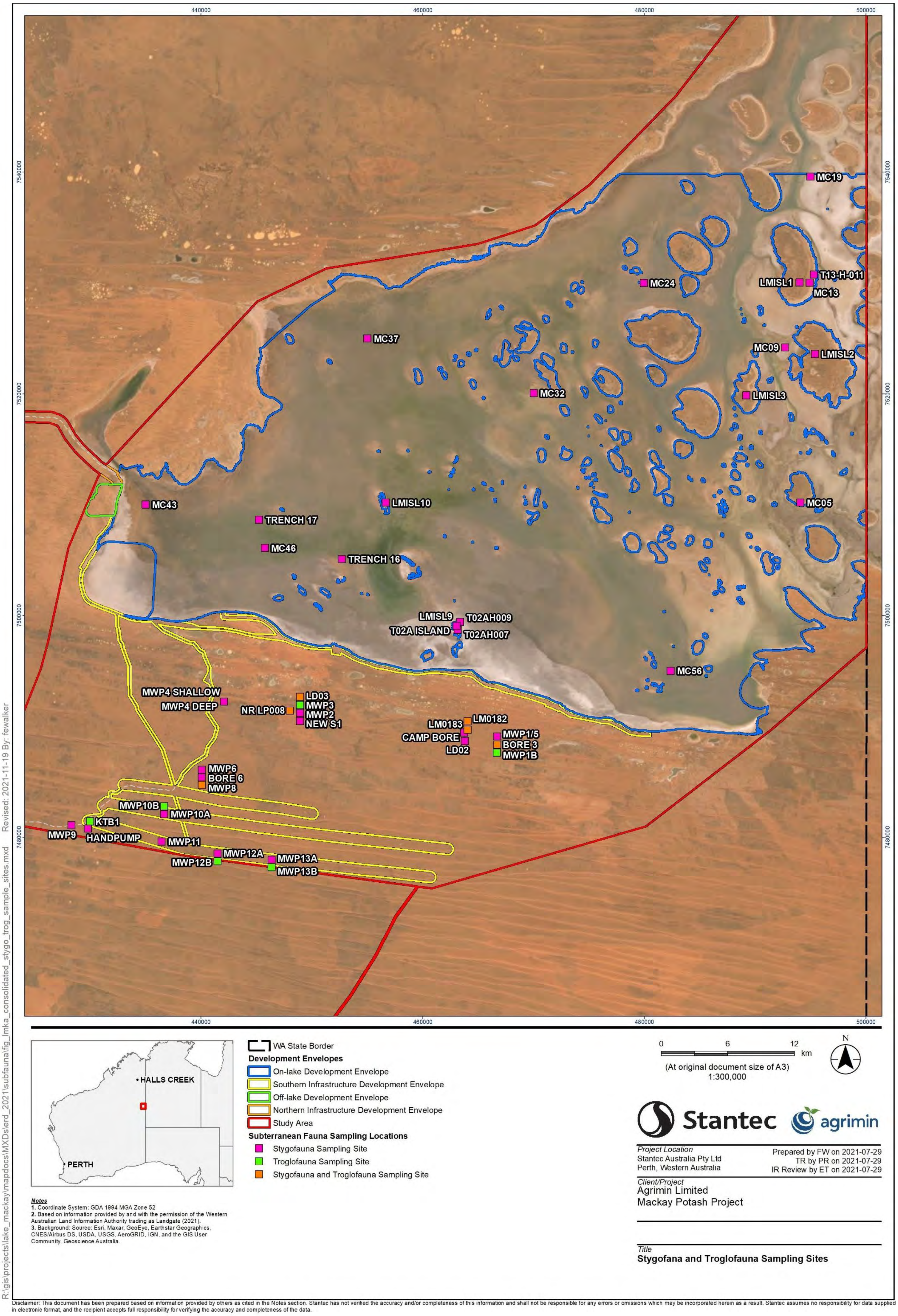

Figure 8-4: Subterranean fauna sampling sites on Lake Mackay and islands (On-LDE) and within the Southern Regional area (SIDE)

Plate 8-1: Lake bed sediments core photos (T02AH-012). (A) 0.0 to 3.0 m, and (B) 3.0 to 6.0 m

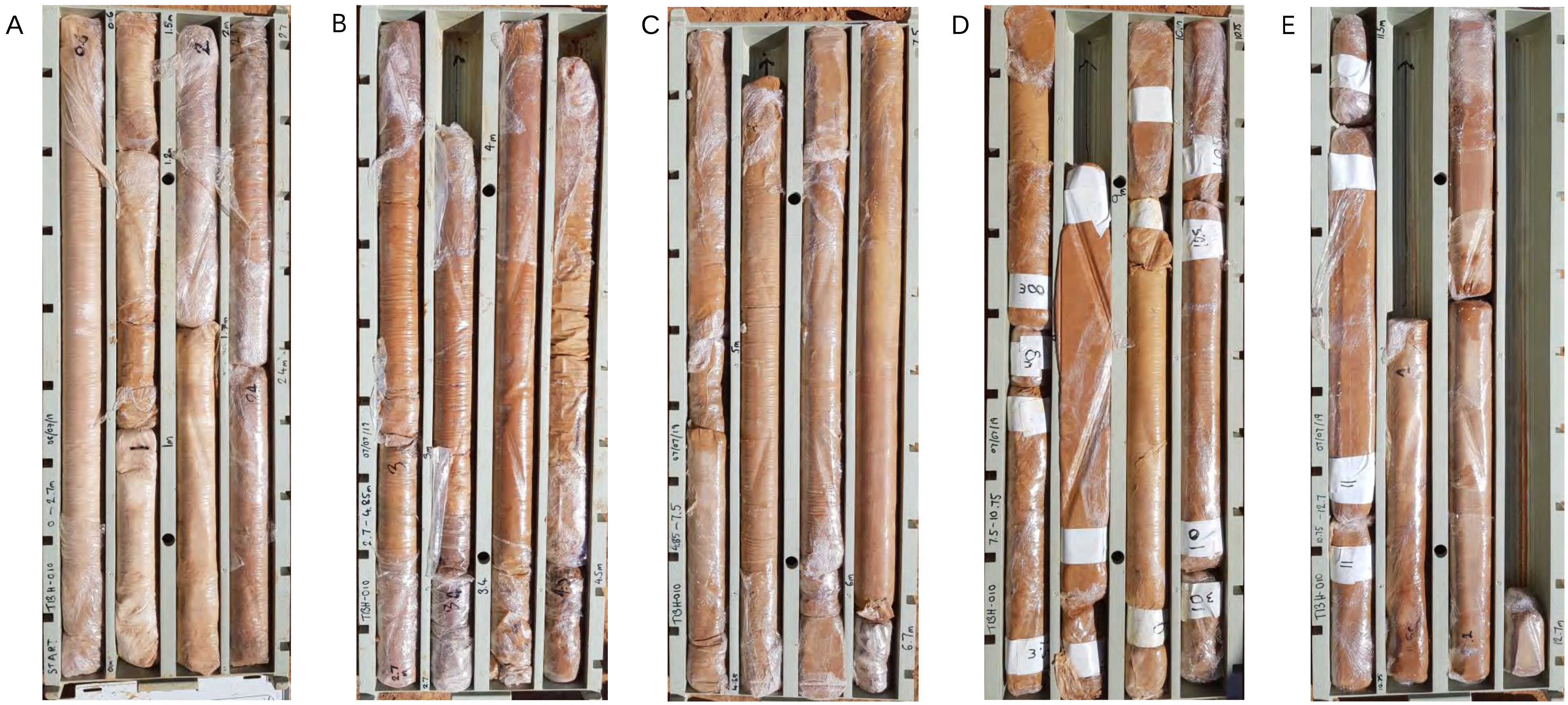

Plate 8-2: Landform island core photos (LMISL-001). (A) 0.0 to 2.70 m, (B) 2.70 to 4.85 m, (C) 4.85 to 7.50 m, (D) 7.50 to 10.75 m, (E) 10.75 to 12.7 m

Plate 8-3: SIDE monitoring bore chip tray photo (MWP13), 0.0 to 109 m

8.4.3.2.4 Stygofauna survey effort

A total of 79 stygofauna samples have been collected from the Study Area to date (Table 8-10) across the three studies (Table 8-9). There were 36 samples collected from Lake Mackay (On-LDE), 11 of which were collected from sites (bores) on the playa and 25 of which were collected from island sites (bores) (Table 8-10, Figure 8-5). There were 12 samples collected from the SIDE borefield, and 31 samples collected from the Southern Regional area (Table 8-10, Figure 8-5). The total consolidated stygofauna survey effort for the Study Area (79 samples) exceeded the recommended guidance for a Level 2 stygofauna survey. (Table 8-10).

Table 8-10: Summary of stygofauna survey effort in the Study Area

Area		May 2017	Nov 2017	Jan 2020	May/Jun 2020	Aug 2020	Oct 2020	Apr 2021	Total Samples	Total Sites
On-LDE	Playa		2			4	5		11	10
	Islands		1	5		5	9*	5	25	11
SIDE Borefield				4	4	4			12	4
Southern Regional Area		5	12	4	5	5			31	16
Total Samples		5	15	13	9	18	14	5	79	41

*Note: *one sample collected with a hand auger.*

8.4.3.2.5 Troglofauna survey effort

A total of 26 troglofauna samples have been collected from the Study Area to date (Table 8-11) across all three studies (Table 8-9). The majority of samples were collected via deployment of litter traps, with additional scrape samples collected utilising stygofauna net hauls. There were seven litter trap samples collected from the SIDE borefield, and 17 litter trap samples and two scrape samples collected from the Southern Regional area (Table 8-11, Figure 8-6). No targeted troglofauna sampling took place on the lake or islands, due to the close proximity of groundwater to the surface and the lack of suitable (uncased) bores (Table 8-11, Figure 8-6). However, one potential troglofauna was recorded as by catch from the islands during a stygofauna net haul. The recommended survey effort for a pilot study, considered by the EPA to provide a reliable indication of habitat prospectivity for troglofauna (10 to 15 samples), was adhered to for the Southern Regional Area and was almost met for the SIDE (Table 8-11).

Table 8-11: Summary of troglofauna survey effort in the Study Area

Area		Nov 2017		Jan 2020	Aug 2020	Total Samples		Total Sites
		Scrape	Litter Trap	Litter Trap	Litter Trap	Scrape	Litter Trap	
On-LDE	Playa					0	0	0
	Islands					*	0	0
SIDE Borefield				3[t]	4	0	7	4
Southern Regional		2	4	7[t]	6	2	17	9
Total Samples		2	4	10[t]	10	2	24	13

*Note: *one potential troglofauna was recorded as by catch from a stygofauna haul; [t] litter traps were left in situ for over 20 weeks due to COVID-19 travel restrictions.*

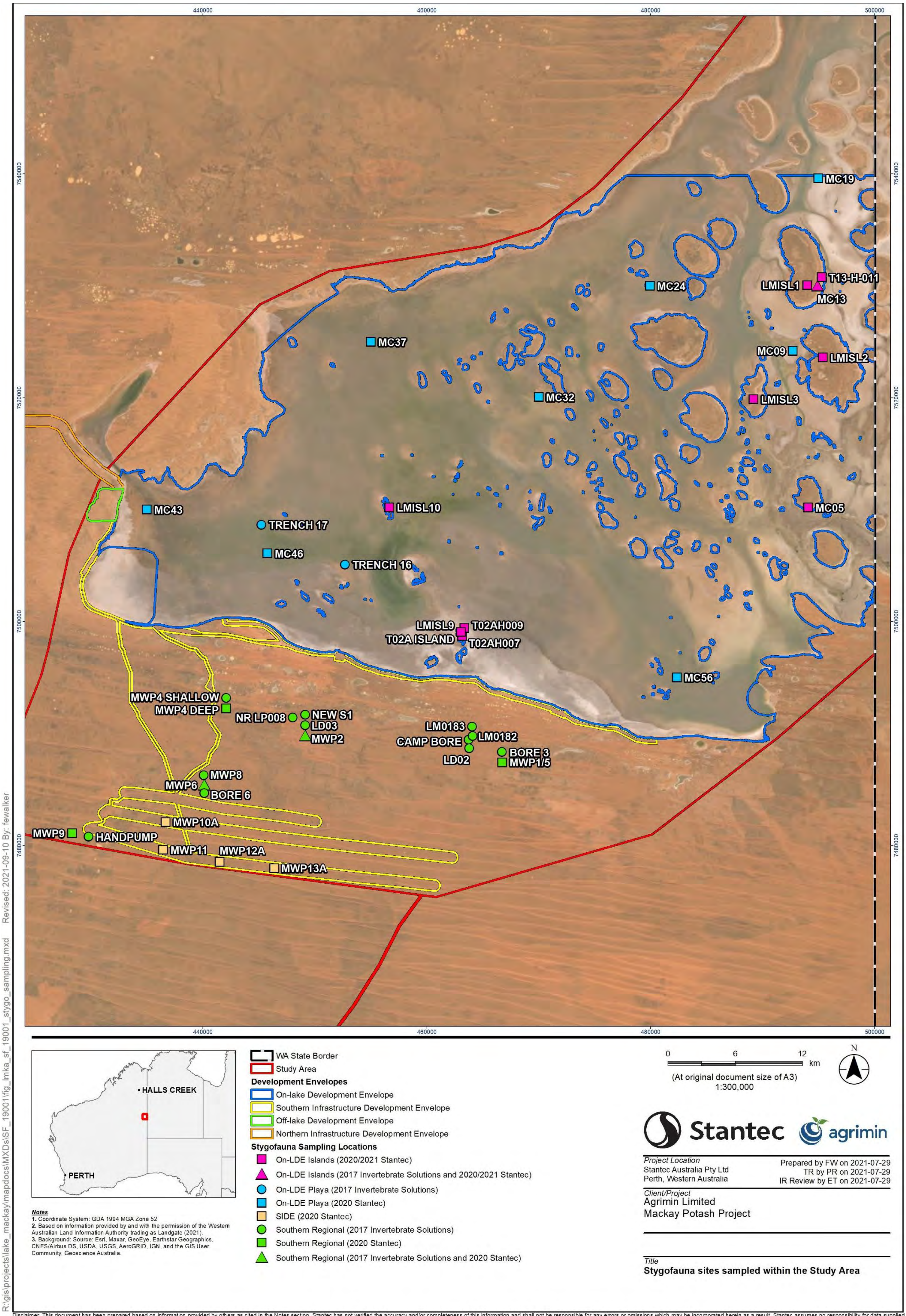

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Figure 8-5: Stygofauna sampling sites within the Study Area, based on the consolidated data from Invertebrate Solutions 2017 and Stantec 2020/2021 studies

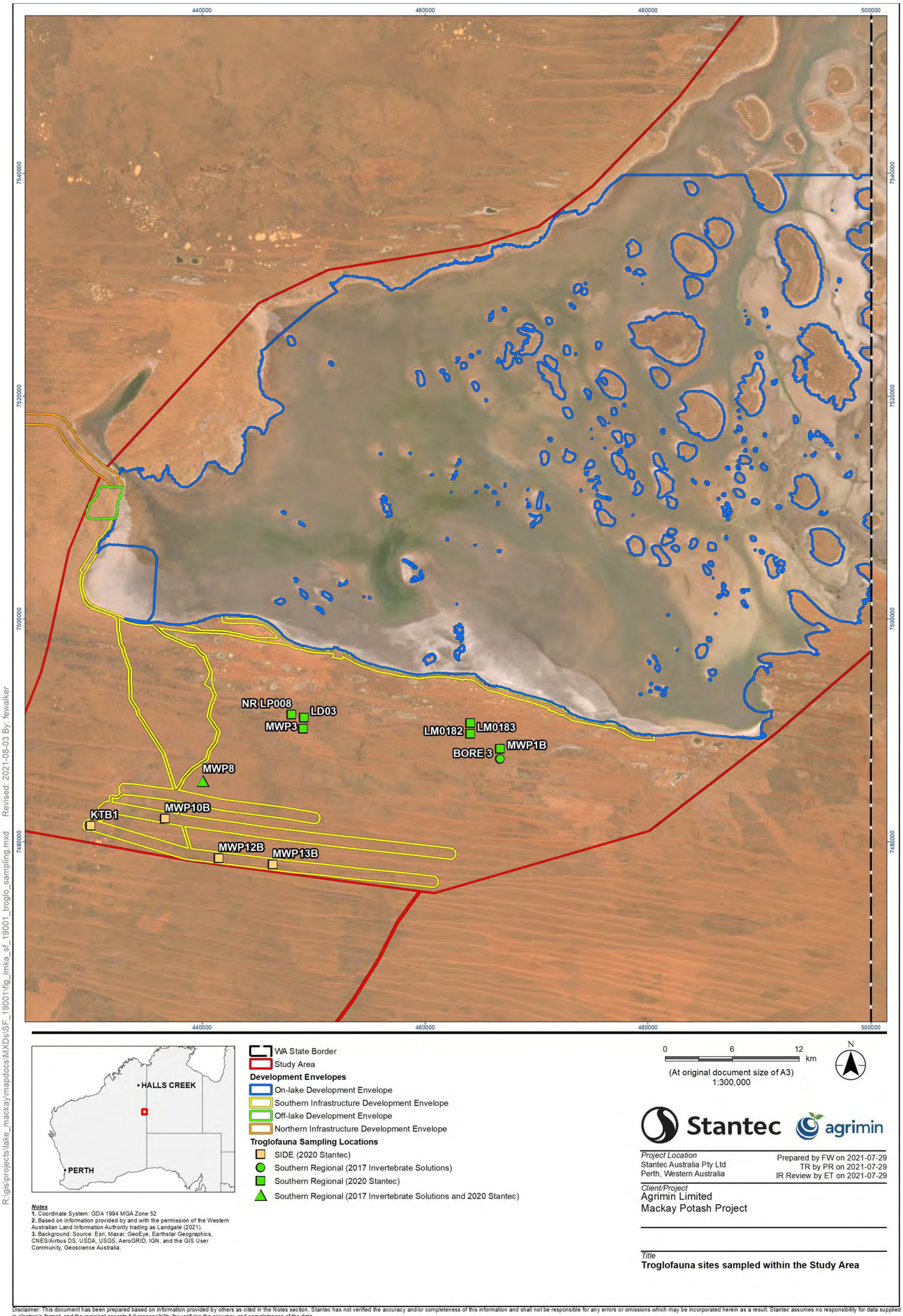

Figure 8-6: Troglofauna sampling sites within the Study Area, based on the consolidated data from Invertebrate Solutions 2017 and Stantec 2020/2021 studies

8.4.3.3 Stygofauna results

8.4.3.3.1 On-LDE Playa

No stygofauna have been recorded from the groundwater associated with the playa of Lake Mackay. This can be attributed to the high salinity (typically >200,000 mg/L) of groundwater and the limited prospectivity of the lacustrine deposits that comprise lake bed sediments (Appendix H).

8.4.3.3.2 On-LDE Islands

In comparison, a total of 85 stygofauna specimens were recorded from the islands. All were collected from four of the 11 sites (bores) sampled, primarily from landform islands in the eastern portion of the lake (Figure 8-7). These were represented by three copepod (microcrustacean) species (Appendix H). In addition, one individual of an oligochaete (segmented worm) Enchytraeidae sp., was also recorded (Figure 8-7). The degree of affinity of enchytraeids to groundwater is unknown, with this group occurring in a wide range of habitats, including terrestrial, marine and freshwater ecosystems (Dumnicka *et al.* 2020; Pinder 2010). The taxonomic framework in Australia is also poorly resolved (Pinder 2010).

The three confirmed stygofauna species include the harpacticoid copepod *Schizopera* 'bradleyi' (21 specimens), and the cyclopoid copepods *Fierscyclops fiersi* (28 specimens) and *Halicyclops kieferi* (33 specimens). *Schizopera* 'bradleyi' is a previously undescribed species and has only been recorded from one of the landform islands on one occasion. However, two specimens designated as *Schizopera ?*'bradleyi' were recorded from a second landform island during sampling in April 2021 and are considered likely to belong to *Schizopera* 'bradleyi' (Appendix H). *Fierscyclops fiersi* and *Halicyclops kieferi* are both known from outside of the Study Area, being widespread throughout the Yilgarn and Murchison regions. While the latter could potentially represent a cryptic species, based on molecular work on the genus *Halicyclops* in calcrete aquifers (Karanovic 2004), it is well distributed in the Study Area.

8.4.3.3.3 SIDE

Two individuals of the potential stygofauna Enchytraeidae sp. (Oligochaeta) have been recorded from the proposed SIDE borefield (Appendix H), both of which were collected from a single bore (Figure 8-7). Regardless of their affinity to groundwater, the extent of comparable geological units (Neogene alluvials) and associated groundwater in the area implies a wider distribution within and outside of the Proposal area (Figure 8-7).

8.4.3.3.4 Southern Regional area

A total of 378 stygofauna specimens, represented by 16 species of five higher level taxonomic groups, were recorded from the 31 samples collected in the Southern Regional area (Appendix H). Stygofauna were recorded from six of the 16 sites (bores) sampled, the majority of which intersect the large unit of shallow calcrete to the south and east of the SIDE borefield (Figure 8-7). A summary of the species records is provided in Table 8-12.

A total of 13 of the 16 stygofauna species recorded from the Southern Regional area to date are undescribed species, not known from outside of the Study Area. These include:

- Copepods:
  - *'Mackaynitocrella mouldsi'*
  - *'Mackaycyclops mouldsi'*
  - *'Mackaycyclops bradleyi'*
  - *Parapsuedoleptomesochra* 'mackay'
  - *Schizopera* 'mackay'
  - *Halicyclops* 'mackay'
  - *Schizopera* 'medifurca'
  - *Schizopera* 'paracooperi'
- Bathynellacea (Syncarids):
  - *Atopobathynella* sp. 'mackay'
- Ostracods (seed shrimp):
  - *Abcandonopsis* 'mackay'

- Coleoptera (aquatic diving beetles):
  - *Paroster* sp. 'mackay large'.
  - *Paroster* sp. 'mackay medium'
  - *Paroster*? sp. 'mackay small'

8.4.3.4 Troglofauna results

8.4.3.4.1 Lake and islands

No troglofauna have been recorded from the playa of Lake Mackay, likely attributed to the low prospectivity of the lacustrine deposits that comprise lake bed sediments, as well as the lack of voids and interconnectivity within this geological unit (Appendix H).

A single specimen of the potential troglofauna Projapygidae-OES3 (dipluran) was recorded as by-catch in a stygofauna haul net sample from one of the landform islands (Figure 8-8) (Appendix H). All diplurans are largely unpigmented and lack eye development. The majority are also soil dwelling (edaphofauna) in mesic (humid) environments (Naumann 1991). The family Projapygidae have been recorded from a range of geological units including alluvial/colluvial profiles (Outback Ecology 2009;2011), sandstone and iron formations (Subterranean Ecology 2010b) throughout WA. The specimen was recorded from one of the landform islands on Lake Mackay within gypsiferous sands overlain by calcrete, with calcrete deposits often associated with endemic and locally restricted species.

8.4.3.4.2 SIDE borefield and Southern Regional area

No troglofauna have been recorded from the Southern Regional area including the SIDE borefield (Appendix H).

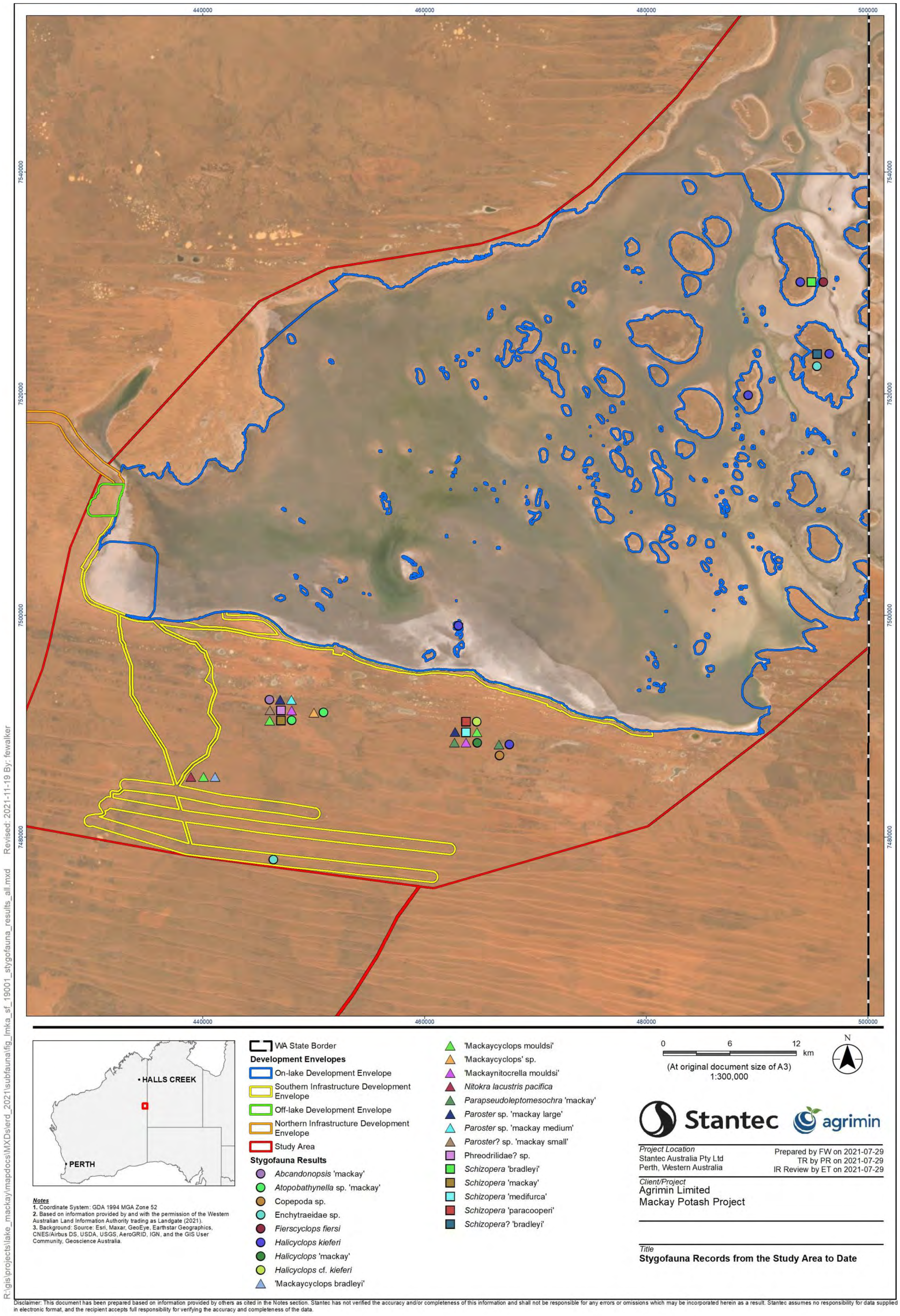

Figure 8-7: Stygofauna records from the lake and islands (On-LDE), Southern Regional area and SIDE, based on consolidated data

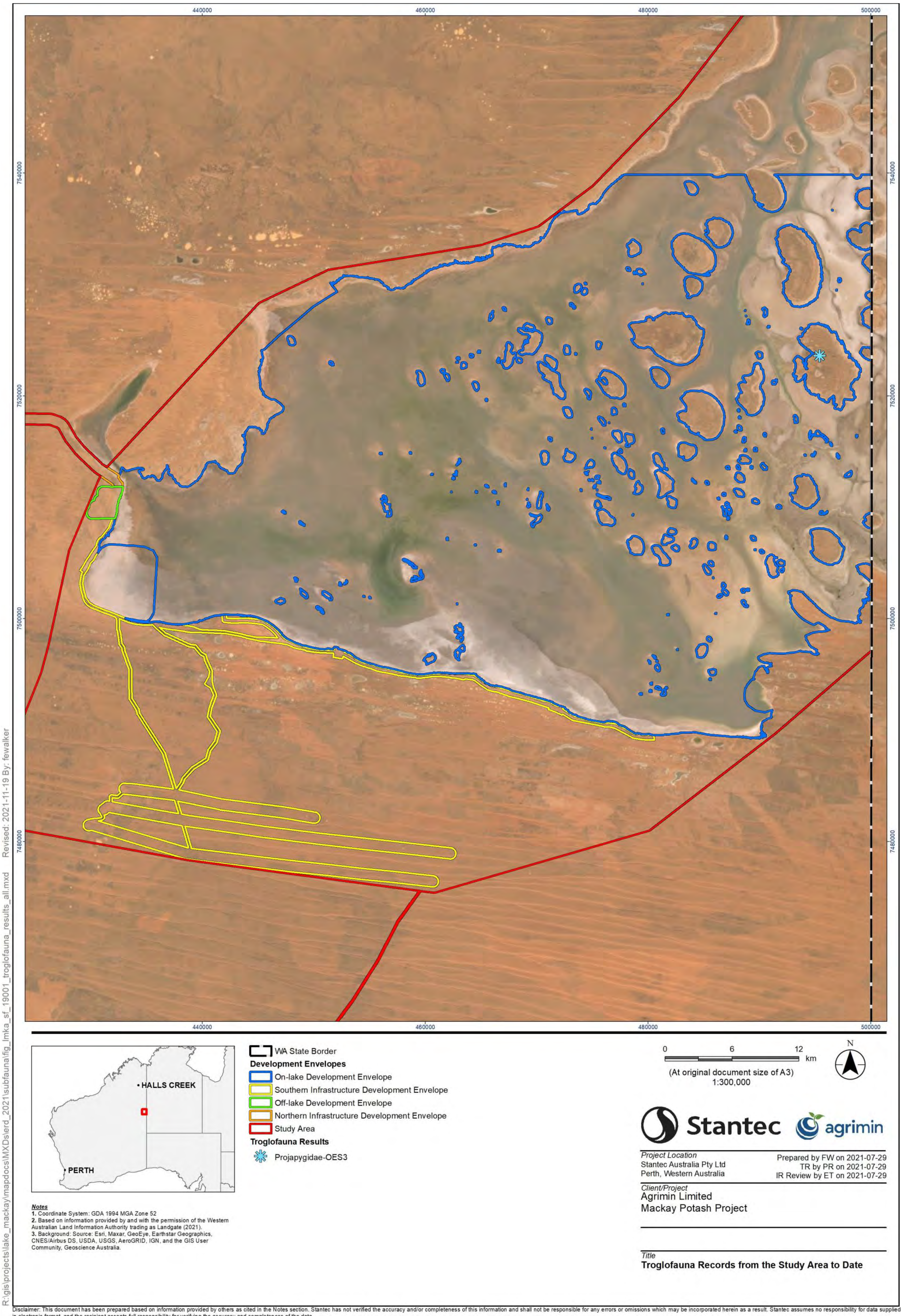

Figure 8-8: Troglofauna records, based on consolidated data

8.4.3.5 Summary of subterranean fauna values

In total, at least 18 stygofauna species, one potential stygofauna species, and one potential troglofauna species have been recorded from the Study Area across seven separate field surveys (Table 8-12). No species have been recorded from lake bed sediments on the playa of Lake Mackay. This habitat is not considered prospective for subterranean fauna, due to hypersaline groundwater and limited interconnected voids. Similarly, the SIDE borefield was also not prospective and was characterised by relatively fine textured alluvial lithology, which is likely to restrict stygofauna and troglofauna.

The On-LDE islands, predominantly landform islands in the eastern portion of the lake, host stygofauna within the calcrete and gypsiferous sands that comprise lower salinity groundwater, although this habitat is comparatively less diverse than the Southern Regional area. Three stygal copepod species have been recorded from the landform islands, including one undescribed species that may be restricted; *Schizopera* 'bradleyi'. (Table 8-12, Figure 8-9). The only potential troglofauna species recorded was the dipluran Projapygidae-OES3 (Table 8-12, Figure 8-9).

The majority of stygofauna records from the Study Area were associated with the surficial calcrete aquifer in the Southern Regional area (outside of the SIDE borefield). A total of 16 species were recorded from this area, including 13 undescribed species (Table 8-12, Figure 8-9). Only one potential stygofauna taxon (affinity to groundwater unknown); Enchytraeidae sp., was recorded from the alluvial aquifer of the SIDE borefield (Table 8-12, Figure 8-9), although is likely more broadly distributed throughout the region.

Table 8-12: Summary of all subterranean fauna records within the Study Area, based on consolidated data

Area	Higher ID	Species	Site Records	Date Records	Distribution and Context
Stygofauna					
On-LDE Islands	Copepoda	*Schizopera* 'bradleyi'	MC13	Nov 2017	New, undescribed species, only recorded from a landform island
		Schizopera ? 'bradleyi'^	LMISL2	Apr 2021	Likely to belong to previously recorded species
		Fierscyclops fiersi	MC13	Nov 2017	Widespread outside of the Study Area
		*Halicyclops kiefer*i	LMISL2, LMISL3, MC13, T02A Island	Jan 2020, Oct 2020, Apr 2021	Species widespread within and outside of the Study Area however could represent cryptic species
	Oligochaeta	Enchytraeidae sp.	LMISL2	Jan 2020	Unknown affinity to groundwater, likely widespread
SIDE	Oligochaeta	Enchytraeidae sp.	MWP13	Jan 2020	Unknown affinity to groundwater, likely widespread
Southern Regional Area	Copepoda	*Schizopera* 'medifurca'	Camp Bore	Nov 2017	New, undescribed species, only recorded from the Southern Regional area
		Schizopera 'paracooperi'	Camp Bore	Nov 2017	New, undescribed species, only recorded from the Southern Regional area
		Halicyclops cf. *kieferi*^	Camp Bore	May 2017, Nov 2017	Widespread outside of the Study Area however could represent cryptic species
		Halicyclops kieferi	MWP1/5	Aug 2020	Widespread outside of the Study Area however could represent cryptic species
		Halicyclops 'mackay'	Camp Bore	May 2017, Nov 2017	New, undescribed species, only recorded from the Southern Regional area
		Parapseudoleptomesochra 'mackay'	Camp Bore, Bore 3	May 2017, Nov 2017	New, undescribed species, only recorded from the Southern Regional area
		'Mackaynitocrella mouldsi'	Camp Bore, Nr LP008	May 2017, Nov 2017	New undescribed genus and species, only recorded from the Southern Regional area
		'Mackaycyclops mouldsi'	Camp Bore, Nr LP008, MWP8	May 2017, Nov 2017	New, undescribed genus/species, only recorded from the Southern Regional area
		Nitokra lacustris pacifica	MWP8	Nov 2017	Widespread in Oceania
		'Mackaycyclops bradleyi'	MWP8	Nov 2017	New, undescribed genus/species, only recorded from the Southern Regional area
		Schizopera 'mackay'	Nr LP008	May 2017, Nov 2017	New, undescribed species, only recorded from the Southern Regional area
		'Mackaycyclops' sp. ^	MWP2	May/Jun 2020	New undescribed genus. Likely to belong to previously recorded undescribed species. Likely endemic to the Study Area
		Copepoda sp.^	MWP1/5	May/June 2020	No further identification possible for one specimen
	Syncarida	*Atopobathynella* sp. 'mackay'	Nr LP008, MWP2	May 2017, Nov 2017, May/Jun 2020	New, undescribed species, only recorded from the Southern Regional area
	Ostracoda	*Abcandonopsis* 'mackay'	Nr LP008	May 2017	New, undescribed species, only recorded from the Southern Regional area
	Coleoptera	*Paroster* sp. 'mackay large'	Camp Bore, Nr LP008	May 2017, Nov 2017	New, undescribed species, only recorded from the Southern Regional area
		Paroster sp. 'mackay medium'	Nr LP008	Nov 2017	New, undescribed species, only recorded from the Southern Regional area
		Paroster? sp. 'mackay small'	Nr LP008	Nov 2017	New, undescribed species, only recorded from the Southern Regional area
	Oligochaeta	Phreodrilidae? sp.	Nr LP008	May 2017	Damaged specimen
Troglofauna					
On-LDE Islands	Diplura	Projapygidae-OES3	LMISL2	Jan 2020	Considered a possible troglofauna, very little known about their ecological status. Only recorded from a landform island

*Note: * Orange highlight indicates new species only recorded from the islands; ^ these taxa have been excluded from total species diversity (likely to belong to a taxon already represented in the taxa list); # taxon included in species diversity for Southern regional area.*

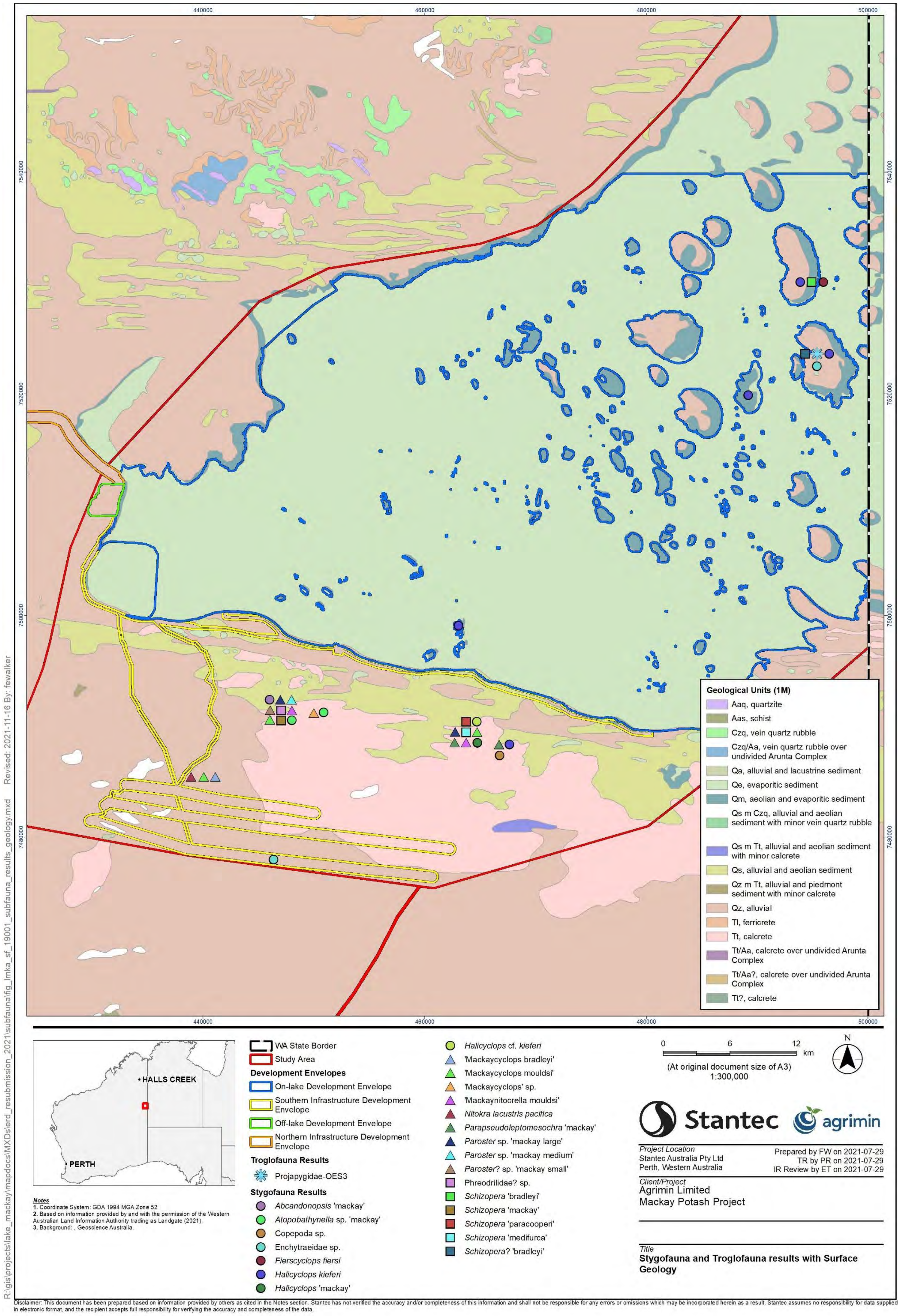

Figure 8-9: Subterranean fauna records from the lake and islands (On-LDE) and Southern Regional area (SIDE), indicating surface geology, based on consolidated data

8.5 Potential Impacts and Mitigation Measures

The potential exists for direct and indirect impacts from the Proposal on the subterranean fauna values of the islands on Lake Mackay (On-LDE) and the SIDE borefield. The risk for key activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of an environmental risk assessment, with a summary of potential impacts provided in Table 8-13. There are no stygofauna or troglofauna receptors, or prospective habitat associated with the lake bed sediments of the playa, and while prospective, there are also no predicted impacts to the Southern Regional area. The key impacts associated with the development of the Proposal on the islands and SIDE borefield are discussed in detail in Sections 8.5.1 to Section 8.5.4 and are as follows:

- Groundwater drawdown and loss of subterranean fauna and/or prospective habitat due to trench brine abstraction from the On-LDE;
- Groundwater drawdown and loss of subterranean fauna and/or prospective habitat due to abstraction from the SIDE borefield; and
- Excavation and disturbance of prospective habitat for stygofauna and troglofauna beneath landform islands within the On-LDE due to development of infrastructure.

Additional potential indirect impacts were identified during the risk assessment which were ranked as lower risk (Table 8-13). These impacts were considered as having a risk level that can be appropriately managed and are not discussed in detail in the following sections; however, these risks will be addressed via management measures in the CEMP. These potential indirect impacts to subterranean fauna include:

- Groundwater contamination on the islands and within the SIDE due to hydrocarbon spills and subsequent seepage into the subterranean environment; and
- Altered surface hydrology and topography from clearing resulting in changes to groundwater flow paths on the islands and within the SIDE.

The mitigation hierarchy has been considered and applied so that the development of the Proposal will "protect subterranean fauna so that biological diversity and ecological integrity are maintained". This aligns with the EPA objective for the Subterranean Fauna Factor (EPA 2016d). Impacts to subterranean fauna and mitigation measures are summarised in Table 8-13, which largely avoid, mitigate, manage, monitor and rehabilitate significant impacts, which may affect sensitive receptors including stygofauna and troglofauna and their associated habitat.

The mitigation measures are discussed in more detail in subsequent sections and will ensure the EPA objective for Subterranean Fauna will be met.

Table 8-13: Mitigation hierarchy applied to mitigate impacts from the Proposal on Subterranean Fauna

Key Proposal Impacts	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
Excavation and disturbance of prospective habitat for stygofauna and troglofauna beneath landform islands within the On-LDE due to development of infrastructure *Direct impact*	• No excavation or disturbance is expected to occur on the landform islands • Implementation of suitable buffer zones around the islands, comprising 500 m for landform islands, 250 m for large and intermediate islands and 100 m for small islands, negating the possibility of habitat excavation	• NA	• NA	• NA	• NA	✓	No
Groundwater drawdown and loss of subterranean fauna and/or prospective habitat due to trench brine abstraction from the On-LDE *Direct and indirect impact*	• Implementation of suitable buffer zones around the islands, comprising 500 m for landform islands, 250 m for large and intermediate islands and 100 m for small islands, minimising localised drawdown impacts to islands • Limited drawdown is expected beneath the landform islands ranging from 1.25 m on the margins to 0.25 m in the centre of the islands, at year 20 • Several larger islands that may contain prospective habitat for stygofauna in the north and east (NT) of Lake Mackay will not be impacted by drawdown	• Progressive implementation of BMUs to limit the rate and magnitude of drawdown across the lake and islands • Major rainfall events (>300 mm in one month), will return groundwater levels to baseline conditions	• Comply with Inland Waters Environmental Management Plan (IWEMP) • Groundwater investigations and modelling will be used to investigate drawdown extent and change in surface flows to minimise impacts to lake, island and associated subterranean fauna habitat	• Environmental monitoring programs with suitable site-specific abiotic trigger criterion will be implemented pre- and post-construction as required	• Following closure of each BMU, recovery of groundwater levels to baseline conditions is expected within two to five years	✓	No
Groundwater drawdown and loss of subterranean fauna and/or prospective habitat due to abstraction from the SIDE borefield *Direct and indirect impact*	• Drawdown within the SIDE borefield is expected to be limited, with a maximum lateral drawdown extent of 5.2 km and a maximum drawdown depth of 6 mbgl immediately adjacent bores, after 20 years of pumping (equivalent to <7%) of total aquifer thickness	• Limited habitat prospectivity for stygofauna, with the broad extent of comparable geological units (Neogene alluvials) and associated groundwater implying a wider distribution of enchytraeids	• Comply with IWEMP • Groundwater investigations and modelling will be used to investigate drawdown extent and change in surface flows to minimise impacts to lake, island and associated subterranean fauna habitat	• Routine monitoring of groundwater levels as required	• NA	✓	No
Groundwater contamination on the islands and within the SIDE due to hydrocarbon spills and subsequent seepage into the subterranean environment *Indirect impact*	• Salt harvesters will be powered using reticulated power sources limiting diesel usage on the lake • Avoidance of fuel/chemical storage and transfers outside of designated areas	• Spill response equipment available to prevent chemical / hydrocarbon spill from spreading within the On-LDE • Spill response training for all personnel and contractors	• Comply with CEMP • Comply with HSMP • Develop Emergency and Spill Response Plans • Bioremediation facility for the treatment of contaminated fill, soils, or sediment • Develop an Incident Reporting Procedure	• Routine monitoring of groundwater quality as required	• NA	✓	No
Altered surface hydrology and topography from clearing resulting in changes to groundwater glow paths on the islands and within the SIDE *Indirect impact*	• Avoid clearing on the islands and within the SIDE • Clearing will only occur in approved ground disturbance areas and will avoid unnecessary changes to surface topography, compaction and/or creation of hard surfaces	• Delineate clearing boundary areas, and confirmed cleared areas	• Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure	• Post clearing surveys • Annual inspections of cleared and rehabilitated areas to detect presence of new weed species and to determine success of weed mitigation measures • Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas	✓	No

8.5.1 Disturbance of Subterranean Fauna Habitat on the Islands

No excavation or disturbance is expected to occur on the landform islands, as a result of the Proposal. The implementation of buffer zones around the islands, of up to 500 m for landform islands, provides an additional mitigation measure, negating potential disturbance impacts (Table 8-13).

The implementation of measures to mitigate the impact of disturbance to stygofauna and troglofauna habitat on the islands will allow the Proposal to meet the EPA objectives for Subterranean Fauna.

8.5.2 Groundwater Drawdown

8.5.2.1 Islands

Groundwater drawdown resulting from brine abstraction within the lake bed sediments (up to 100 GL/a) will be progressive, facilitated by the implementation of BMUs over the 20-year operation of the Proposal. The BMUs construction will initially commence in the southern portion of the lake and will progressively move east, west and northwards by year 17. Over the LoM, pumping schedules and abstraction rates will vary across BMUs to maximise potassium concentrations and brine volume required in the evaporation ponds.

There is natural seasonal variation in groundwater levels across the lake and islands. Groundwater monitoring indicates that baseline groundwater levels range from 0.1 to 1.1 mbgl within the lake bed sediments, and from 3.4 to 4.0 mbgl on the landform islands. The average year-round depth to groundwater in the lake bed sediments is approximately 0.5 mbgl (Appendix I.16). Average annual groundwater level fluctuations are approximately 0.3 m across the wet and dry seasons. During prolonged dry conditions, a decrease of up to 0.2 m was recorded within the lake bed sediments, while a reduction of up to 0.6 m was observed on a landform island. (Appendix I.17).

Drawdown extent and depth will be more pronounced in the eastern portion of the lake, which includes the landform islands. At year 2 of mining, drawdown of up to 3.0 m is expected in the immediate vicinity of the trenches, decreasing to between 0 m and 1.8 m between the trenches and islands. Maximum drawdown of the lake bed sediments beneath the landform islands is expected to range from 1.25 m on the island fringes to less than 0.25 m in the centre of the islands (Figure 8-11). Most of the drawdown of lake bed sediments below islands, are subject to drawdown of less than 0.75 m (Figure 8-11).

On islands, the hydraulic connectivity of groundwater in the low salinity calcrete and gypsiferous sandy units, to underlying silty/clayey lake bed sediments is under investigation and requires seasonal monitoring. This is complex due to the variability of the island lithology and aeolian sand sequence thicknesses. However, this unit is a source of recharge to the lake bed sediments and therefore a transitional zone exists both in the occurrence of groundwater and in water quality (Appendix I.17). This natural recharge will not be altered during brine abstraction and therefore groundwater quality changes associated with the islands is unlikely.

Numerical modelling also assumes that recharge beneath the islands is the same as the lake bed sediments in the eastern portion of the lake. However, given that the islands are composed of highly permeable dune sand, the percentage of precipitation that recharges the brine aquifer beneath the islands is likely higher than the surrounding lower permeability lake bed sediments. As such, the current model, which predicts a maximum groundwater level drawdown of up to 1.8 m beneath islands is considered conservative, and likely overestimates drawdown beneath the islands. Regardless, it has been estimated that a rainfall event of more than 300 mm within one month will reset the lake groundwater level to within 0.6 mbgl, effectively returning the system to baseline conditions (Appendix I.8).

Drawdown and recovery on the landform island (MC13) over time is presented in Figure 8-10. Brine abstraction from BMU01 (in the vicinity of this island), begins in year 10, with a drawdown maximum of up to 0.10 m expected in this area during year 12. Water levels gradually increase over an eight-year period and fluctuate as the pumping level in the BMU is adjusted until production stops on completion of year 20, at which time the water begins to recover and reaches pre-brine abstraction levels after approximately seven years (based on average annual rainfall, excluding larger precipitation events).

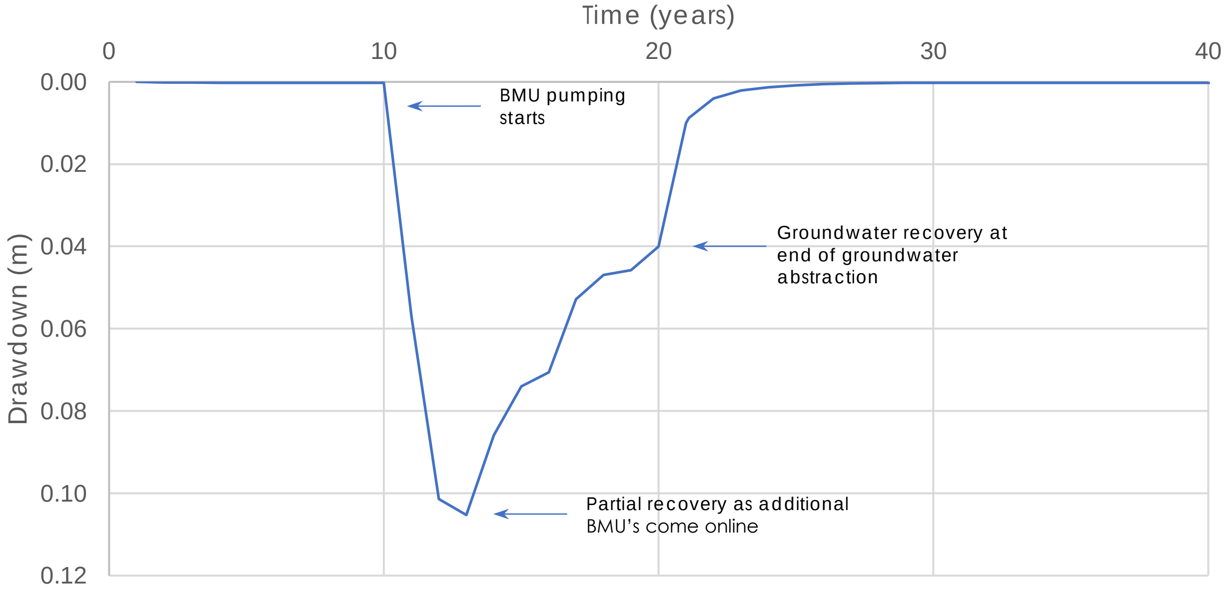

Figure 8-10 Variability in drawdown conditions and water level recovery over the LoM from landform island bore MC13

Stygofauna have been recorded from four islands (including small, large and landform islands) within the Study Area (Section 8.4.3.3). The community is represented by at least three stygal copepod species, *Schizopera* 'bradleyi', *Fierscyclops fiersi* and *Halicyclops kieferi*, as well as the potential stygofauna Enchytraeidae sp. (Oligochaeta). *Fierscyclops fiersi* is a widespread species known from outside of the Study Area, highlighting the potential for dispersal of copepods throughout the area. *Halicyclops kieferi* is widespread within and outside the Study Area however may represent a cryptic species, with work on *Halicyclops* in calcrete systems indicating that representatives of the genus can be locally restricted. *Schizopera* 'bradleyi' is an undescribed species which has only been recorded from a single landform island in the north east portion of the lake. Two specimens designated as *Schizopera* ?'bradleyi' were recorded from an adjacent landform island and are considered likely to belong to *Schizopera* 'bradleyi'. More broadly, the distribution of *Schizopera* 'bradleyi' is currently unknown. Similarly, the potential troglofauna Projapygidae-OES3 (dipluran) was also recorded from one of the landform islands (Section 8.4.3.3) and appears restricted.

Drawdown is expected to have a minor to negligible effect on subterranean fauna inhabiting the low salinity groundwater of the islands. Drawdown from abstraction of the brine occurs within the lake bed sediments and by year 20 is considered only marginally greater than the natural fluctuations observed during prolonged dry conditions (Figure 8-11). This is demonstrated in Figure 8-12 and Figure 8-13, with the 10-year and 20-year LoM drawdown, which ranges from 0 m to 1 m for the majority of the islands. Connectivity and interaction between the lake bed sediments and overlying low salinity groundwater hosting prospective subterranean fauna habitat on the landform islands is currently under investigation. Recent groundwater monitoring data, however, indicates that the low salinity groundwater is predominantly influenced by seasonal changes, with recharge occurring in response to rainfall during the wet season (Appendix I.17).

Based on groundwater modelling, there is also limited drawdown that extends into a minor portion of the NT towards the end of the LoM (Stantec Consulting Services 2021). This drawdown ranges from <40 cm at the WA/NT border, to <7 cm at 1 km from the border and is well within the natural seasonal variation of groundwater levels within the lake bed sediments, which is in the order of 50 cm (Stantec Consulting Services 2021). This indicates that there may only be limited direct impacts to stygofauna and potential indirect impacts to troglofauna inhabiting the islands on the WA side of Lake Mackay, if connectivity occurs between the lake bed sediments and low salinity groundwater systems.

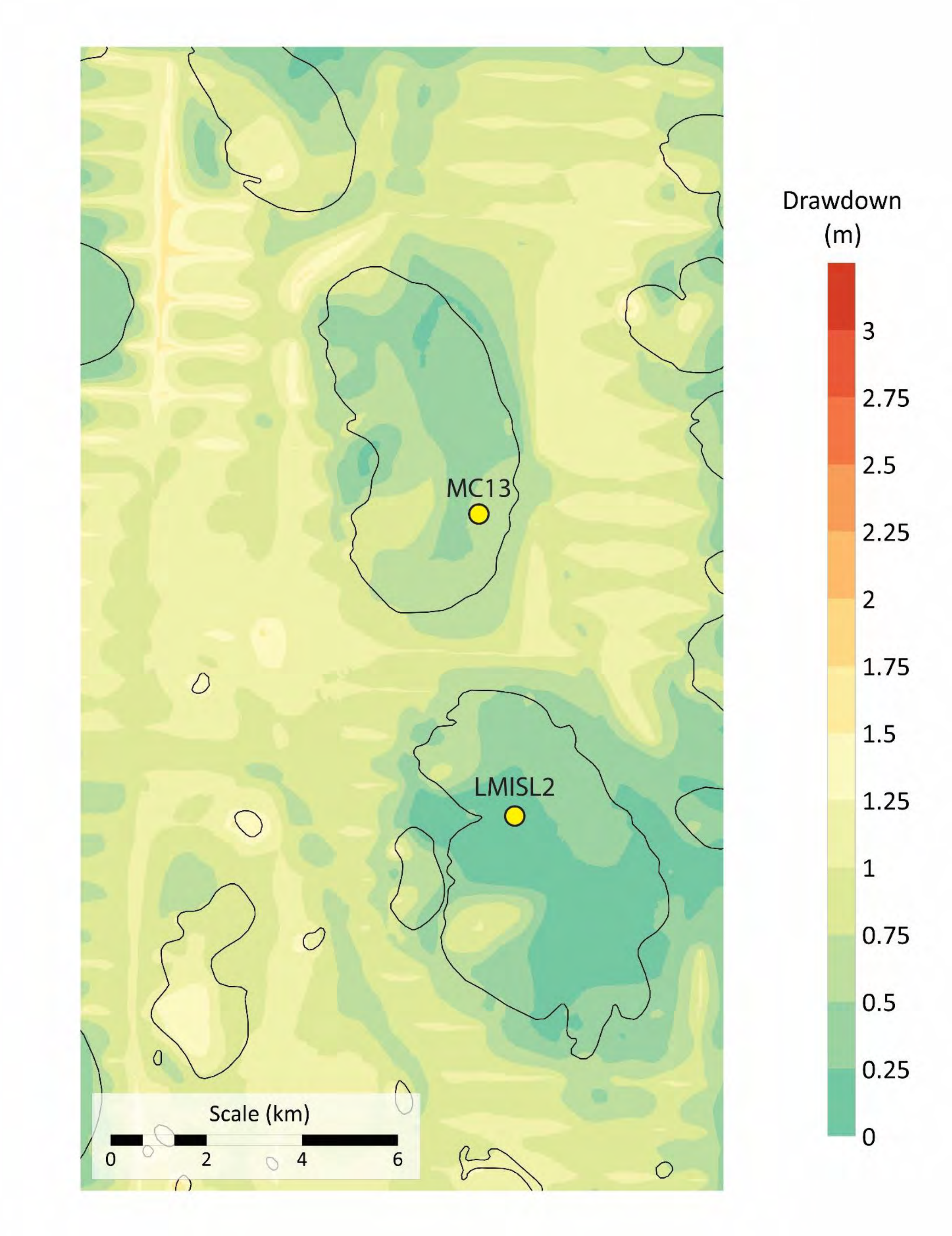

Figure 8-11: Drawdown modelled on the eastern landform islands at year 20 of mining, indicating the location of groundwater monitoring and stygofauna sampling bore MC13

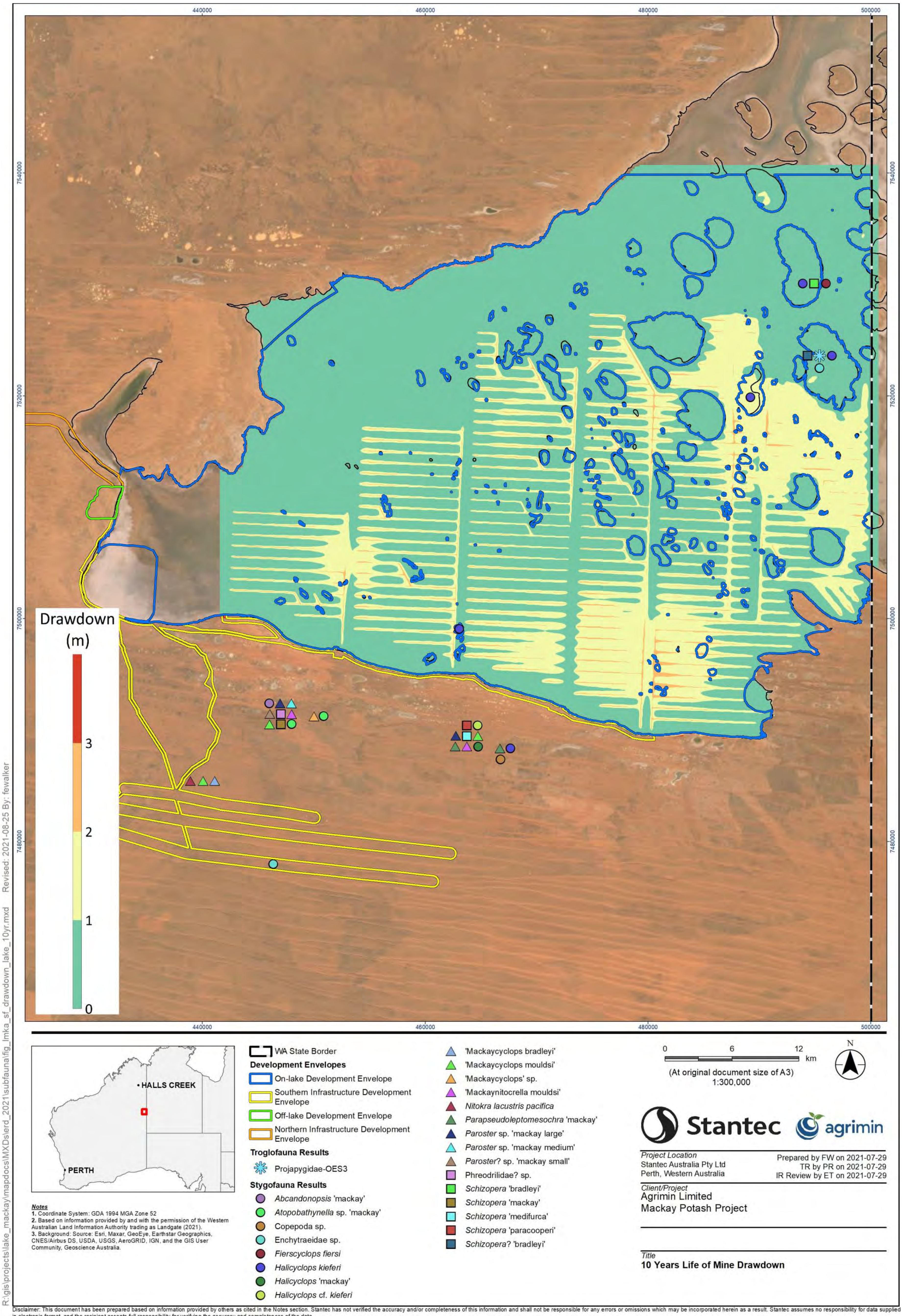

Figure 8-12: Subterranean fauna records for On-LDE islands relative to 10 years LoM drawdown

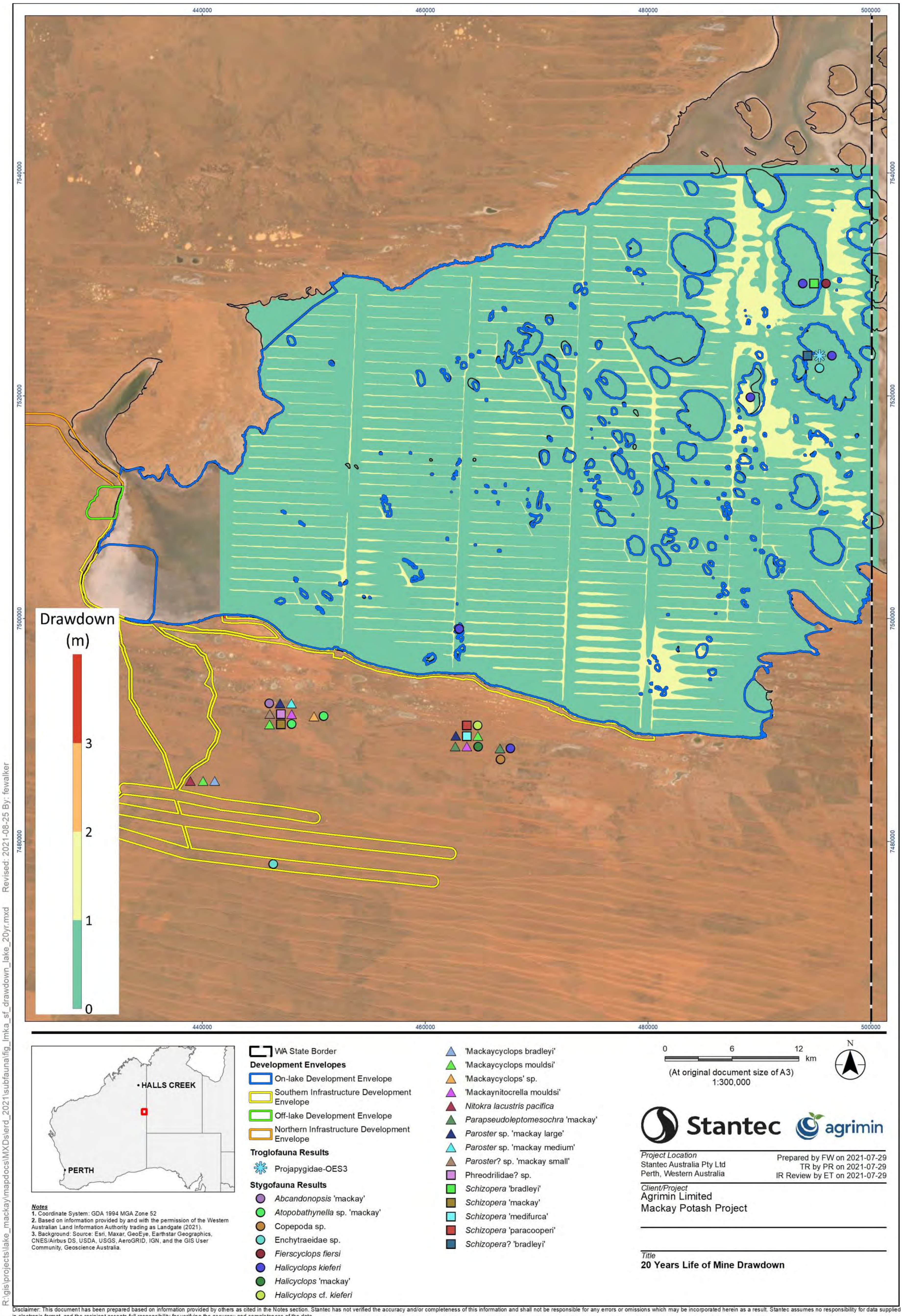

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Figure 8-13: Subterranean fauna records for On-LDE islands relative to 20 years LoM drawdown

While changes to lake-wide, seasonal groundwater levels from drawdown are considered unlikely, and low salinity groundwater on landform islands are subject to recharge from rainfall, contingency buffer zones were developed to minimise potential direct and indirect impacts to prospective subterranean fauna habitat. The largest buffer zone (500 m) was applied to the landform islands (Appendix I.10), which support one potentially new stygofauna species that is currently only known from two of these islands, including MC13 (Figure 8-11). This buffer will reduce drawdown extent below the landform islands, in the event there may be some connectivity to low salinity groundwater and the lake bed sediments. One large island was also found to support one stygofauna taxon that was also identified from landform and small islands, as well as being recorded from the margins of Lake Mackay. As this taxon is also widespread in the Yilgarn and Murchison regions of WA, a buffer zone of 250 m was applied to the large and intermediate islands (Appendix I.10). A minor buffer zone (100 m) was applied to the small islands (Appendix I.10), as a precautionary measure.

Stygofauna and troglofauna are inhabiting environments such as those found on the islands of Lake Mackay are likely to have an inherent resilience to fluctuating groundwater conditions, associated with periods of drought and rapid recharge during the wet season. Regardless, drawdown in this part of the lake is considered temporary, with abstraction not beginning in the vicinity of the landform islands until after 10 years of operations and ceasing at year 20, with recovery of groundwater levels to occur within seven years, aided by major rainfall events (Figure 8-10) (Appendix I.17). A summary of the mitigation measures that will be implanted to reduce the risk of impacts to subterranean fauna on the islands includes:

- large portions of the lake within the exclusion zone on the NT side of the lake comprise similar sized larger islands (approximately 10 islands), which likely have comparable habitat and therefore may support subterranean fauna values, will remain unimpacted by drawdown;
- buffer zones (of up to 500 m) have been implemented between the trenches and islands, minimising immediate localised drawdown impacts to islands;
- progressive implementation of BMUs will limit the rate and magnitude of drawdown to temporary effects, with abstraction in the vicinity of the landform islands occurring later in the LoM (>10 years);
- major rainfall events (>300 mm in one month), will increase groundwater levels to baseline conditions; and
- post-mining and abstraction, recovery of groundwater levels to baseline conditions is expected within five years (based on annual rainfall).
- groundwater investigations and modelling will be used to investigate drawdown extent and change in surface flows to minimise impacts to island aquifers and associated subterranean fauna habitat; and
- groundwater and subterranean fauna monitoring programs with suitable site-specific trigger criterion (abiotic and biotic) will be implemented pre- and post-construction.

Based on the expected drawdown and recovery of groundwater associated with the landform islands, impacts on subterranean fauna are expected to be minor. However, further hydrogeological investigations are planned to characterise stygofauna and troglofauna habitat and assist with monitoring and management.

The implementation of measures to mitigate the impact of drawdown on stygofauna and troglofauna habitat on the islands will allow the Proposal to meet the EPA objectives for Subterranean Fauna.

8.5.2.2 SIDE

The Proposal requires 3.17 GL/a of raw water for the processing and production. Hydrogeological studies identified suitable fresh to brackish aquifers within the SIDE to provide water of sufficient quantity and quality. The Proposal's water supply will be abstracted from a borefield comprising 28 operating bores within the SIDE. The bore water will be collected into a nearby tank and then pumped via a pipeline to the raw water pond at the processing plant. The borefield has been designed to provide up to 3.5 GL/year which translates to a production rate of 111 litres per second (L/s) (Appendix I.12).

The final borefield configuration for groundwater abstraction selected for the SIDE is a single line of 28 bores spaced 1 km apart along the southern most line of the Development Envelope (Figure 8-14). The majority of the bores (23) will abstract water from the aquifer hosted within shallow Neogene alluvials, which is approximately 88.5 m thick. The remaining five bores are predicted to source water from the deep aquifer within of the Angas Hills formation, primarily comprising conglomeritic sand and gravel (Appendix I.12).

At the predicted abstraction rate of 3.5 GL/annum, modelling predicts a maximum groundwater level drawdown of 6 m immediately adjacent to the bores (representing <7% of total aquifer thickness), up to 0.1 m 5.2 km from the bores, following a pumping period of 20 years (Figure 8-14; Table 8-14). While the drawdown potentially represents a direct impact for stygofauna and indirect impact for troglofauna, the nominated area of the borefield represents only a small proportion of the broadly distributed Neogene alluvials/Angas Hills aquifers in the Proposal area (Appendix I.12).

Table 8-14: Maximum lateral and vertical extent of drawdown at year 20 of abstraction

Distance from bore (m)	Drawdown below water table (m)
0	5
260	6
460	5
680	4
1000	3
1670	2
2740	1
3560	0.5
4520	0.2
5200	0.1

Only two specimens of potential stygofauna Enchytraeidae sp. have been recorded from one bore within the SIDE and predicted zone of drawdown (Figure 8-14). This was based on a total of 12 samples across four sites and three field surveys. Limited records coincide with the Neogene alluvials of very fine to granular clayey sandstone. The degree of affinity of enchytraeids to groundwater remains uncertain, with this group occurring in a wide range of habitats, terrestrial and aquatic habitats (Dumnicka *et al.* 2020; Pinder 2010). Regardless, the extent of comparable geological units and associated groundwater in the area implies a wider distribution. As no troglofauna were identified from the SIDE borefield, habitat prospectivity within this area is considered low.

Habitat prospectivity within the SIDE borefield is limited to potential stygofauna within the Neogene alluvials (occurring more broadly in the area), however, may be affected by a nominal amount of drawdown (Figure 8-14). Further hydrogeological investigations are planned to characterise groundwater, with the borefield likely to expand further south after year 20 of operations. This will assist with monitoring and management of groundwater in this area. The highly prospective surficial calcrete of the Southern Regional area, which yielded 16 stygofauna species, will not be impacted by drawdown (Figure 8-14).

The implementation of measures to mitigate the impact of drawdown on stygofauna habitat within the SIDE will allow the Proposal to meet the EPA objectives for Subterranean Fauna.

8.5.3 Groundwater Contamination

During the LoM there is potential for accidental spills of fuels or hydrocarbons leading to contamination of surface water and/or groundwater, potentially indirectly affecting subterranean fauna. Under the Proposal, all fuel and chemicals will be stored in a secure and appropriately bunded area within the Off-LDE, and outside of the 1:100-year flood zone, to prevent release or spillage. The planned implementation of exclusion zones of 100 m from small islands, 250 m from medium sized islands, and 500 m from large/landform islands, will prevent any localised changes to groundwater quality or hydrocarbon contamination within On-LDE islands (Table 8-13).

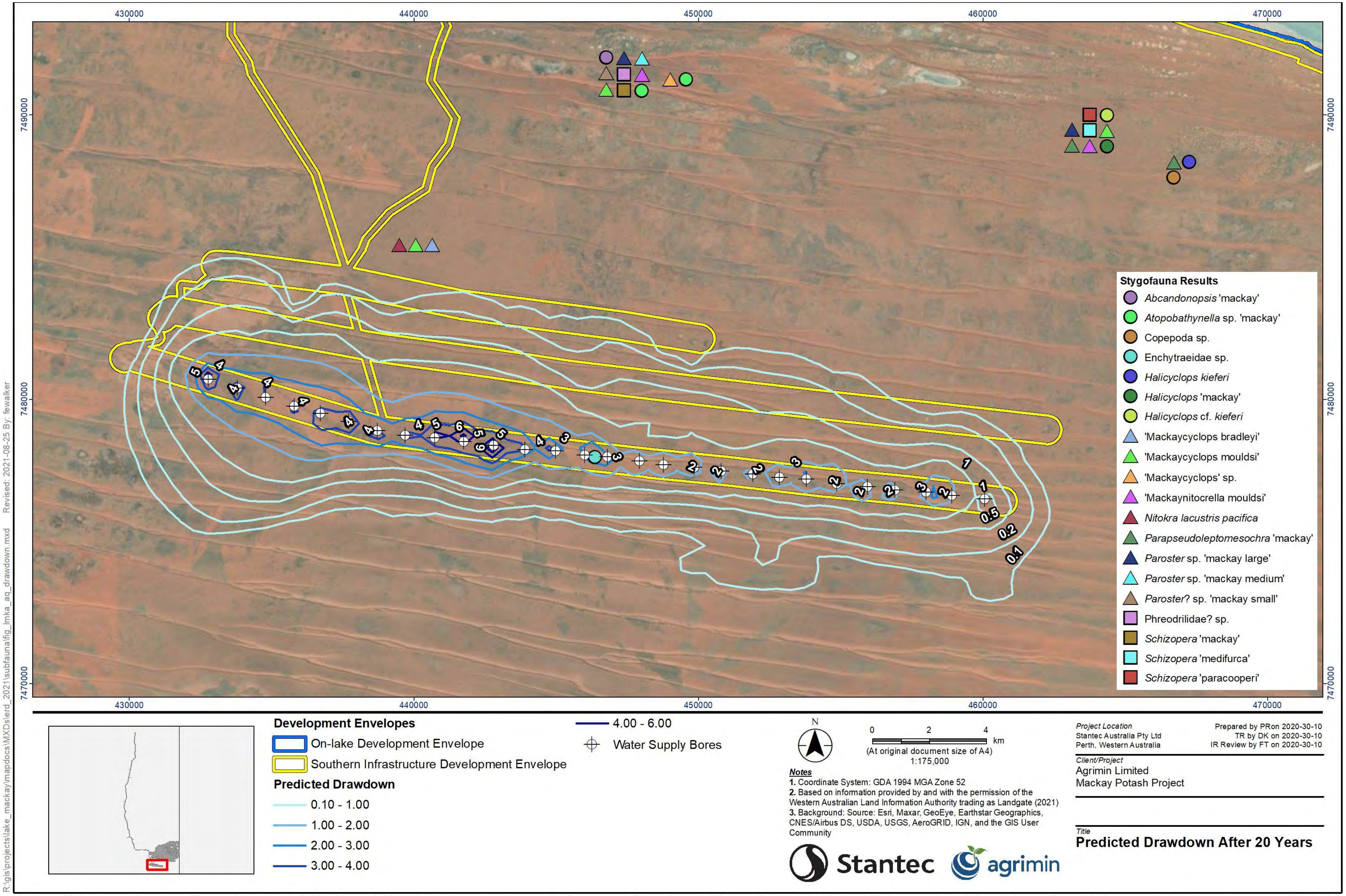

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Figure 8-14: Subterranean fauna records in the SIDE and Southern Regional area (consolidated data) in relation to maximum predicted drawdown for the SIDE (at year 20)

The implementation of appropriate industry standard hydrocarbon mitigaton and procedures will provide an additional level of protection for On-LDE island groundwater, including:

- transport, storage and use of any designated dangerous goods or substances to be conducted 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;
- vehicles and equipment are to be regularly inspected and maintained to reduce the likelihood of spills and leaks;
- spill kits will be located at strategic locations and training provided on their appropriate use; and
- spills are to be contained, remediated, investigated and reported to the relevant authorities as required.

The implementation of measures to mitigate the impact of groundwater contamination within the SIDE will allow the Proposal to meet the EPA objectives for Subterranean Fauna.

8.5.4 Alterations to Groundwater Flow in the SIDE

Minimal land disturbance and/or clearing is expected within the SIDE borefield. While this could potentially represent an indirect impact to subterranean fauna, it is expected that changes to groundwater flow paths will be avoided (Table 8-13). This will occur through the management of clearing and construction, including:

- avoidance of unnecessary alteration of surface topography, compaction and/or creation of hard surfaces within the SIDE borefield; and
- avoiding clearing of native vegetation where possible, following appropriate vegetation clearing mitigation and procedures.

The implementation of measures to mitigate the impact of alterations to groundwater flow within the SIDE will allow the Proposal to meet the EPA objectives for Subterranean Fauna.

8.5.5 Cumulative Impacts

The location of the Proposal is extremely remote with no cumulative impacts from other developments within or surrounding the Proposal area currently, or in the foreseeable future. Sensitive receptors (stygofauna or troglofauna) are not expected to be significantly impacted by the Proposal or by potential disturbance, drawdown, or changes to groundwater quality and/or groundwater flow paths.

8.6 Predicted Outcome

Potential impacts on the Subterranean Fauna factor and proposed mitigation measures are outlined in Table 8-13, with detailed impact assessment provided in Section 8.5. Agrimin is of the view that the potential environmental impacts of the Proposal can be effectively managed and are unlikely to result in long-term (or significant), residual impact to subterranean fauna values. Therefore, no offsets, as defined in *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) are required for the Subterranean Fauna factor.

The majority of the Proposal area has limited or no habitat prospectivity for stygofauna and troglofauna. The lake bed sediments and hypersaline groundwater of Lake Mackay are not conducive to subterranean fauna, while the SIDE borefield also has limited habitat within the fine textured alluvials. Low salinity groundwater in calcareous gypsiferous sands on the landform islands support stygofauna and troglofauna and may be affected by minor drawdown. Connectivity to the lake bed sediments is under investigation, however, recent monitoring data indicates recharge from rainfall is the predominant driver of low salinity groundwater that is prospective for stygofauna. Drawdown to the NT is also spatially limited and within natural seasonal variation of groundwater levels within the lake bed sediments. Therefore, any direct impacts to stygofauna habitat or indirect impacts to troglofauna habitat are expected to be negligible and occur over a temporary period and mitigated by seasonal recharge.

Complete recovery of groundwater levels in the lake bed sediments is predicted to occur following cessation of mining, within approximately seven years, which may be accelerated by major rainfall events. Further groundwater monitoring and additional hydrogeological characterisation are also planned for the larger lake islands, to appropriately manage potential impacts from the Proposal, which are not expected until year 10 of operations, with cessation at year 20. Therefore, it is predicted that significant residual impact to subterranean fauna and prospective habitat will be prevented.

Based on the implementation of all mitigation measures to limit the impact of the Proposal on the environment, the EPA objective for Subterranean Fauna will be met.

9. Inland Waters

9.1 EPA Objective

The EPA's environmental objective for inland waters is "*To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected*" (EPA 2018a).

9.2 Policy and Guidance

The State and Commonwealth legislative instruments, policy, guidelines, and advice relevant to the Proposal and their application are presented below. Table 9-1 also summarises the scope of each guide as relevant to the Proposal.

Table 9-1: Legislative instruments, policies and guidelines relevant to inland waters impact assessment

Legislative instrument	
Biodiversity Conservation Act 2016	
Biosecurity and Agricultural Management Act 2007	
Environment Protection and Biodiversity Conservation Act 1999	
Environmental Protection Act 1986	
Rights in Water and Irrigation Act 1914	
EPA policy or guidance	**Considerations**
Environmental Protection Authority. (EPA 2018a). Environmental Factor Guideline – Inland Water Quality.	The EPA's advice in relation to consideration of impacts to Inland Waters has been considered in the design of the Proposal to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected
Environmental Protection Authority. (EPA 2016e). Environmental Factor Guideline – Terrestrial Environmental Quality.	This guideline is intended to outline the values and significance of terrestrial fauna and the various activities that may impact this factor.
Environmental Protection Authority. (EPA 2018a). Environmental Factor Guideline – Inland Water Quality.	The EPA's advice in relation to consideration of impacts to Inland Waters has been considered in the design of the Proposal to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected
Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA.	This Statement provides guidance to ensure that a Proposal addresses the holistic view of its environmental impact relevant to the EP Act.
Environmental Protection Authority. (EPA 2021a). Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual Requirements under the *Environmental Protection Act 1986*	Describes the principles and practices of EIA within the context of Part IV of the EP Act.
Environmental Protection Authority. (EPA 2016b). Environmental Factor Guideline – Flora and Vegetation.	The EPA's advice on the flora and vegetation factor was considered for the EIA of the Proposal's activities and Development Envelopes, with particular focus on riparian vegetation.
Environmental Protection Authority. (EPA 2016i). Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment.	Vegetation surveys to support the Proposal were undertaken in accordance with this guideline's methodologies and reporting requirements.
Environmental Protection Authority. (EPA 2020b). Technical Guide: Terrestrial Fauna Surveys.	The EPA's advice for conducting desktop studies, survey preparation, habitat assessment, survey techniques, specimen handling, data analysis, mapping and report to ensure a high standard of data available for EIA.

Legislative instrument	
Environmental Protection Authority. (EPA 2020b). Technical Guide: Terrestrial Fauna Surveys.	This guideline is intended to outline the values and significance of terrestrial fauna and the various activities that may impact this factor.
Other policy or guidance	**Considerations**
ANZECC & ARMCANZ. (ANZECC & ARMCANZ 2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1, The Guidelines (Chapters 1-7).	Used to assess and subsequently manage ambient water quality in natural and semi-natural water resources.
Water Quality Australia. (Water Quality Australia 2018). Australian & New Zealand Guidelines (ANZG) for Fresh & Marine Water Quality.	Detailed guidelines for implementing adequate management of water quality in natural and semi-natural water resources.
Australian Government National Water Commission. (Australian Government National Water Commission 2012). Australian Groundwater Modelling Guidelines.	Seeks to provide a consistent and reliable approach to developing groundwater flow and solute transport models.
Department of Environmental Regulation. (DER 2015a). Identification and investigation of acid sulphate soils and acidic landscapes.	Used to address the minimum level of investigation into identifying presence and to define the nature and extent of ASS in a given area.
Department of Water. (DoW 2013). Western Australian water in mining guidelines.	Advice on the management of water and the licensing assessment process to be considered in the Proposal of mine planning.
Environmental Protection Authority. (EPA 2021c). How to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans: Instructions.	A guide for preparing Environmental Management Plans that may be required in conjunction with the Proposal.
Geoscience Australia. (Geoscience Australia 2016). Australian Rainfall and Runoff Guidelines.	Used for estimating flood characteristics, this guideline provides guidelines as well as data and a software suite.

9.3 Overview of Studies

A substantial body of work has been completed to understand the Inland Waters factor for the Proposal. More than 30 studies have been undertaken across the geology, groundwater, surface water and aquatic ecology disciplines, the results of which have been collated into technical reports and memorandums (Table 9-2). These studies span from 2001 to 2021 and have included the lake and islands (On-LDE), claypans and riparian zone (Off-LDE), and the southern region (including the SIDE). The distribution of sites sampled for aquatic biota during dry or flooded conditions in addition to the Agrimin sampling bores is illustrated in Figure 9-1. Due to the remoteness of the Proposal area, there have been significant logistical challenges, specifically the mobilisation of heavy equipment across Lake Mackay for groundwater assessments (Plate 9-1).

Recently, substantial rainfall in early 2021 allowed for opportunistic sampling of the Lake Mackay and claypans during inundated conditions, which included the assessment of aquatic biota, waterbirds and flowering plants in the riparian zone. Analysis of satellite imagery was also completed, to validate the development of a long-term time series water balance model, associated with Proposal development. The subsequent sections provide detailed information on the studies undertaken for each discipline relating to the receiving environment and summarise the key findings to understand the Inland Waters factor for the Proposal.

Table 9-2: Summary of studies relating to Inland Waters

Receiving Environment	Number of Reports/Memos	Description
Geology	10*	Technical studies characterising the lake and regional geology, including resource definition within the lake bed sediments
Groundwater	22*	Technical studies characterising lake bed sediments (resource modelling), islands and southern regional hydrogeology, in relation to groundwater levels and drawdown, and water balance modelling
Surface Water	7*	Technical studies characterising lake hydrology, satellite imagery of flooding regimes, surface water modelling, water balance modelling, salt balance and ionic composition
Aquatic Ecology+	8+	Technical studies characterising ecological values of the lake and peripheral wetlands, documenting significant communities and species

*Note: * indicates some reports and technical memorandums overlap, + includes relevant flora and fauna studies*

Plate 9-1: Lake bed sediments and palaeochannel drilling on Lake Mackay

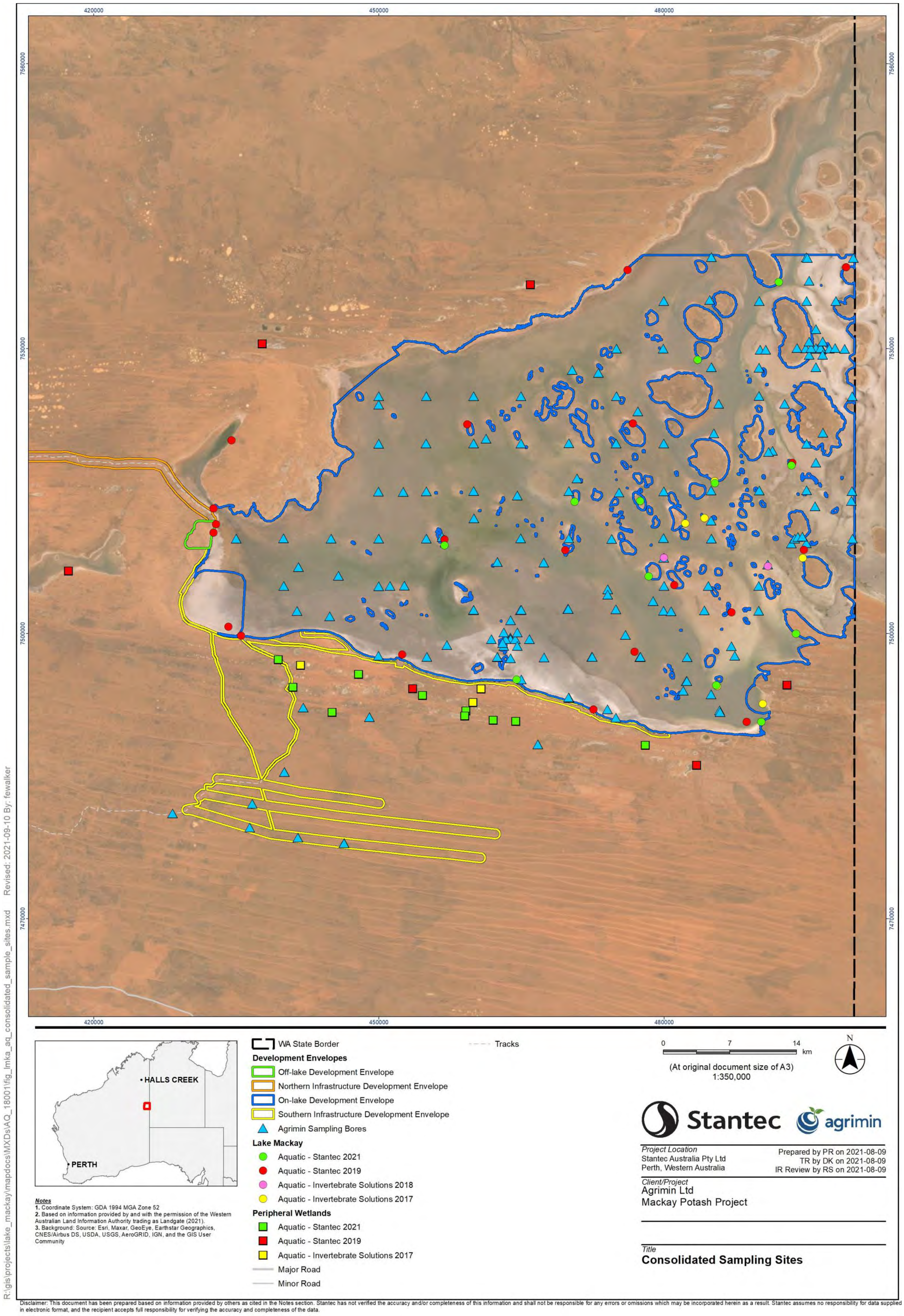

Figure 9-1: Study Areas on Lake Mackay and islands (On-LDE), claypans and riparian zone (Off-LDE), and southern region (SIDE)

9.3.1 Survey limitations

Due to the infrequent inundation of Lake Mackay and peripheral wetlands, there is limited information on aquatic biota during major flood events. Rewetting trials were undertaken in the laboratory in 2019 to simulate flooding and document the emergence of aquatic biota; however, these trials cannot completely replicate natural conditions. Two opportunistic field surveys were subsequently completed when the lake was inundated in early 2021, which due to the size of the system represented substantial logistical challenges. This was overcome where possible by utilising a helicopter to access remote parts of the lake. However, additional surveys in future flood events will likely identify increased biodiversity from the lake and broaden understanding of the range of conditions expected over the course of the hydroperiod. Regardless, survey effort was considered adequate, both spatially and temporally, to understand and characterise the ecological values, habitats and significant species associated with the lake, islands, peripheral wetlands and riparian zone.

9.4 Receiving environment

9.4.1 Geology

Numerous exploration field work programs have been carried out between 2011 and 2020, to investigate and characterise the geology of the Proposal area. The technical memorandums and reports based on these programs are summarised in Table 9-3, and where available, presented in Appendix I.1 to Appendix I.17. Initial exploration work on the lake comprised shallow drilling programs carried out between 2011 and 2015. Following Agrimin's acquisition in 2015, extensive exploration has been undertaken focusing on the geology of the lake bed sediments, with targeted island drilling in 2019. In 2017 and 2019, exploration activities targeted potential process water supply south of the lake (SIDE), which followed a review of historic regional drilling data.

Table 9-3: Summary of geological data and studies

Reference	Area	Title
Groundwater Exploration Services (2016)	On-LDE	Lake Mackay Preliminary Groundwater Modelling Study
Hydrominex Geoscience (2017)	On-LDE	Technical Report on the Lake Mackay Potash Project Western Australia
Advisian (2018)	On-LDE	Prefeasibility Study Chapter 6: Hydrological and Hydrogeological Modelling
Knight Piesold (2018)	On-LDE	Hydrogeological Modelling for the Mackay SOP Proposal Prefeasibility Study
Agrimin (2020)	On-LDE, Off-LDE	Definitive Feasibility Study
Agrimin (2020)	On-LDE	Island Drilling Memorandum
Agrimin (2020)	On-LDE	Infill Drilling Memorandum
CDM Smith (2020)	SIDE	Water Supply Assessment for Mackay SOP Project
Stantec (2020)	On-LDE	Islands Characterisation Memorandum
Agrimin (2020)	On-LDE	Shelby Tube Sampler Memorandum

9.4.1.1 Lake geology

The surface of Lake Mackay typically comprises a thin crust (<5 mm), of evaporitic material, predominantly halite. In the west of the lake halite coverage is more extensive than in the east, where it becomes patchy and interspersed with increasing proportions of gypsum and windblown quartz sands. The western halite crust typically forms a near horizontal surface (Plate 9-2), whereas the lake bed surface in the east is noticeably more undulating (Plate 9-2), and contains air filled vugs/void spaces. The halite crust has been observed to dissolve rapidly after rainfall and reprecipitate when flood water evaporates.

Across much of the lake surface, the halite crust is underlain by variably decomposed organic material, which can be up to several cm thick and typically occurs at surface or within ~5 cm of surface, as shown in Plate 9-2. This organic layer is often exposed in patches where surficial halite is not present. This organic material typically has a high moisture content and is black in colour. The relatively thin crust of halite and organics is underlain by a variable lake bed sequence which displays distinct characteristics east-west across the lake area.

The remaining lacustrine or lake bed sediments sequence of Lake Mackay is characterised into three broad lithological units, including:

- fine to coarse grained gypsum sand, with an approximate thickness of 1 m that varies laterally east-west across the lake. Gypsum sand horizons are noticeably thicker in the east. This unit progressively grades downward into clayey and silty sand approximately 3 m below ground level (mbgl) (Plate 9-4);
- sandy and silty clay, containing discrete interbedded layers of evaporites (including granular/crystalline gypsum, halite and calcite), and organics continues to around 150 mbgl. The density of the clays increases with depth; and
- a palaeochannel unit in the southern section of the lake, comprising sands and gravels, with minor silt and clay continues to a known depth of 211 mbgl. The upper part of this unit contains discrete detrital iron, lignites and evaporite horizons. The lake bed sediments are unconformably underlain by what is interpreted to be a highly weathered pelitic bedrock.

The shallow lake bed sediments are the primary geological unit of interest within the On-LDE and vary in composition from east to west due to varying depositional processes (Table 9-4). Island (Section 9.4.1.3) and claypan (Section 9.4.1.4) geologies are described separately due to their unique characteristics.

- West lake portion is characterised by a distinct white evaporite crust often underlain by a dark grey organic bed or laminations within a red-brown clay matrix and typically interspersed with gypsum crystals of varying grain sizes; and
- East lake portion is characterised by a variably cemented, white-brown, evaporitic crust, largely comprised of halite and gypsum underlain by a sequence of largely unconsolidated and damp gypsum sand.

Table 9-4: Lake lithology descriptions

Lithology	Description
Surficial Halite	Surficial halite layer occurs as either; <5mm white crystalline evaporite layer in the western and central areas of the lake. In the east the surficial halite is intermixed with pale brown fine to medium gypsum sand and forms a brittle crust with many voids and vugs.
Organic Material	A dark grey organic layer (preserved material) ranges in thickness from 3 mm to 30 mm. This layer lies immediately below the salt crust in the western and central areas of the lake and is exposed at the surface in depressions where the surficial halite crust has been dissolved. In the east, this layer occurs at variable depths immediately above the water table and first occurrence of clay.
Gypsum Sand	Gypsum sand is widespread across the lake and occurs in the western and central areas as interbedded layers in silt and clay layers. Gypsum sand in the eastern region of the lake immediately underlies the brittle crust makes up a major portion of the sediment profile. It varies from fine to coarse and is friable and unconsolidated.
Red Brown Clay	Red brown clay with interspersed bands of crystalline gypsum sand is the dominant lithology on the lake. It occurs within 0.1m of the surface in the west and up to 1.0 m from the surface in the east.
Crystalline Gypsum	Crystalline gypsum occurs as both interspersed crystals <50 mm in size at the lake water table and large laterally continuous horizons of consolidated crystal growths >100 mm at between 3 to 6 m depth, primarily encountered in the eastern region of the lake.

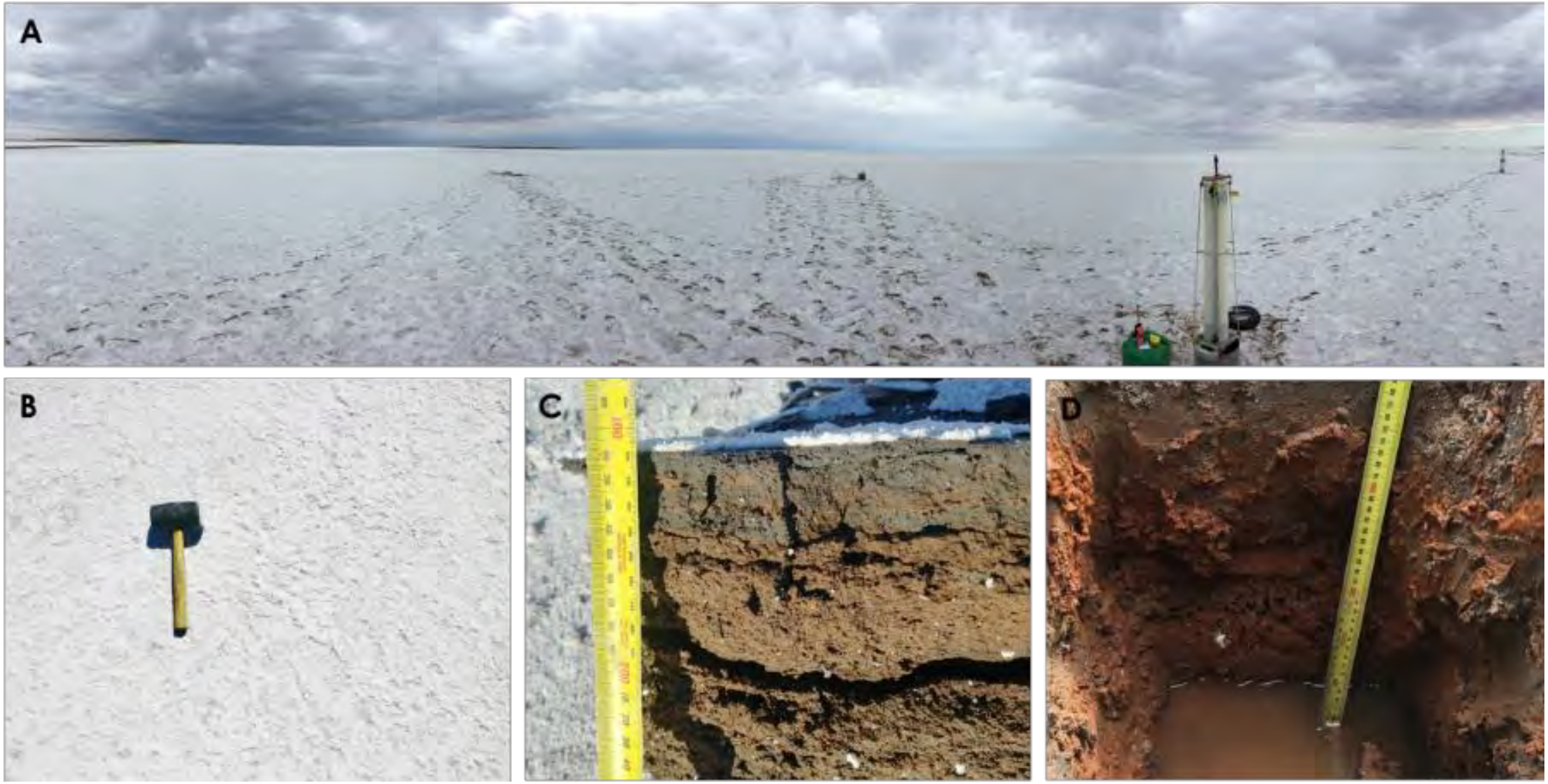

Plate 9-2: Western portion of Lake Mackay near surface sediment. (A) Surface expression of western lake sediment, (B) Evaporitic salt crust, (C) Organic mud and clay underlying salt crust, (D). Red-brown clay down to lake water table

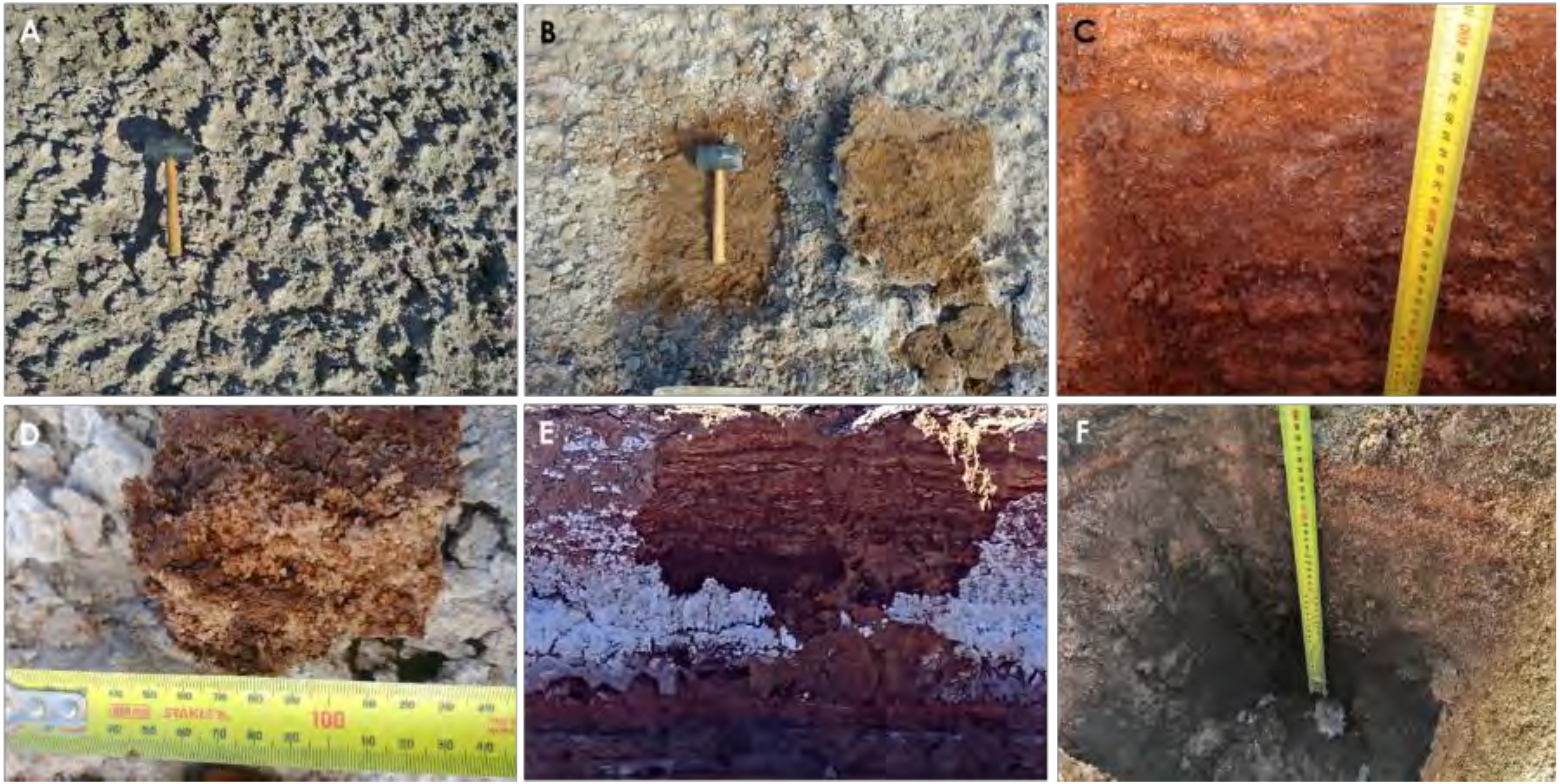

Plate 9-3: Eastern portion of Lake Mackay near surface sediment. (A), (B). Gypsiferous crust, (C), (D), (E). Coarse gypsum sand underlying crust, (F) Grey brown to red-brown clay at lake groundwater table

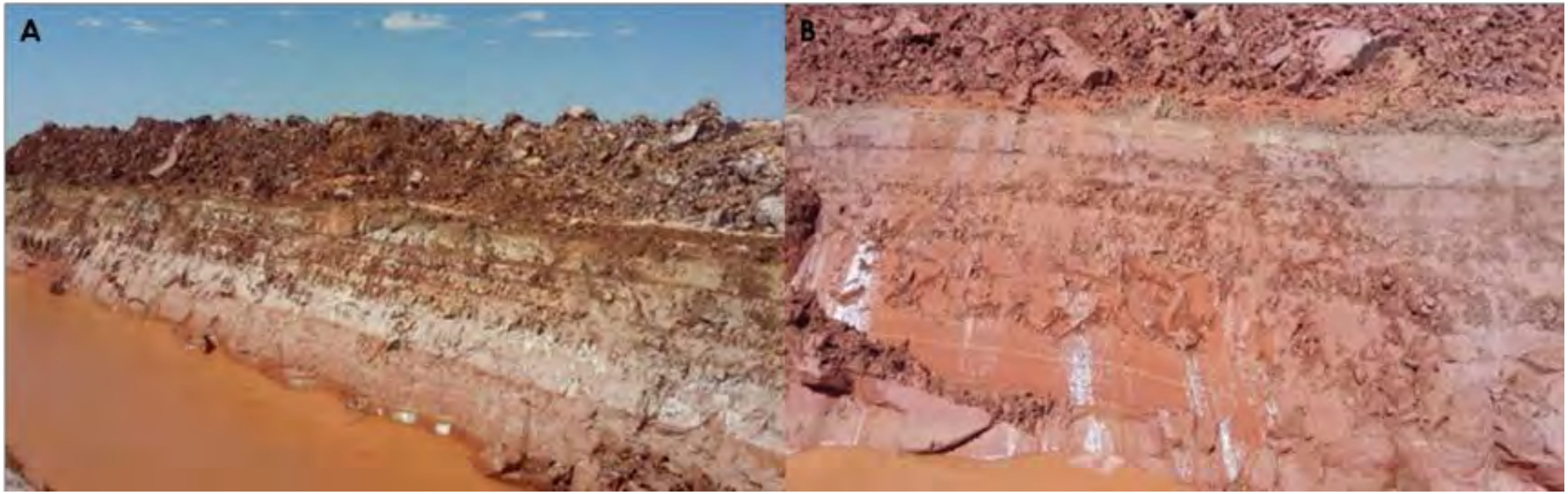

Plate 9-4: Example of lake bed stratigraphy (up to 3 m), exposed during the excavation of pilot trenches

9.4.1.2 Island geology

Lake Mackay is host to more than 270 islands within the On-LDE. These range from small unvegetated formations to large formations that host extensive sand dunes (Plate 9-5). The islands range from less than 1 m in height to more than 13.5 m, with the larger islands providing the greatest topographic relief (Appendix I.10). Drilling investigations completed on six lake islands (Appendix I.15) confirmed that they are surficial features of variable thickness underlain by lake bed sediments and are not linked to another subsurface geologic feature.

The lake islands are composed of unconsolidated aeolian sand at surface which is underlain by calcrete and gypsiferous sand. Clay content increases with depth and typically marks the transition from island sediment to the lake bed sediments. The thickness of the island sequences varies depending on the size of the island and topographical elevation.

9.4.1.3 Claypan geology

Ephemeral claypans occur on the Off-LDE and are irregularly spaced between the longitudinal dunes on the periphery of Lake Mackay (Plate 9-6). The claypans are typically flat and compact, baring ferruginous pisolitic pebbles scattered at the surface. Shallow excavation of these claypans returns poorly sorted interbedded sand and pebbles in a red-brown clay dominated matrix. These features allow the claypans to retain water after rainfall.

9.4.1.4 Southern geology

Within the SIDE, south of Lake Mackay, exploration has focussed on identifying a processing water supply. The geology in this region comprises rocks of the Amadeus Basin. The western portion of the SIDE is dominated by the Angas Hills Formation consists of interbedded pebble and cobble conglomerate, sandstone, pebbly sandstone and siltstone with a matrix of clayey sandstone and minor mudstone. The eastern portion of the SIDE hosts a sequence of sandstone, siltstone and shale and is consistent with the Carnegie/Pertatataka Formation.

9.4.2 Groundwater

A summary of the main groundwater related investigations completed across the On-LDE, Off-LDE, SIDE and southern regional area are presented in Table 9-5. Numerous field programs have targeted the surficial lake bed sediments to determine the hydrogeological properties. As part of this, drilling, utilising various methods, has been completed across the lake, with over 250 bores installed, many of which are used for groundwater monitoring. Several bores have been equipped with data loggers, collecting up to five years of continuous water level data.

In addition, trial trenches (up to 6 m in depth) have been excavated at 23 locations across the On-LDE, to understand groundwater properties, including hydraulic ranges, groundwater quality, groundwater drawdown and potential pumping rates from the lake bed sediments, as well as infill rates (sedimentation) for the trenches. Groundwater sampling and monitoring was also completed as part of drilling programs on the islands and for the SIDE (process water supply), while Southern Regional bore data was collected as part of subterranean fauna surveys (Section 8).

The results of these extensive investigations were used to develop an integrated groundwater flow and solute transport model for Lake Mackay and contributed to the water balance modelling (Table 9-5). The hydrogeological conceptual model for the lake and surrounding catchment is shown in Figure 9-2. Recharge, a key parameter investigated, is predominantly from direct rainfall onto the lake surface. Surface water contributions from the immediate catchment areas surrounding the lake are infrequent and only occur as a result of major rainfall events. As the lake is a terminal drainage point for the surrounding watershed, discharge is solely from evaporation and evapotranspiration.

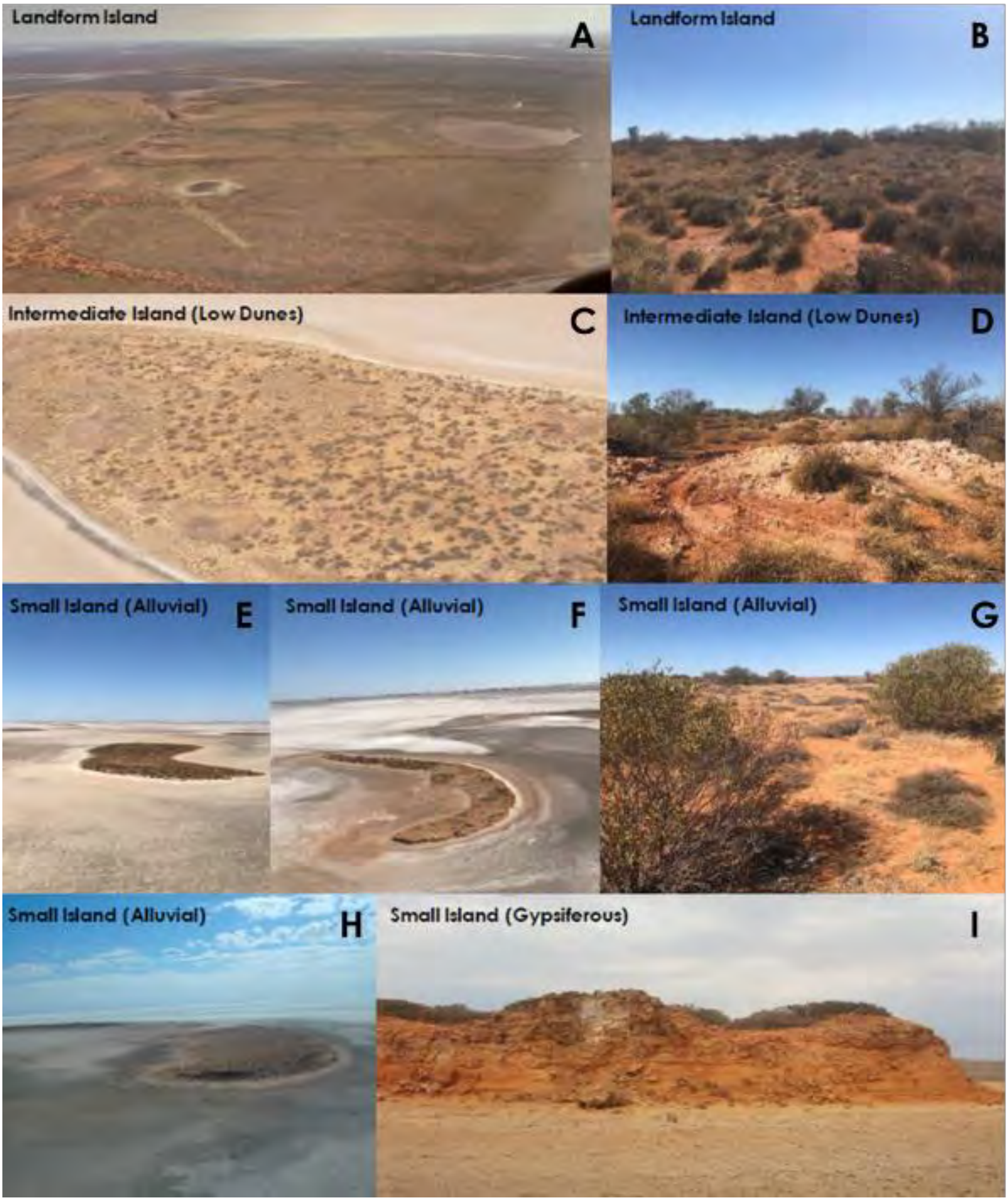

Plate 9-5: Different island morphologies on Lake Mackay from largest to smallest. (A-B) landform island, (C-D) intermediate islands, (E-H) small alluvial islands, and (I) small gypsiferous island.

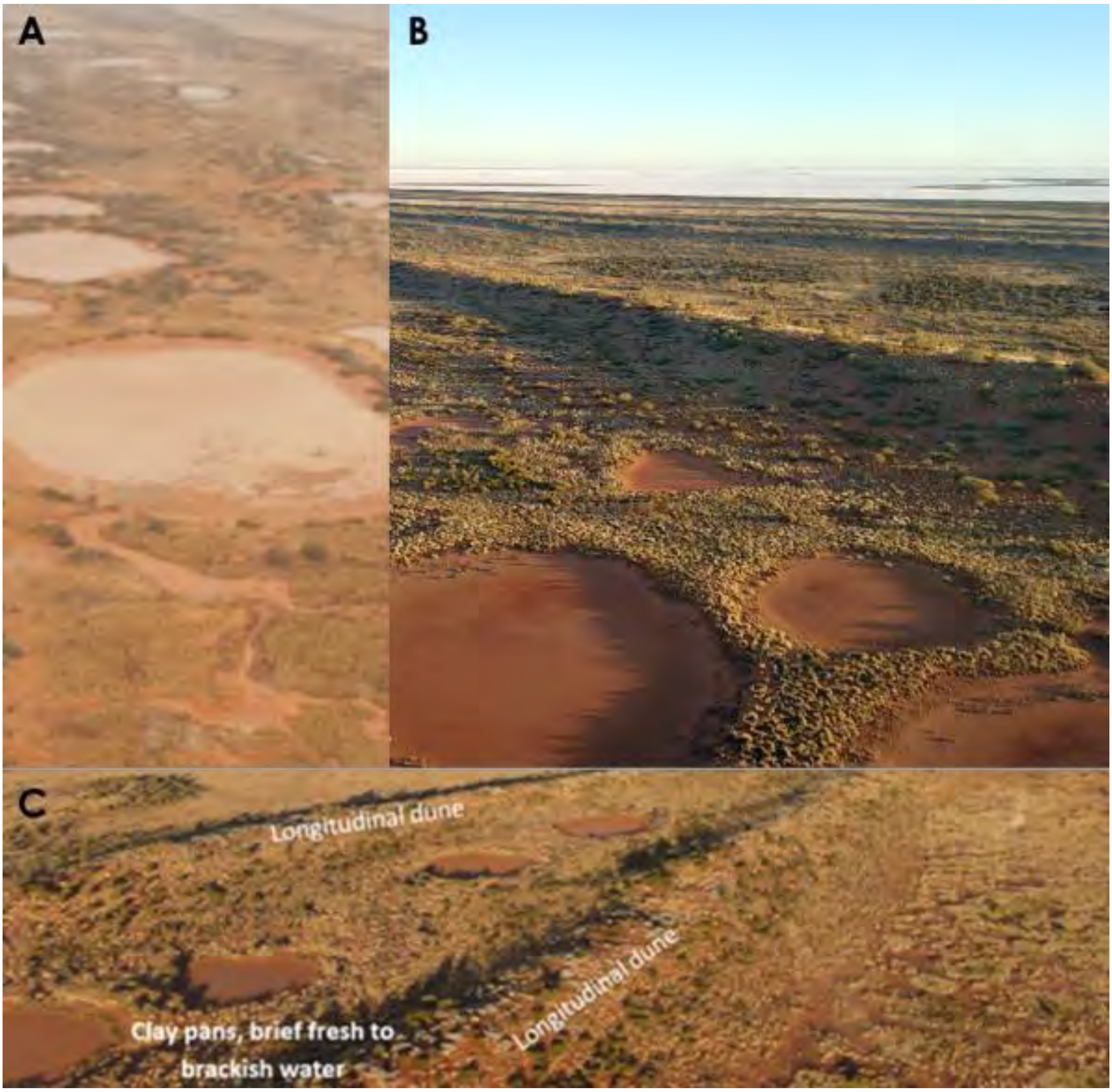

Plate 9-6: (A) inundated claypans after a rainfall event, (B) claypans during dry conditions, and (C) claypans between longitudinal dunes.

Table 9-5: Summary of key groundwater data and studies

Reference	Area	Title
Groundwater Exploration Services (2016)	On-LDE	Lake Mackay Preliminary Groundwater Modelling Study
Hydrorminex Geoscience (2017)	On-LDE	Technical Report on the Lake Mackay Potash Project Western Australia
Advisian (2018)	On-LDE	Prefeasibility Study Chapter 6: Hydrological and Hydrogeological Modelling
Knight Piesold (2018)	On-LDE	Hydrogeological Modelling for the Mackay SOP Proposal Prefeasibility Study
Agrimin (2020)	On-LDE	Closed Lysimeter Testing Memorandum
Agrimin (2020)	On-LDE, Off-LDE	Definitive Feasibility Study
Agrimin (2020)	On-LDE	Infill Drilling Memorandum
Agrimin (2020)	On-LDE	Infiltration Testing Memorandum
Agrimin (2020)	On-LDE	Island Drilling Memorandum
Agrimin (2020)	On-LDE	Regional Lake Groundwater Levels Memorandum
Agrimin (2020)	On-LDE	Shelby Tube Sampler Memorandum
CDM Smith (2020)	SIDE	Water Supply Assessment for Mackay SOP Project
Stantec (2020)	On-LDE	Trench Pump Test Analysis Report
Agrimin (2020)	On-LDE	Island Impacts Groundwater Memorandum
Stantec (2020)	On-LDE	Integrated Groundwater Flow and Solute Transport Model Report
Agrimin (2020)	On-LDE	Long Term Pump Test Memorandum
Stantec (2020)	On-LDE	Lake Mackay Stage 1 and Stage 2 Surface Water Assessment
Stantec (2020)	On-LDE	Island Characterization Memorandum
Stantec (2020)	On-LDE	Recharge Assessment Memorandum
Stantec (2020)	On-LDE	Recharge Lab Assessment Memorandum
Agrimin (2021)	On-LDE, SIDE	Groundwater Sampling and Analysis Memorandum
Stantec (2021b)	On-LDE, Off-LDE	Lake Mackay Inundation and Water Balance Modelling Memorandum

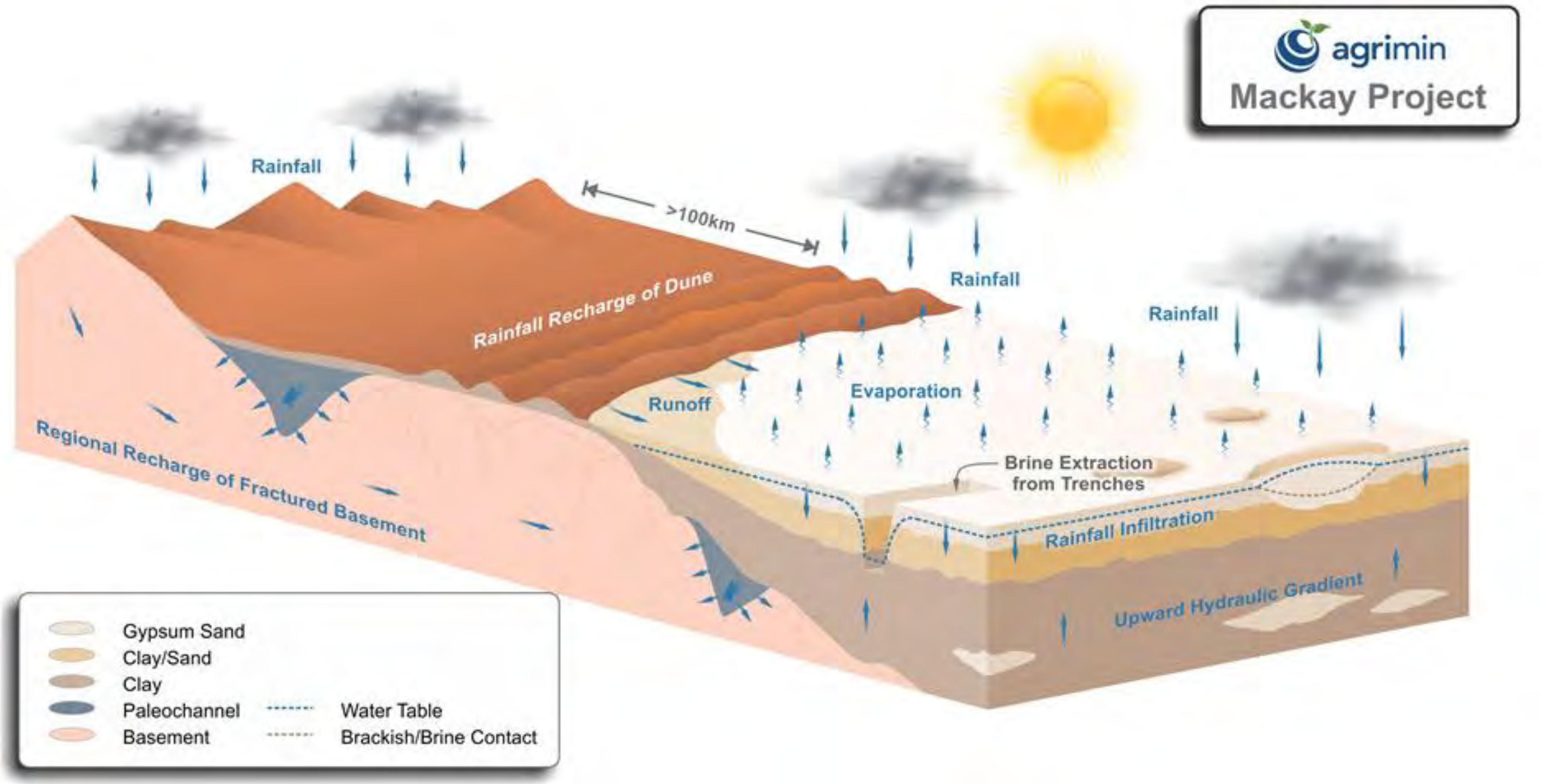

Figure 9-2: Conceptual Hydrogeological Model of Lake Mackay

9.4.2.1 Lake groundwater

The relatively flat topography of Lake Mackay results in a very low horizontal groundwater flow gradient (<0.0002 m/m) in a northwest to southwest direction (Appendix I.16). In 2019, during prolonged dry conditions, groundwater levels showed minimal change on the lake between the wet (March) and dry seasons (September), with only approximately a 0.2 m variation between the monitoring periods (Figure 9-3, Figure 9-4). However, long-term (five years) groundwater level monitoring across the lake, plus more recent and detailed (<2 years) monitoring of test trenches and piezometers, shows seasonal fluctuations in groundwater levels ranging from 0.4 to 0.7 mbgl, with an average fluctuation of 0.3 m.

Groundwater levels at monitoring bores tend to increase rapidly in response to the first major rainfall event of the wet season. As rainfall frequency decreases toward the end of the wet season, levels begin to recede in response to groundwater discharge via evaporation. This gradual decline in groundwater level continues until the cycle resets at the commencement of the following wet season (Figure 9-5). Data from two bores located on two lake islands do not show the same rapid increase following rainfall. This is attributed to the increased topographical elevation of the islands and therefore the greater depth to groundwater levels on the islands (Figure 9-5).

Under prolonged dry conditions, groundwater levels show a decreasing trend over time; up to 0.2 mbgl (Figure 9-5), observed since monitoring commenced in 2017. observed since monitoring commenced in 2017. This was associated with below average rainfall, with only 169 mm received in 2018 and only 30 mm recorded in 2019, compared to the average of approximately 300 mm. Data for 2020 (although incomplete), also indicates rainfall will be below the annual average.

Groundwater characteristics associated with the lake bed sediments varies from east to west across the lake (Appendix I.2 - I.9), due to the differing geological composition and can be broadly summarised as follows:

- West lake portion - relatively low infiltration rates (range 1.8 mm/h to 42 mm/h) and low hydraulic connectivity (range 0.46 m/day to 5.22 m/day) (Appendix I.9). This results in water remaining on the surface for several days following a rainfall event.

- East lake portion - high infiltration capacity (range 1280 mm/h and 5750 mm/h) and high hydraulic conductivity (range 6.7 m/day and 200 m/day) (Appendix I.9). The high infiltration rates of this area result in surface water rapidly infiltrating the lake bed sediments following major rainfall events.

In addition, from extensive recharge and evaporation test work, the east and west portions of the lake were further subdivided into four recharge and evapotranspiration zones (Zones1 to 4). Recharge as a percentage of the mean annual precipitation ranged from 38% to 43% in the western recharge Zones 1 and 2 respectively, and between 18% to 13% in the eastern recharge Zones 3 and 4 respectively (Appendix I.9). The relevance of this is that as groundwater levels decrease, the amount of recharge increases. The most recharge is experienced in Zones 1 and 2, with the least recharge occurring in Zone 4. While infiltration is high in Zone 4, evaporation of stored water in the profile is quickly evaporated reducing the amount of time for water to migrate past the groundwater reference depth.

Groundwater sampling and monitoring at Lake Mackay indicates the lake bed sediments are characterised by circumneutral pH (mean of 6.6), with naturally elevated nitrate concentrations (Table 9-6)(Appendix I.20). Groundwater salinity of lake bed sediments varies across the lake, although is typically greater than 200,000 mg/L, with a maximum of approximately 340,000 mg/L (Table 9-6). In contrast, the major ionic constituents of the lake bed sediments are consistent (Figure 9-6), comprising a cation dominance of Na>K>Mg>Ca, and an anion sequence of $Cl>SO_4>HCO_3$ (Table 9-6). Background concentrations of Na and Cl are approximately 100,000 mg/L and 145,000 mg/L, respectively, while potassium concentrations range from 3000 mg/L to 3,350 mg/L (Appendix I.13).

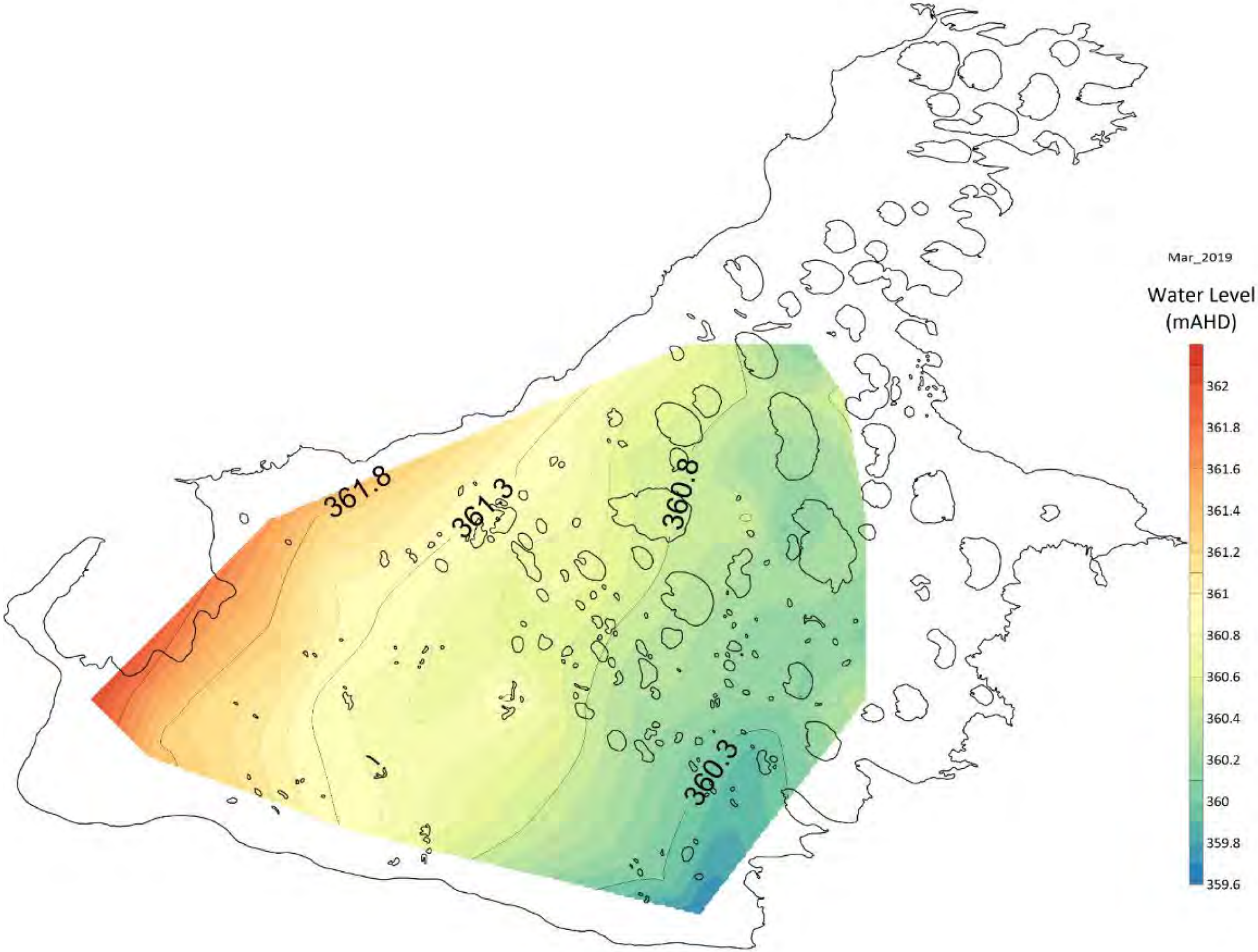

Figure 9-3: Groundwater levels at Lake Mackay in March 2019 (wet season)

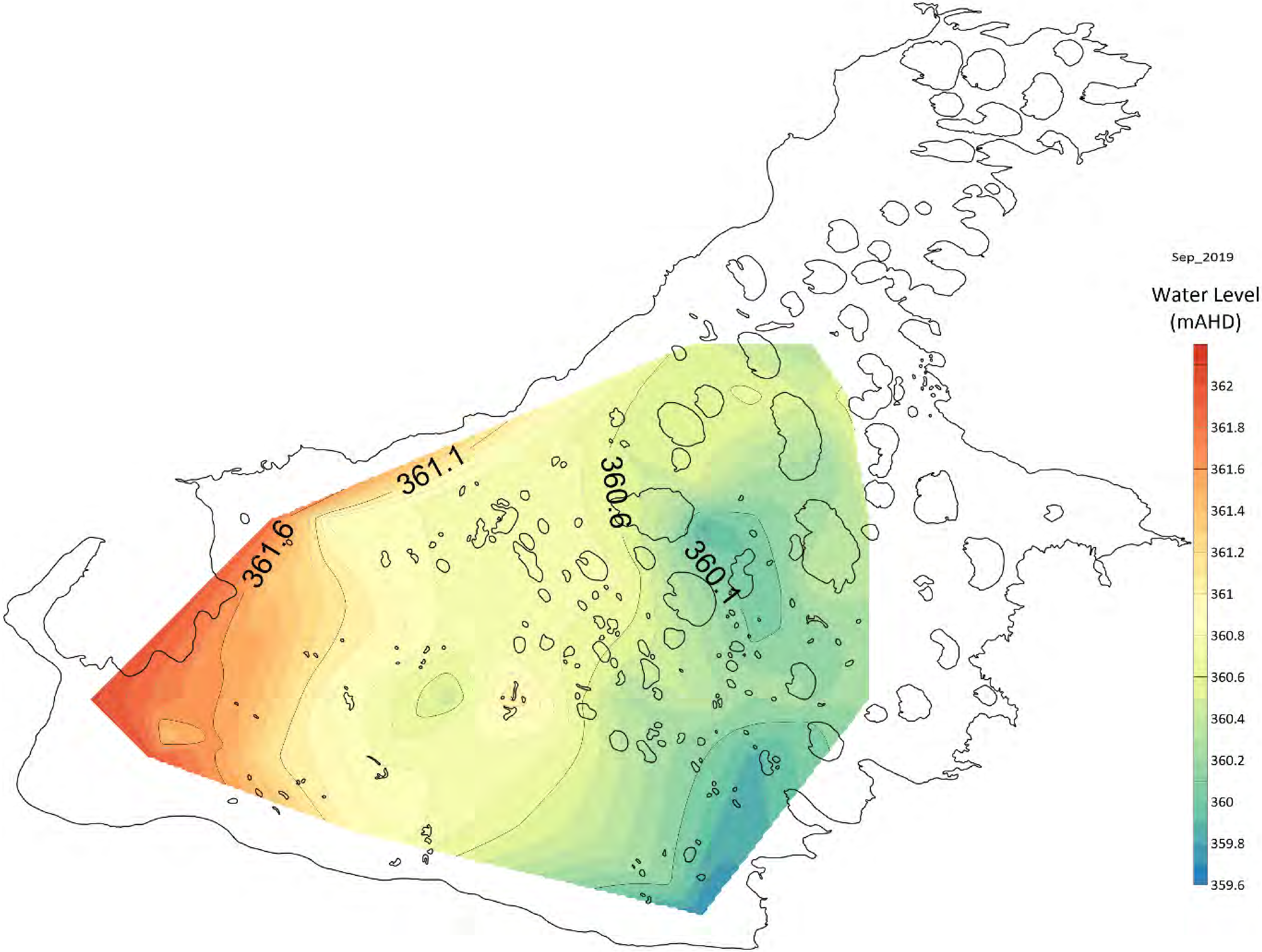

Figure 9-4: Groundwater levels at Lake Mackay in September 2019 (dry season)

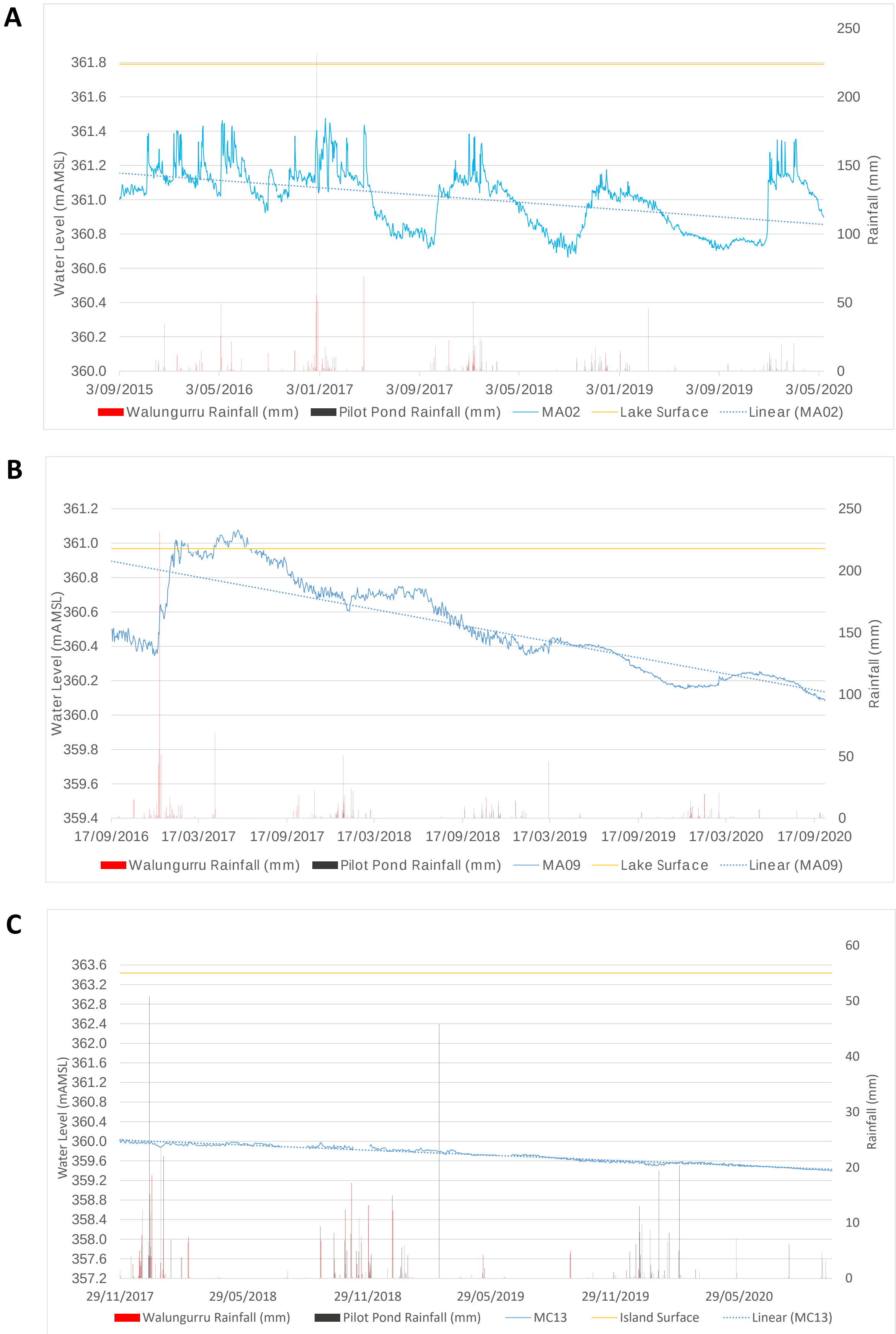

Figure 9-5: Seasonal fluctuation in groundwater levels compared to rainfall. (A) Western portion of the lake (MA02), (B) eastern portion of the lake (MA09), and (C) landform islands (MC13)

Table 9-6: Summary of groundwater quality from lake bed sediments during trench pump testing

Parameter	Records	Minimum	Mean	Median	Maximum
pH (units)	32	5.34	6.63	6.68	7.22
Salinity (TDS)	349	6,569	214,678	228,456	339,995
Magnesium	213	57	2,551	2,240	6,790
Calcium	213	140	598	602	1,220
Sodium	213	6,823	88,786	89062	134,348
Potassium	213	390	3,088	3080	9,640
Chloride	213	164	131,987	132050	186,950
Sulphate	213	3,870	19,688	19325	60,900
Bicarbonate	28	10	37	20	210
Nitrate	32	4	31	11	151

Note: all parameters are mg/L, except where shown.

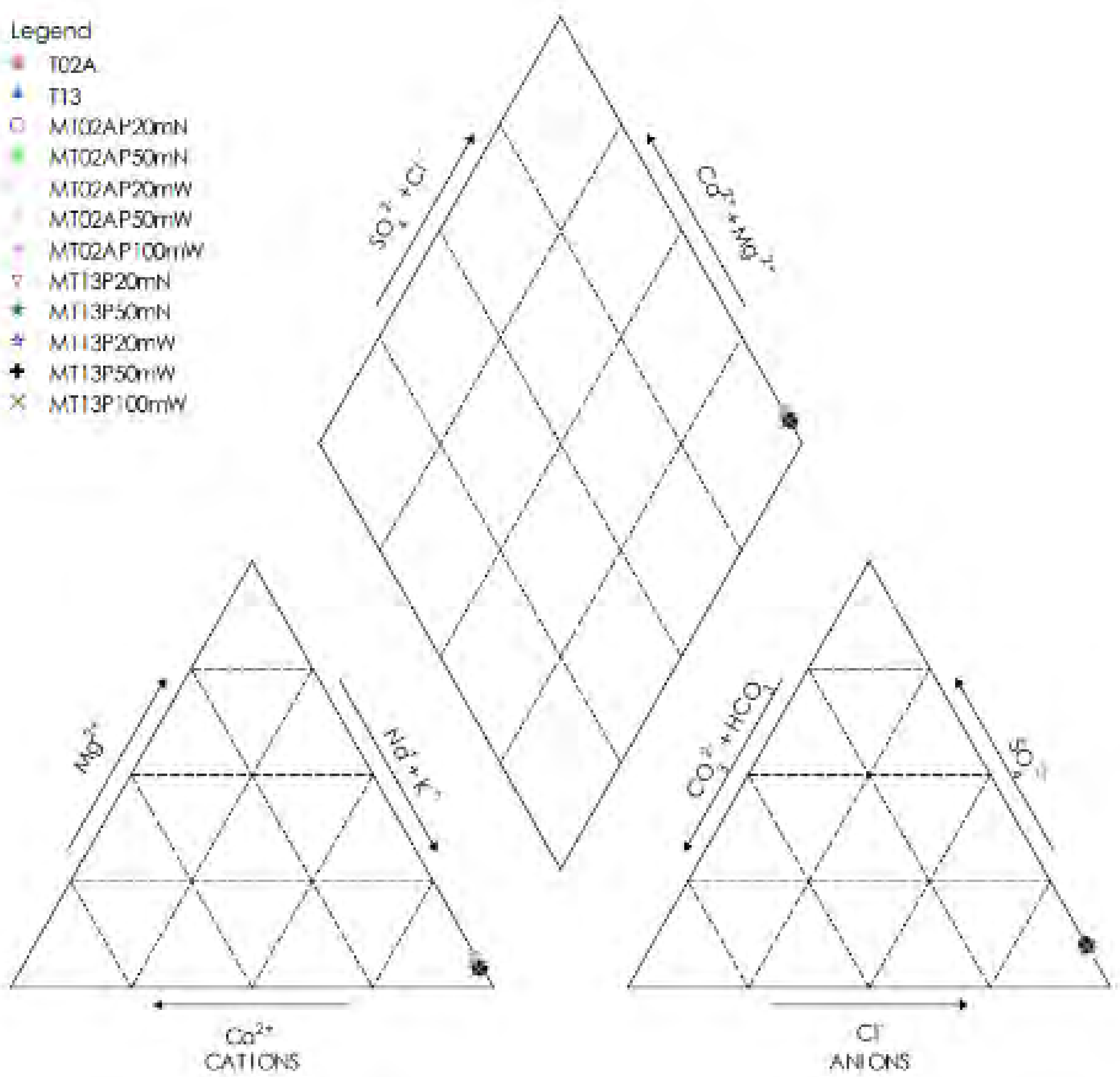

Figure 9-6: Piper plot showing ionic composition of groundwater within the lake bed sediments

9.4.2.2 Island groundwater

The depth to groundwater on the islands of Lake Mackay varies, depending on immediate topography, however, is typically less than 5 mbgl (Appendix I.15). Groundwater levels are influenced by a dynamic equilibrium between precipitation, evaporation and evapotranspiration.

The largest landform islands in the eastern portion of the lake also appear to host a lower salinity water, within the porous gypsiferous sands that overlay the clay dominant lake bed sediments (brine). The pH is typically circumneutral (mean6.9), with naturally elevated nitrate concentrations (Table 9-7). Salinities are typically below 60,0000 mg/L, with an ionic composition dominated by Na and Cl (Table 9-7).

The lower salinity groundwater is likely associated with the infiltration of rainfall into the shallow, permeable aeolian sediment and where present, with calcrete outcrops. Seasonal fluctuations in water levels are expected on the islands, associated with both temporal water levels within the aeolian sands and the deeper lake bed sediments.

Initial data collected from field investigations on one of the major landform islands are that the island features act as recharge zones to the lake bed sediments below them. Above average rainfall events (>300 mm in one month) are likely to result in significant recharge, saturating the vadose zone and increasing groundwater levels to within 0.6 m of the surface (Appendix I.4). This process is also likely responsible for sustaining riparian vegetation on the islands. Further studies are planned to characterise the groundwater occurrence of the lake islands.

Table 9-7: Summary of groundwater quality from the islands during drilling

Parameter	Records	Min.	Mean	Median	Max.
pH (units)	2	6.83	6.87	6.87	6.90
Salinity (TDS)	2	41,864	48,988	48,989	56,113
Magnesium	2	373	446	446	520
Calcium	2	1,080	1,135	1,135	1,190
Sodium	2	12,450	14,675	14,675	16,900
Potassium	2	325	418	418	510
Chloride	2	20,425	24,738	24,738	29,050
Sulphate	2	5,295	5,573	5,573	5,850
Bicarbonate	2	40	105	105	170
Nitrates	2	8	38	38	68

Note: all parameters are mg/L, except where shown.

9.4.2.3 Southern regional groundwater

Two prospective aquifer units have been identified in the SIDE, with depth to groundwater between 5.8 m bgl and 8.2 m bgl (Appendix I.12). These units host groundwater characterised by circumneutral pH (mean7.3), with salinity concentrations ranging from approximately 1,600 mg/L to 6,300 mg/L (Table 9-8). In comparison, bores in the surrounding southern regional area range from less than 5,000 mg/L to approximately 47,000 mg/L, with concentrations decreasing with distance from the lake.

Table 9-8: Summary of groundwater quality from the SIDE/Southern Regional area during drilling

Parameter	Records	Min.	Mean	Median	Max.
pH (units)	3	7.2	7.27	7.3	7.30
Salinity (TDS)	3	1,567	3,465	2,528	6,300
Magnesium	7	35	69	55	180
Calcium	7	55	118	95	264
Sodium	7	350	695	600	1,622
Potassium	7	30	49	40	124
Chloride	7	326	867	950	1,290
Sulphate	7	240	503	390	1,312
Bicarbonate	3	296	345	315	424

Note: all parameters are mg/L, except where shown.

9.4.3 Surface hydrology

There have been several studies undertaken on Lake Mackay (Table 9-9), used to inform the key surface water assessment and modelling for the Proposal (Appendix I.11 and Appendix I.21). This included a detailed LiDAR survey, and the compilation of climate, satellite imagery and geology data, which provided the basis for the surface water modelling. Modelling was used to assess surface water levels and the frequency, duration, and extent of flooding in relation to individual rainfall events (Appendix I.11) and long-term hydrological cycles in relation to the lake's water balance (Appendix I.21). This provided an understanding of the natural hydrological regime of the lake in relation to the development of the Proposal. In addition, assessment of the salt balance and ionic composition of the lake was completed (Table 9-9), focussing on the evaporation ponds and salt piles associated with the Proposal (Appendix I.18).

Table 9-9: Summary of surface hydrological and hydraulic data and studies

Reference	Area	Title
Agrimin 2019	On-LDE	Agrimin LiDAR survey of the Western Australia portion of Lake Mackay (1 m Digital Elevation Model)
Advisian 2018	On-LDE	Hydrological and hydrogeological modelling for the Mackay SOP Proposal Prefeasibility Study
Agrimin 2018	On-LDE, Off-LDE	Hydrology and hydrogeology of the Lake Mackay SOP Proposal, Western Australia
https:eos.com/landviewer	On-LDE	Time series function analysis of Lake Mackay inundation (1982-2020)
Stantec 2020	On-LDE	Salt Balance and Ionic Composition Memorandum for the Mackay SOP
Stantec 2021a	On-LDE, Off-LDE	Lake Mackay Stage 1 and Stage 2 Surface Water Assessment
Stantec 2021b	On-LDE, Off-LDE	Lake Mackay Inundation and Water Balance Modelling Memorandum

9.4.3.1 Lake Hydrology

Lake Mackay is the fourth largest salt lake in Australia and the largest in WA, covering an area of approximately 3,500 km^2, extending more than 100 km east-west and 80 km north-south. The topography of Lake Mackay and surrounds is subdued and flat. Lake bed elevations range from approximately 360 mAHD in the east to 364 mAHD in the west. The deepest parts of the basin are located in the south eastern extremities during inundation, while the western half of the lake is comparatively shallow. The eastern portion of the lake is also characterised by more than 270 islands varying in size from less than 100 ha to >2,000 ha. The largest of these, classified as landform islands, are more than 13.5 m in height above the lake surface and support a diverse range of geology and biodiversity (Appendix I.10).

Lake Mackay lies within the internally draining Mackay Basin. The lake is a closed system with no outflow or historic evidence of spilling into adjacent lakes. A regional surface water assessment (Appendix I.11) determined that the total catchment area of Lake Mackay is approximately 87,000 km^2, of which only approximately 20% is considered effective in terms of contributing direct surface water runoff. The catchment stretches more than 550 km east of the lake into the MacDonnell Ranges and comprises three sub-catchments. The east to west drainage line is uncoordinated along its length, comprising hundreds of small playas that superficially resemble a river flow path, although a dune system substantially impedes surface water movement. Flow paths meander longitudinally along the dunes, with surface water movement only likely to occur intermittently at topographic lows.

There are small ephemeral creeks and watercourses along the margins of the lake that drain the surrounding landscape and potentially contribute surface water runoff to the lake during periods of extreme rainfall. These features are localised and tend to be more common in the southeast portion of the lake. Based on a review of aerial photographs and available topographic data, no major defined channels appear to reach the lake (Appendix I.19).

The lake is predominantly dry and is rarely subject to inundation. The northern and western portions of the lake are less likely to hold water, attributed to lower infiltration rates and higher surface elevation. In comparison the south-east portion of the lake coincides with higher infiltration rates and lower topographic elevation. Rainfall events of approximately 30 mm typically occur several times each year, resulting in the formation of isolated, pooled surface water usually within the southern half of the lake. However, these shallow bodies of water (<0.1 m) are strongly influenced by prevailing winds, infiltration, and evaporation, rarely persisting on the lake for longer than a few days (Agrimin, pers. comm. 2020).

More widespread inundation occurs in response to large, infrequent rainfall events. While extended dry conditions can prevail, storms and cyclones that move inland from the northern coastline of WA have the potential to generate intensive rainfall, particularly during the wet season. Given the size of the catchment and surface area of the lake, peak inflows generally result from longer duration storms (three to four days of storm activity). During peak flow conditions there are some areas of concentrated flow between islands and/or, where inflow from external runoff enters the lake. While typically negligible, flow velocities of up to 0.5 m/s may occur under peak conditions.

According to the analysis of satellite imagery, Lake Mackay is dry approximately 60% to 75% of the time. When inundated, following large rainfall events, there is a high degree of variability in the frequency, extent and distribution of surface water, influenced by the spatial distribution and intensity of rainfall, as well as prevailing winds and evaporation. Hydrological modelling indicates that the lake appears to fill to an average of approximately 2 m, once every 5 to 10 years (Appendix I.21) (Stantec 2021e)which inundates most of the visible perimeter of the lake. As shown in Figure 9-7 and in the additional satellite imagery in Appendix I.21, the deepest areas with the longest retention times on the WA portion of the lake occur in the southeast extremity. It is likely that the NT side is deeper; however, no detailed terrain data were available for the NT side of the lake (Duguid *et al.* 2005). The lake may remain inundated for several months while subject to major flooding; however, the persistence of surface water is variable and dependent on preceding conditions. There are also smaller pockets of the lake that hold water more regularly and for longer, periods, including the north western arm and central southern area of the lake adjacent to a small island (Appendix I.21).

The longest inundation of Lake Mackay based on the available records occurred in 2001 (Plate 9-7). This followed well-above average annual rainfall (at Balgo) during the preceding wet season of 2000 (768 mm), and again in 2001 (796 mm), causing flooding of the lake equivalent to a 1:20 or 1:50-year event (Appendix I.21). Water levels were initially predicted to reach over 2 m across most of the playa (up to 4 m in the south-east), spilling into the surrounding riparian vegetation zone (Figure 9-7). During this period, surface water persisted for more than 12 months between December 2000 and early March 2002 and appeared to peak in April 2001 (Appendix I.21).

Most recently in December 2016, more than 400 mm of rainfall was measured at Walungurru Airport, causing a major flood, with surface water lasting on the lake for approximately six months until June 2017 (Plate 9-7). In early 2021 more than 180 mm of rainfall was recorded at the Lake Mackay weather station, corresponding to inundation of the lake for approximately two months (Appendix I.21). Analysis of satellite imagery also indicates that since 2000, the lake has had increased rainfall, resulting in more frequent, smaller inundation events (Plate 9-7). This is likely attributed to climate change, with increased intensity of rainfall during the wet season. However, major flood events such as those that occurred in 2000 and 2001 are rare, with the lake tending to dry rapidly unless subsequent top-up rainfall occurs (Appendix I.21).

9.4.3.2 Claypan Hydrology

Lake Mackay is surrounded by numerous smaller claypans and saline wetlands; there are more than 200 of these waterbodies within 10 km of the playa. They are typically inundated during the wet season, by direct rainfall and surface water runoff from the immediate catchment area; however, they can also hold water for short periods (typically less than one week) following approximately 10 mm or more of rain (Agrimin, pers. comm. 2020). They are typically perched surface water features isolated from groundwater due to the low permeability of their substrate. Infiltration is negligible, demonstrated by the persistence of surface water several weeks following a rainfall event. The discharge of water from the claypans is primarily by evaporation.

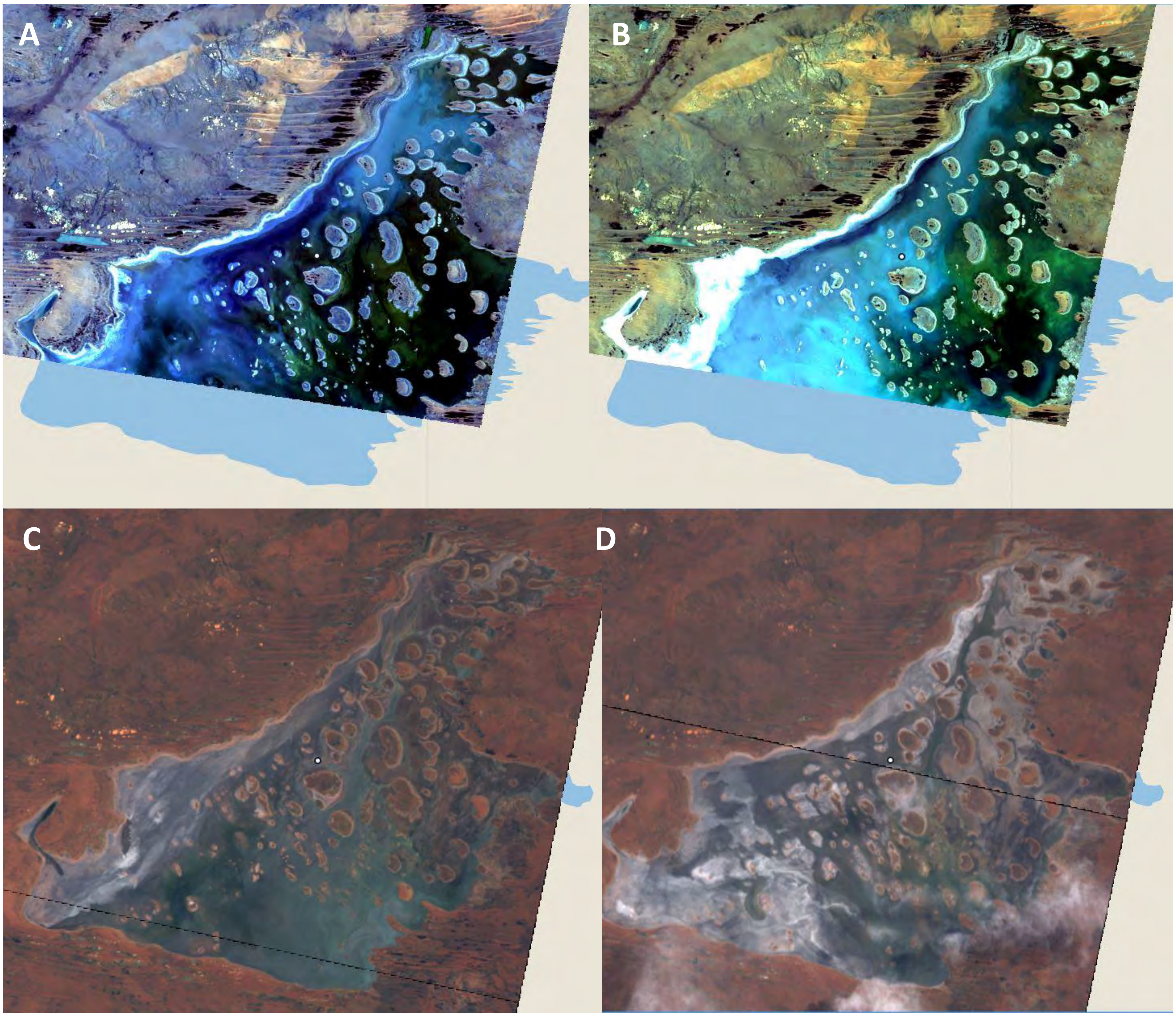

Plate 9-7: Satellite imagery of previous major flood events on Lake Mackay. (A-B) May and June 2001, and (C-D) February and March 2017.

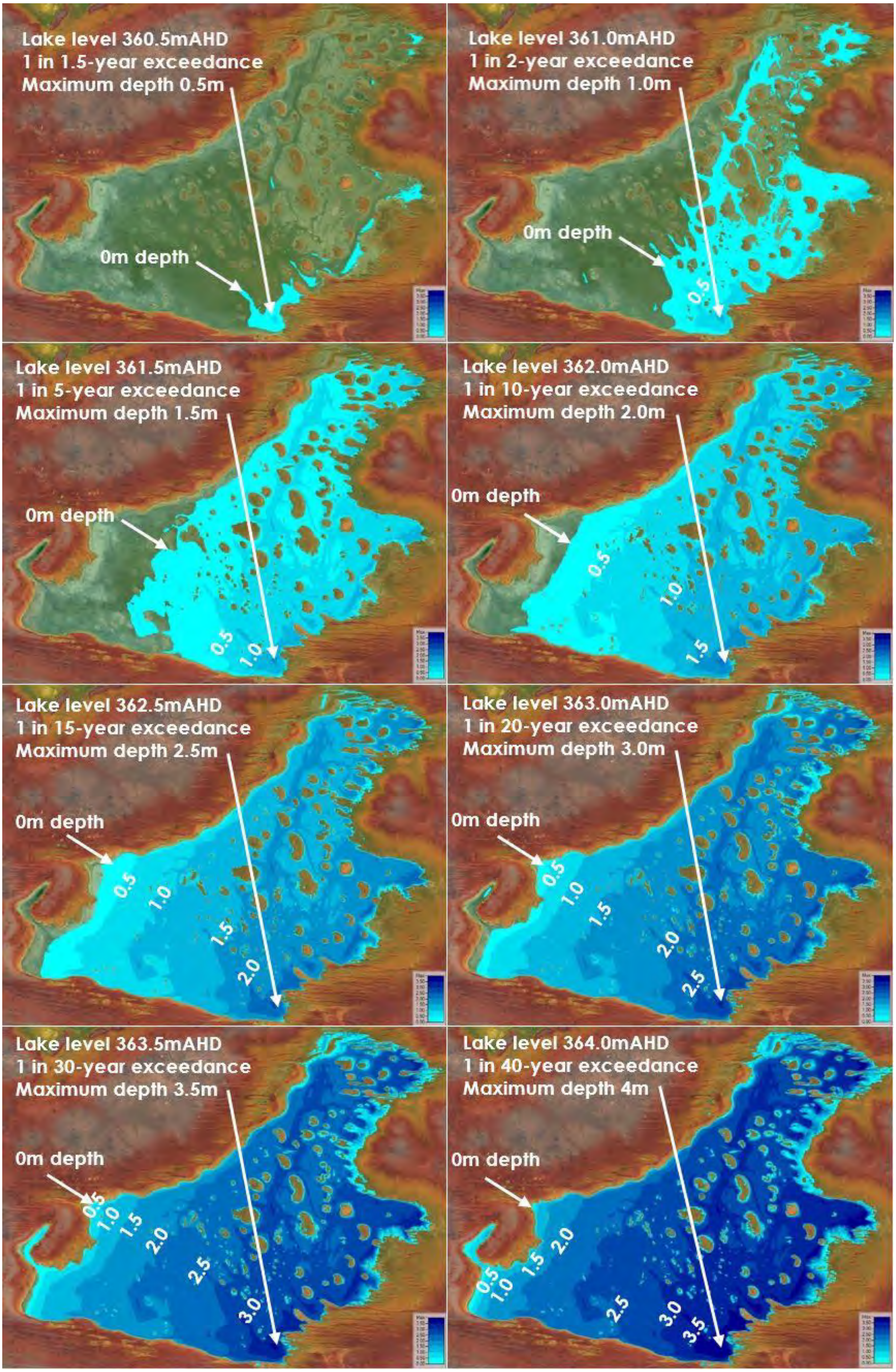

Figure 9-7: Surface water levels on Lake Mackay, based on topography

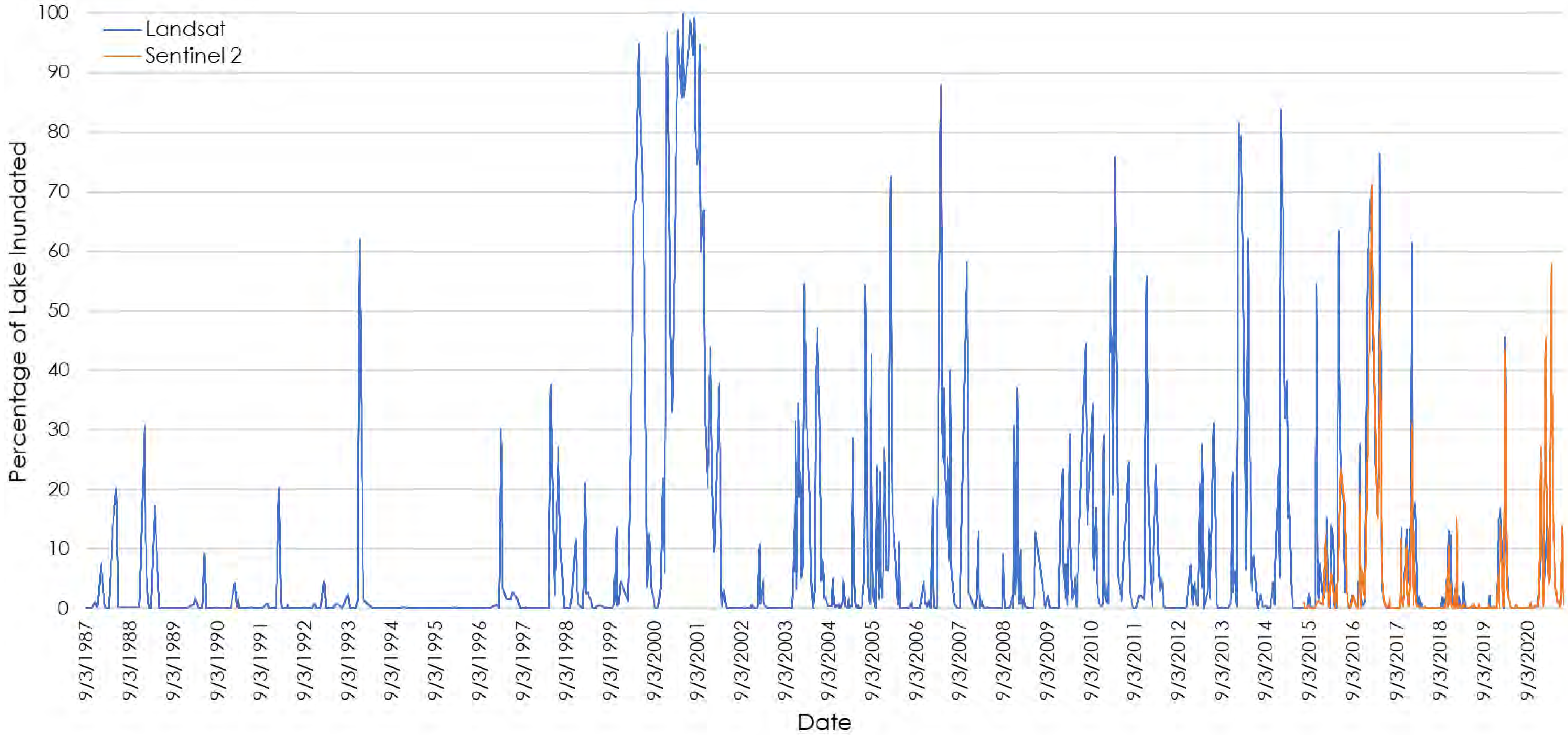

Figure 9-8: Percentage surface area of Lake Mackay inundated from Landsat and Sentinel satellite imagery from 1987 to 2021.

9.4.4 Aquatic ecology

9.4.4.1 Aquatic Ecology Survey Effort

There have been several lake-based ecological studies, which have investigated lake sediment, aquatic biota, riparian vegetation and waterbirds, the technical reports of which are presented in Appendix G to Appendix J. A summary of these studies is also provided in Table 9-10, with Figure 9-9 showing aquatic ecology sampling sites on the lake and periphery. The majority of these studies have been completed during prevailing dry conditions (Plate 9-8).

Prior to undertaking opportunistic flood survey work in early in early 2021 (Appendix J), there was limited information available on the lake during inundated conditions. One exception was a comprehensive waterbird survey completed in 2021 (Table 9-10). Limited sampling of aquatic invertebrates was also undertaken at the end of the hydroperiod in 2017, with a waterbird survey of the lake and claypans. Riparian vegetation has been assessed on several occasions, including the assessment of transects and targeted collection of flowering plants (Table 9-10, Figure 9-9, Figure 9-10).

Between May 2019 and April 2021, a comprehensive baseline aquatic ecology study was undertaken (Appendix J). This comprised a desktop review to consolidate previous studies on the lake, and the results of five separate field surveys, which sampled Lake Mackay, the islands and peripheral wetlands, in both dry (Plate 9-8) and flooded conditions (Plate 9-9). During the 2019 and 2020 field surveys (Appendix J), conditions were dry, with 26 sites assessed in total, across the WA portion of the lake, islands and peripheral wetlands (Table 9-10, Figure 9-9). Sediment samples were collected for chemical analysis and to conduct laboratory rewetting trials, which simulate a major flood event and provide a measure of biodiversity. Sampling of riparian vegetation was also undertaken, with transects established at 19 sites (Table 9-10, Figure 9-9, Figure 9-10).

Following substantial rainfall events in February and March 2021 (Plate 9-9), opportunistic sampling of 22 sites across Lake Mackay (including an island claypan) and peripheral wetlands occurred during flooded conditions (Figure 9-9). Ecological components sampled included water and sediment quality, algae and macrophytes, diatoms and aquatic invertebrates (Appendix J). Targeted collection of flowering Tecticornia (samphires) was undertaken and consolidated with previous survey effort (Table 9-10, Figure 9-9, Figure 9-10), with a summary of the opportunistic waterbird survey also collated (Table 9-10). A synthesis of the key findings from the baseline aquatic ecology study, and relevant information from previous surveys of the lake and claypans are provided in Sections 9.4.4.2 to Section 9.4.4.4.

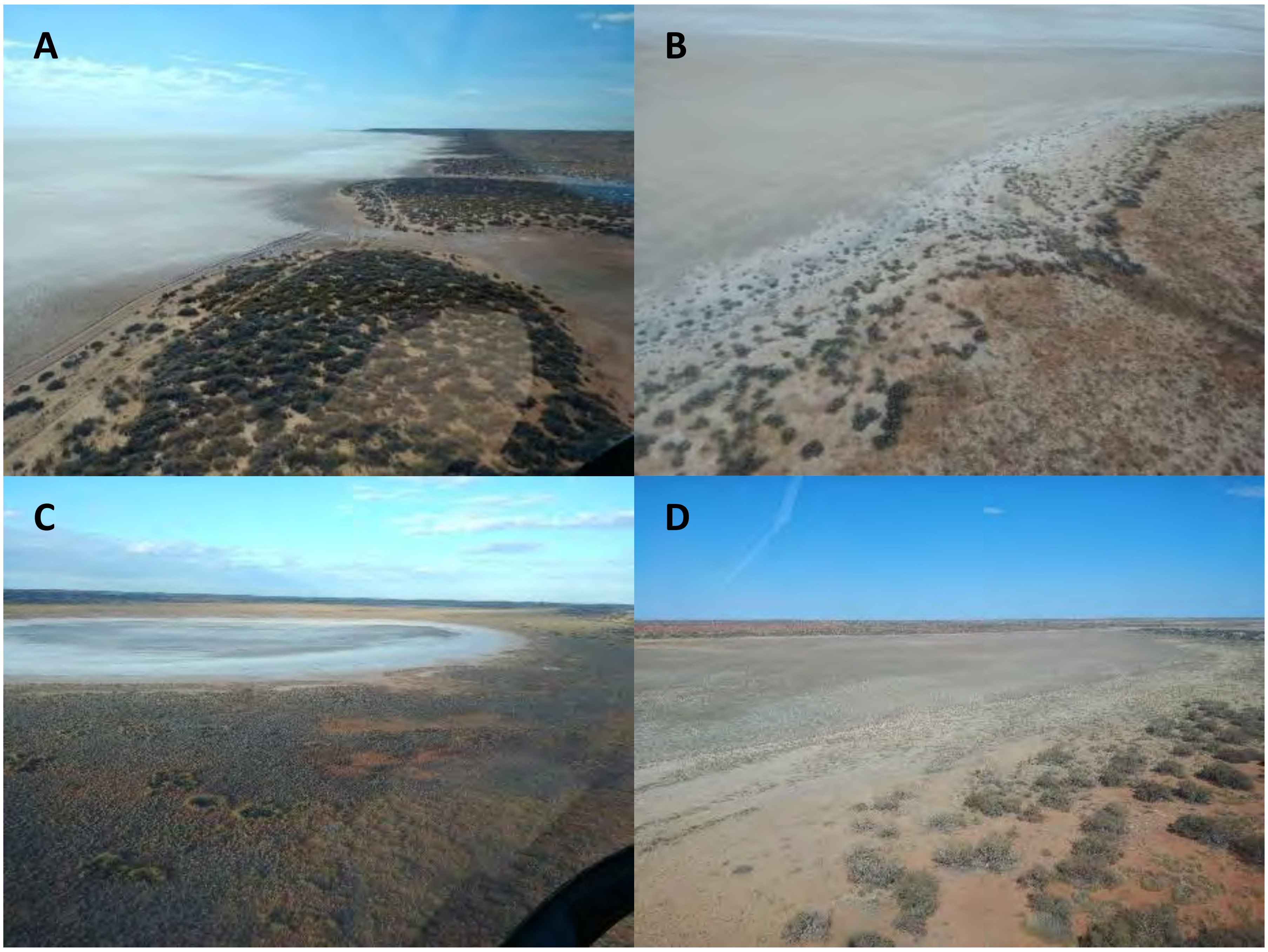

Plate 9-8: Sampling sites during dry conditions (A) Site in the western portion of Lake Mackay, (B) site in the eastern portion of Lake Mackay, and (C-D) peripheral wetlands

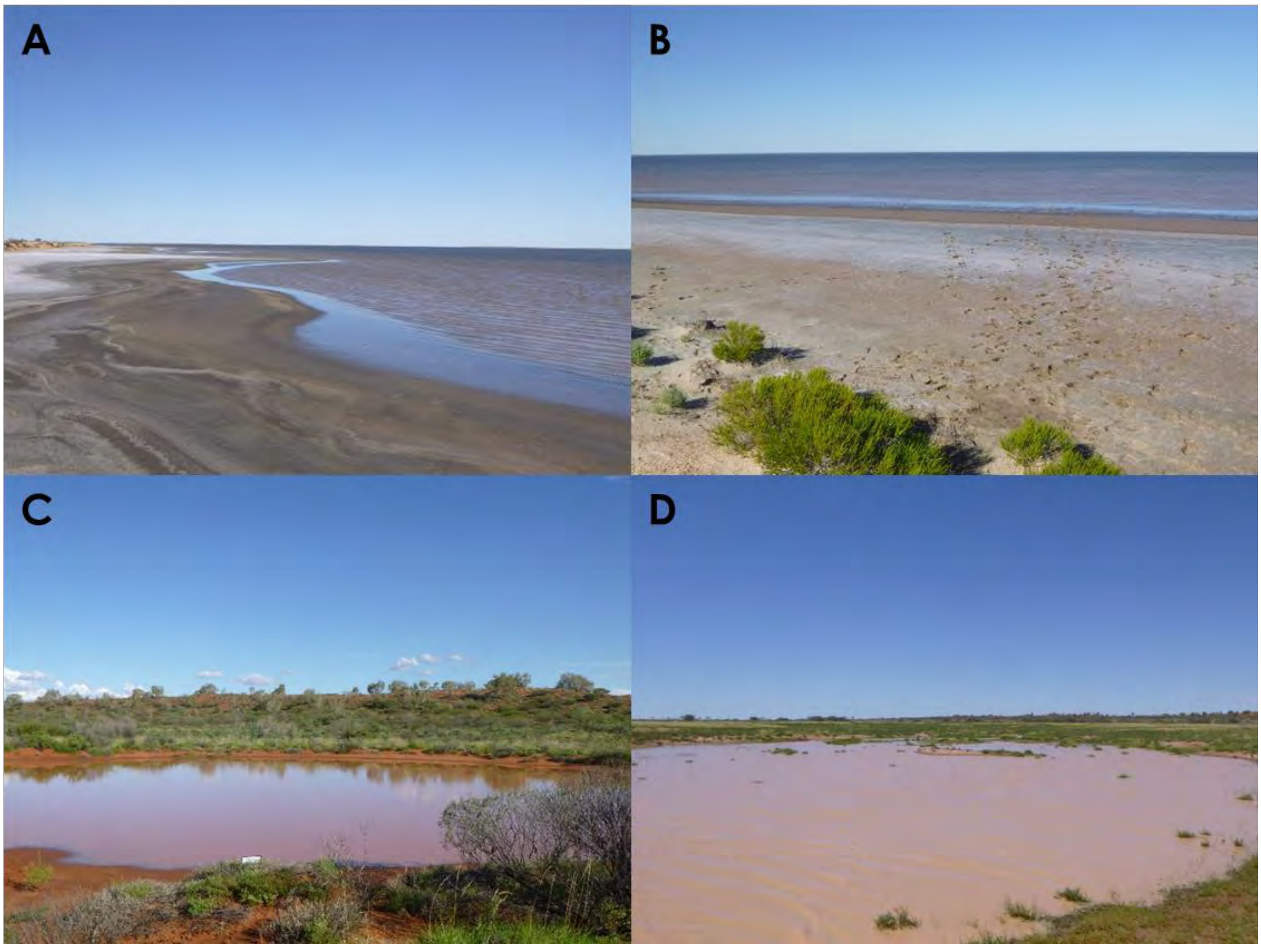

Plate 9-9: Sampling sites during flooded conditions (A) Site in the central portion of Lake Mackay, (B) site in eastern the portion of Lake Mackay, and (C-D) peripheral wetlands

Table 9-10: Summary of studies that include surveying values of Lake Mackay and peripheral wetlands

Reference	Title	Assessment Type	Sampling Location	Sampling Methods	Key Findings	Taxa of Significance / Scientific Interest / Other Significance
360 Environmental (2017b)	Waterbird Survey at Lake Mackay	Waterbirds	• Ground survey effort 20hrs 47 minutes; comprising 10 sites on Lake Mackay and seven sites at surrounding claypans. 600km targeted flight for 45 georeferenced sites.	• Visual observation; list of bird species and a count or estimate of the number of individuals of each bird species	• Low richness and abundance	• Waterbirds: ○ Australian Painted Snipe (*Rostrata australis*) ○ Red-necked Stint (*Calidris ruficolis*)
360 Environmental (2018b)	Lake Mackay SOP Project, Preliminary Acid Sulphate Soils Investigation	ASS	• Lake Mackay	• Sediment samples collected during excavation of 14 trenches and a pilot pond to a depth of 10 mbgl.	• No record of ASS from 119 soil samples • Record of PASS from two black ooze samples along southern edge of the lake	• NA
Duguid *et al.* (2005)	Wetlands in the Arid Northern Territory	Waterbirds	• Fixed wing aerial and ground survey of Lake Mackay	• Visual observation; list of bird species and a count or estimate of the number of individuals of each bird species	• 27 species recorded • Breeding site for Banded Stilt of national significance (>10,000 individuals) • Low silver gull population	• Waterbirds: ○ Banded Stilt (*Cladorhynchus leucocephalus*)
Invertebrate Solutions (2017b)	Survey for Aquatic Macroinvertebrates and SRE Fauna for the Lake Mackay SOP Proposal, Western Australia	Aquatic Ecology, SRE Fauna	• Lake Mackay and peripheral wetlands	• Timed sweep using a 250µm dip net.	• No aquatic invertebrates recorded Lake Mackay • Common and widespread groups recorded from freshwater claypans	• NA
Invertebrate Solutions (2018b)	Survey for Aquatic Macroinvertebrates for the Lake Mackay SOP Project, Western Australia	Aquatic Ecology	• Lake Mackay	• Opportunistic sampling	• One common, widespread aquatic invertebrate species recorded from the lake	• NA
Appendix F	Lake Mackay Potash Project, Detailed Flora and Vegetation Survey and Consolidation	Flora and Vegetation	• Lake Mackay	• A total of 138, 50m x 50m quadrats and 16 relevés. Mapping notes, targeted searches and opportunistic collections. Consolidation of previous surveys.	• 14 broad floristic formations • 50 vegetation types • Vegetation condition ranked as Excellent	• 11 Priority flora taxa previously recorded • Three Priority flora taxa from survey: ○ *Comesperma sabulosum* (P3) ○ *Eragrostis lanicaulis* (P3) ○ *Indigofera ammobia* (P3) • 7 taxa of other significance • Numerous range extensions
Appendix G.1	Lake Mackay Potash Project: Detailed and Targeted Vertebrate Fauna Survey and Consolidation	Vertebrate Fauna	• Lake Mackay, NIDE and surrounds	• Detailed and targeted surveys employing trapping, transects, motion cameras, acoustics, and visual observations. Consolidation of previous surveys including habitat mapping.	• 10,283 ha of potential Night Parrot habitat • Population size expanded to a total of 64 Great Desert Skink burrows • Consolidated mapping of the Proposal area	• 19 significant species including: ○ 4 mammals ○ 3 reptiles ○ 12 birds, 7 of which were migratory listed waterbirds
Appendix J	Baseline Aquatic Ecology Study of Lake Mackay and Peripheral Wetlands	Aquatic Ecology, Riparian Vegetation	• Lake Mackay, an island claypan and peripheral wetlands	• Sampling of multiple ecological components, including water and sediment quality, algae and macrophytes, aquatic invertebrates and riparian vegetation across multiple surveys. Sampling undertaken in dry and flooded conditions, as detailed in (Table 9-11).	• Low algal and invertebrate diversity within Lake Mackay related to high salinity and infrequent flooding regime (halophilic diatoms and crustaceans dominant) • Higher overall diversity of algae, diatoms and invertebrates within peripheral wetlands, related to freshwater and organic inputs • Widely distributed riparian vegetation communities	• 10 new aquatic invertebrates, including: ○ 8 ostracods (seed shrimp) ○ 2 spinicaudatans (clam shrimp) • Riparian Vegetation (*Tecticornia*): ○ *Tecticornia globulifera* (P1) ○ Three Tecticornia range extensions ○ Two affinity species ○ Eight sterile taxa

Table 9-11: Summary of field survey timing, conditions, sites and components sampled during the aquatic ecology baseline study.

Season / Rainfall / Lake Condition	Sampled By	Number of Sites Sampled					Ecological Assessment Components
		Lake Mackay	Playa Islands	Island Claypan	Peripheral Wetlands	Total	
Field Survey 1: 17-25 May 2019							
• Season: dry • Rainfall: below average	Stantec	• 13 aquatic* • 6 riparian	• 7 riparian	• -	• 6 aquatic • 6 riparian	• 19 aquatic • 19 riparian	• Collection of sediment for chemical analysis and rewetting trials • Riparian vegetation transect/quadrat assessment
Field Survey 2: 28-29 August 2019							
• Lake condition: dry	Agrimin	• 7 aquatic	• -	• -	• -	• 7 aquatic	• Collection of sediment for rewetting trials
Field Survey 3: 25-28 August 2020							
•	Agrimin	• 5 riparian	• -	• -	• 3 riparian	• 8 riparian	• Riparian vegetation transect/quadrat assessment
Field Survey 4: 20-21 February 2021							
• Season: post-wet • Rainfall: above average • Lake condition: flooded	Agrimin	• 2 aquatic • 2 riparian	• -	• -	• 1 aquatic	• 3 aquatic • 2 riparian	• Flood sampling of water and sediment for chemical analysis • Flood sampling of aquatic biota • Targeted flowering plant collection in riparian zone
Field Survey 5: 25 March – 2 April 2021							
•	Agrimin	• 9 aquatic • 9 riparian	• 13 riparian	• 1 aquatic	• 9 aquatic	• 19 aquatic • 22 riparian	• (refer to Section 3.2.4)

*Note: * includes one site that was a pilot pond on Lake Mackay.*

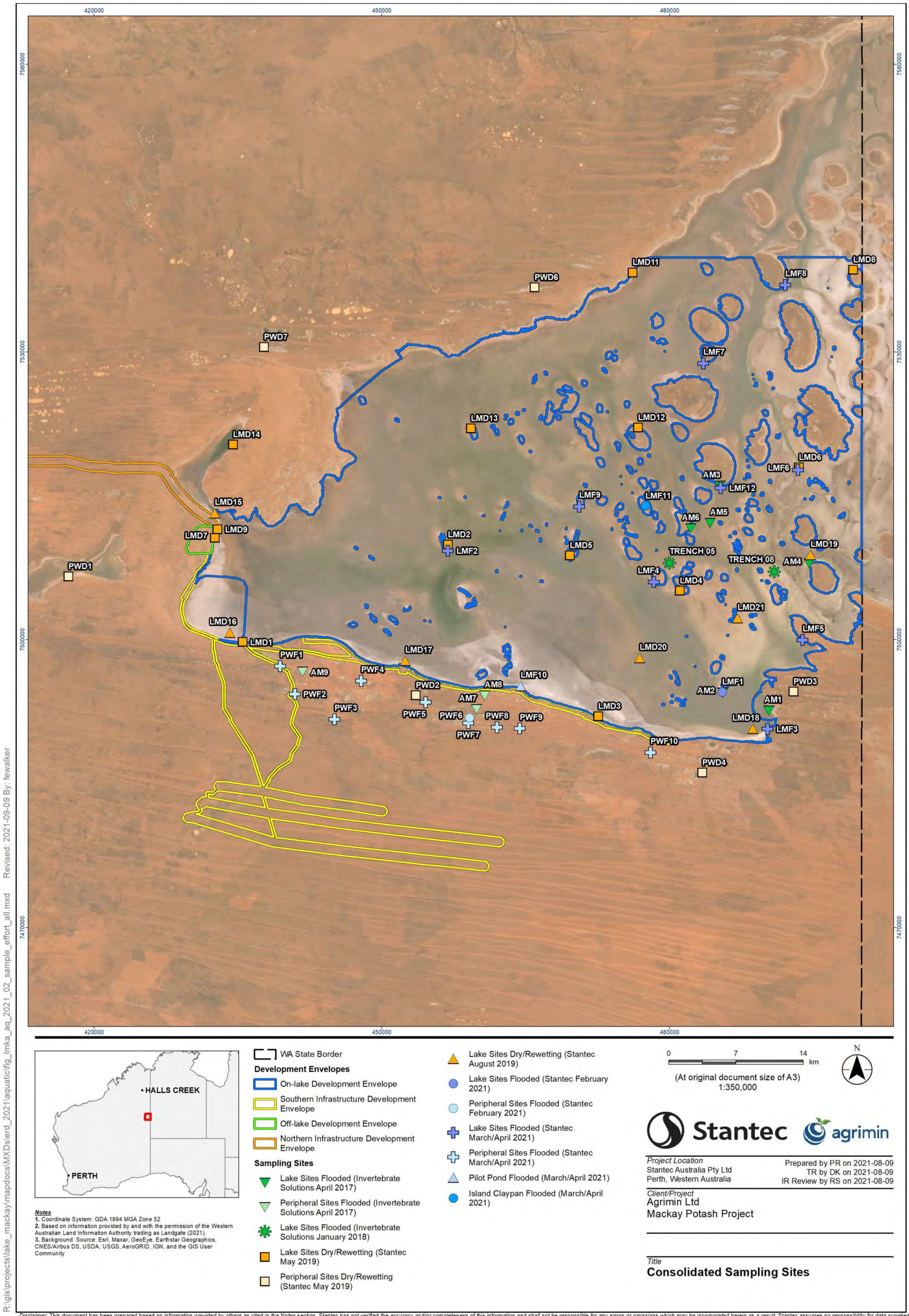

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Figure 9-9: Aquatic biota study sites on Lake Mackay and peripheral wetlands

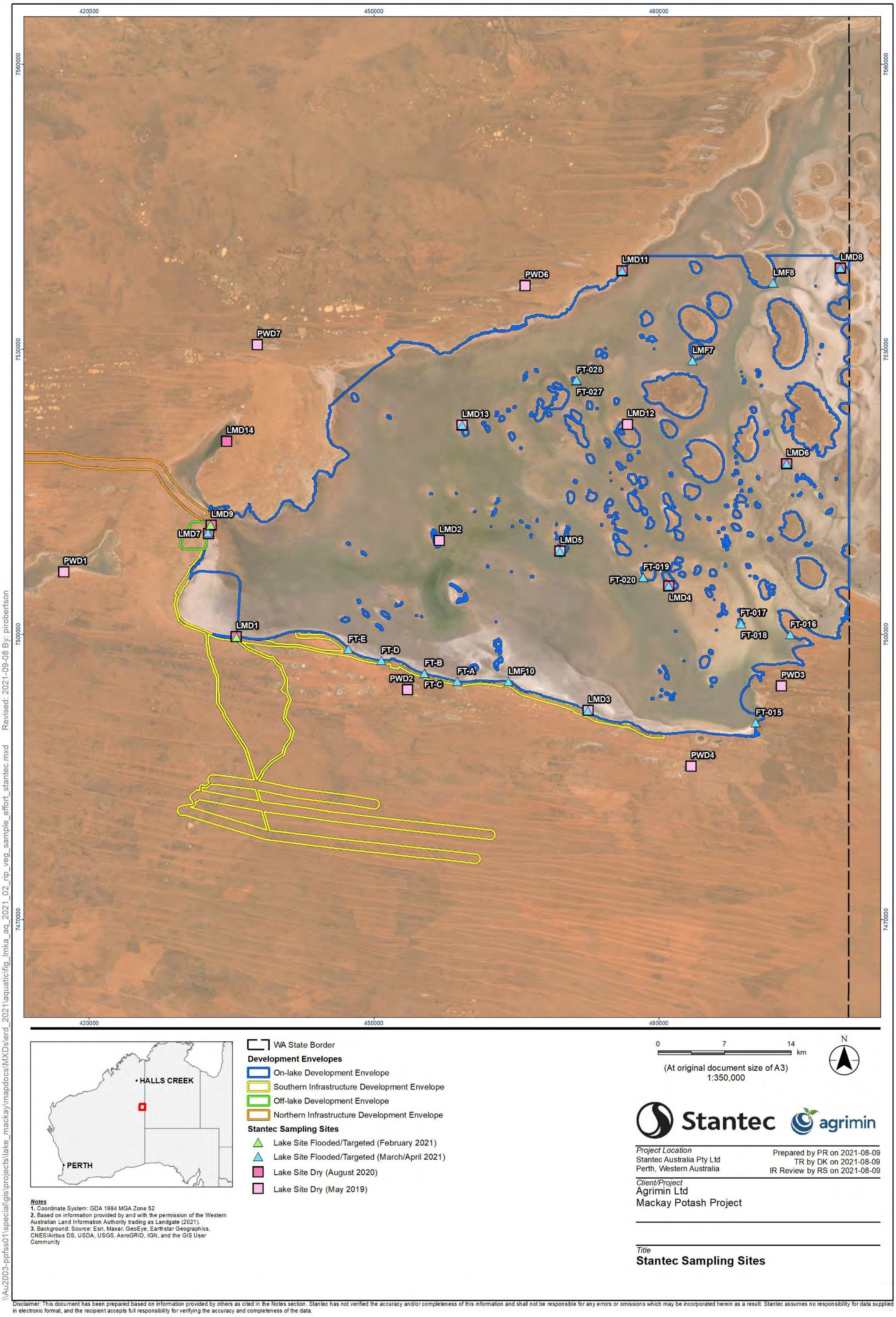

Figure 9-10: Riparian vegetation study sites on Lake Mackay and peripheral wetlands surveyed by Stantec

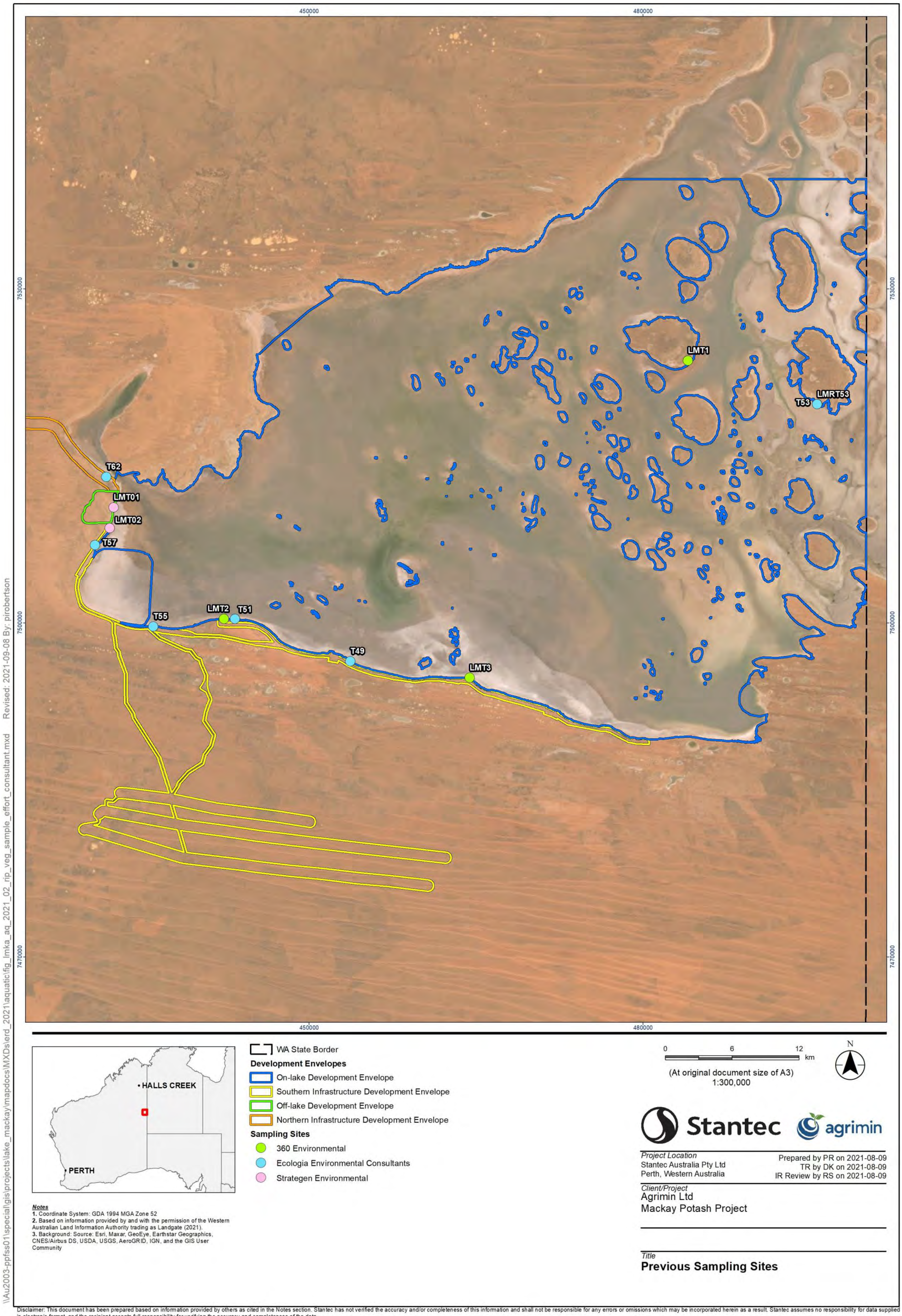

Figure 9-11: Riparian vegetation study sites on Lake Mackay during previous surveys

9.4.4.2 Surface Water Quality

During flooded conditions (February-March 2021), Lake Mackay surface water was acidic and circumneutral Foged (1978), with pH ranging from 6.5 to 6.7 (Table 9-12). The peripheral wetlands (6.6 to 6.7) and island claypan (6.6) exhibited a similar range (Table 9-12). While this was considered slightly uncharacteristic of salt lakes across WA, where pH generally ranges from 7.0 and 9.5 during flooded conditions (Smith *et al.* 2004), more acidic surface water conditions are known from some Goldfields lakes.

The pH of salt lakes can vary during flood events according to factors such as surface runoff (which may be poorly buffered), level of biological productivity, the presence of organic matter, and local catchment geology (Boulton and Brock 1999; Gregory 2008; Smith *et al.* 2004). Limited historic data collected in 2017 (Invertebrate Solutions 2017b) show that towards the end of the hydroperiod, the pH of Lake Mackay ranged from acidic (6.22) to alkaline (7.59), while peripheral wetlands were alkaline (8.54 to 8.95) (Table 9-12), considered more typical of salt lakes in WA. This was supported by laboratory rewetting trial data, which recorded acidic (5.58) to alkaline (8.67) pH from the lake samples, and neutral (7.27) to alkaline (8.13) pH from peripheral wetland samples (Appendix J).

Salinity, measured as electrical conductivity (EC), varied across Lake Mackay under flooded conditions, ranging from hyposaline (29,800 µs/cm) to hypersaline (131,000 µs/cm) (Table 9-12). These measurements were taken relatively early in the hydroperiod, with salinity subsequently increasing as water levels recede due to evapoconcentration. This is reflected in rewetting trial and historic (2017) data, where salinities of over 162,000 µS/cm and 215,000 µS/cm were recorded, respectively (Table 9-12).

Salinity at most peripheral wetlands, as well as the island claypan, was typically freshwater, ranging from 62 µs/cm to 3,820 µs/cm (Table 9-12). The exception was two peripheral salinas (saltpans), which were hyposaline (22,400 to 40,800 µS/cm) (Table 9-12), likely reflecting the dissolution of a naturally occurring salt crust and/or connectivity with saline groundwater. Low salinities were also recorded at peripheral wetlands during historic (2017) sampling (up to 3,300 µS/cm) (Table 9-12). However, the salinity of peripheral wetlands during rewetting trials was much higher (20,000 µS/cm to 188,000 µS/cm), reflecting the potential for natural salinisation of these wetlands as the hydroperiod progresses.

Nutrient concentrations (total nitrogen, nitrites, nitrates and total phosphorous) were generally low at Lake Mackay under flooded conditions, in comparison to peripheral wetlands. Average total nitrogen and total phosphorous at Lake Mackay was 0.59 mg/L and 0.17 mg/L, respectively, compared to 1.49 mg/L and 2.06 mg/L at peripheral wetlands (Table 9-12). Background total nitrogen and total phosphorus concentrations were above respective ANZG DGVs (Water Quality Australia 2018) for wetlands (1.2 mg/L and 0.05 mg/L), at the majority of peripheral wetlands (Table 9-12). This was likely associated with allochthonous inputs of organic material from riparian vegetation habitats, and the release of nutrients from newly wetted sediment.

The majority of dissolved metals at Lake Mackay were typically, below analytical detection limits (limit of reporting; LOR) during flooding. In addition, where detected, concentrations were also below ANZG DGVs (Water Quality Australia 2018) for marine water. This is to be expected given the isolated nature of Lake Mackay, which receives only minor catchment flows from the surrounding region, limiting transport pathways for deposition of mineralised sediment. Some dissolved metals were naturally higher within peripheral wetlands (Table 9-12), in particular, concentrations of aluminium and iron at peripheral wetlands were approximately 100- and 250-times, respectively, above Lake Mackay concentrations, respectively. This may be related to differences in local geology and/or groundwater discharge rates.

Table 9-12: Water quality characteristics of Lake Mackay and island and peripheral wetlands

Param.	Lake Mackay	Island Claypan	Peripheral Wetlands
pH	• Acidic during early hydroperiod (pH 6.45 to 6.66) • Acidic to alkaline during late hydroperiod (pH 6.22 to 7.59)	• Acidic during early hydroperiod (pH 6.63)	• Slightly acidic during early hydroperiod (pH 6.62 to 6.70) • Alkaline during late hydroperiod (pH 8.54 to 8.95)
Salinity	• Hyposaline (29,800 µs/cm) to hypersaline (131,000 µs/cm) • Trending to hypersaline (over 215,000 µs/cm) during late hydroperiod	• Freshwater (3,820 µs/cm)	• Freshwater across the hydroperiod (62 to 3,300 µs/cm) • Two hyposaline peripheral saltpans the exception (22,400 to 40,800 µs/cm)
Nutrients	• Generally low under flooded conditions • Total nitrogen 0.2 to 1.6 mg/L • Total phosphorus 0.01 to 0.6 mg/L	• Naturally elevated total nitrogen (8.9 mg/L) • Low total phosphorous (0.2 mg/L)	• Generally higher than Lake Mackay, due to natural organic inputs • Total nitrogen >0.01 mg/L to 3.2 mg/L • Total phosphorous 0.03 to 7.3 mg/L
Metals	• Generally below limits of reporting/ ANZG DGVs (Water Quality Australia 2018) under flooded conditions	• Generally below limits of reporting / ANZG DGVs (Water Quality Australia 2018) under flooded conditions	• Natural background concentrations of some metals (Al, Cr, Co, Cu, Pb, Fe, Zn) above ANZG DGVs (Water Quality Australia 2018) under flooded conditions, related to local geology and groundwater discharge

9.4.4.3 Sediment quality

Sediment pH at Lake Mackay ranged from neutral to alkaline (6.6 to 8.1) (Hazelton and Murphy 2007) during dry conditions, trending to alkaline when in flood (7.4 to 7.9) (Table 9-13). Similarly, pH at peripheral wetlands was neutral to alkaline when dry (7.3 to 8.4) and was more variable during flooded conditions (5.4 to 8.5) (Table 9-13). Sediment at the island claypan, only sampled during flooding, was neutral (7.4) (Table 9-13). In temporary systems, sediment pH is typically influenced by changes in the hydroperiod, inputs from groundwater, redox reactions, carbonates and organic matter (Commander 1999; Ponnamperuma 1972).

Sediment salinity (measured as total soluble solids; TSS) was variable, with the Lake Mackay sites ranging from 74,800 mg/kg to 179,000 mg/kg under dry conditions, with substantial dilution evident during flooded conditions (20,700 to 58,100 mg/kg) (Table 9-13). Similar trends were observed at peripheral wetlands, with salinity during dry conditions ranging from 78,200 mg/kg to 302,000 mg/kg, and from 80 mg/kg to 46,000 mg/kg when flooded (Table 9-13).

Nutrient concentrations within Lake Mackay sediment were typically higher during dry conditions. Total nitrogen ranged from 80 mg/kg to 330 mg/kg during dry conditions, and between 20 mg/kg and 130 mg/kg when the lake was in flood (Table 9-13). Similarly, total phosphorus ranged from 42 mg/kg to 115 mg/kg when the lake was dry, and between 26 mg/kg and 107 mg/kg following flooding (Table 9-13). The peripheral wetlands displayed a greater variability in nutrient concentrations, as well as higher maxima, in comparison to the lake. Total nitrogen was 130 to 1,380 mg/kg, and total phosphorous 56 to 223 mg/kg under dry conditions, whereas total nitrogen was 30 to 460 mg/kg, and total phosphorous 26 to 111 mg/kg, when flooded (Table 9-13).

Nutrients were relatively high at the island claypan under flooded conditions (260 mg/kg and 202 mg/kg for total nitrogen and total phosphorous, respectively) (Table 9-13). Higher nutrients were recorded in peripheral and island wetlands, compared to Lake Mackay, likely due to differences in allochthonous inputs (Boulton and Brock 1999), as well as the high productivity of wetlands under flooded conditions. During inundation, decomposition of algae, bacteria, protozoa and rotifers return nutrients to lake sediment (McComb and Qui 1998).

All metals in the sediment of Lake Mackay, the island claypan, and peripheral wetlands were below the ANZG DGVs (Water Quality Australia 2018), during both dry and flooded conditions (Table 9-13). In addition, cadmium and mercury levels in sediment were below the respective limits of reporting (LORs) at all sites during dry and flooded conditions. Where detected, metal concentrations tended to be lower and more uniform throughout the lake, compared to the peripheral wetlands, likely attributed to local catchment geology and runoff.

Table 9-13: Summary of sediment characteristics for Lake Mackay and island and peripheral wetlands (Appendix J).

Param.	Lake Mackay	Island Claypan	Peripheral Wetlands
pH	• Neutral to alkaline (pH 6.6 to 8.1) during dry conditions • Alkaline when in flood (pH 7.4 to 7.9)	• Neutral when in flood (pH 7.4)	• Neutral to alkaline when dry (pH 7.3 to 8.4) • Highly variable when in flood (pH 5.4 to 8.5)
Salinity	• High salinity during dry conditions 74,800 to 179,000 mg/kg • Reduced salinity when in flood (20,700 to 58,100 mg/kg)	• Low salinity (643 mg/kg) during flooded conditions	• High salinity when dry (78,200 to 302,000 mg/kg) • Reduced salinity when in flood (80 to 46,000 mg/kg)
Nutrients	• Nutrients typically higher during dry conditions • Total nitrogen 80 to 330 mg/kg during dry conditions, 20 to 130 mg/kg when in flood • Total phosphorus 42 to 115 mg/kg when dry, 26 to 107 mg/kg when in flood	• Relatively high total nitrogen and total phosphorous (260 mg/kg and 202 mg/kg, respectively)	• Greater variability in nutrient concentrations as well as higher maxima, in comparison to Lake Mackay • Total nitrogen 130 to 1,380 mg/kg during dry conditions, 30 to 460 mg/kg when inundated • Total phosphorous 56 to 223 mg/kg under dry conditions, 26 to 111 mg/kg when inundated
Metals	• Generally below limits of reporting / ANZG DGVs (Water Quality Australia 2018) during dry and flooded conditions • Metals levels lower and more uniform across Lake Mackay, compared to peripheral wetlands	• Generally below limits of reporting / ANZG DGVs (Water Quality Australia 2018) during dry and flooded conditions	• Generally below limits of reporting / ANZG DGVs (Water Quality Australia 2018) during dry and flooded conditions

9.4.4.4 Aquatic biota

9.4.4.4.1 Algae and macrophytes

A total of 42 algal taxa comprising three phyla were recorded across Lake Mackay and peripheral wetlands (algae and macrophytes were not sampled at the island claypan). These taxa comprised benthic and planktonic algae from rewetting trials and flood sampling. Lake Mackay supported higher diversity (37), compared to the peripheral wetlands (25 taxa) (Table 9-14). Bacillariophyta (diatoms) was the most specious phyla (21 taxa), followed by Cyanophyta (cyanobacteria) (13 taxa) and Chlorophyta (green algae) (eight taxa).

Diatoms where the dominant phyla within Lake Mackay (20 taxa), compared to cyanobacteria (12 taxa) and green algae (5 taxa), whereas the diversity of diatoms and cyanobacteria was relatively similar in the peripheral wetlands (11 and nine taxa, respectively), with green algae depauperate (5 taxa) (Table 9-14). Both diatoms and cyanobacteria are commonly associated with benthic microbial communities in salt lakes throughout inland Australia (Handley 2003; John *et al.* 2009; Paerl *et al.* 1993).

The taxa recorded from the lake and peripheral wetlands were considered widespread, with composition assemblages that are also known from inland waters throughout WA (Campagna 2007, Handley 2003, Taukulis and John 2009). The diatom *Hantzschia* sp. aff. *baltica* was a common component of the benthic algae of Lake Mackay (recorded from 90% sites) and peripheral wetlands (recorded from 77% sites) (Table 9-15). *Navicula* sp. aff. *incertata* was also widespread, although was mostly recorded from the lake (50% of sites), while several *Amphora* taxa were documented from the lake and peripheral wetlands (Table 9-15).

Dunaliella sp. was the most common green alga, recorded in both rewetting trials and flood studies at Lake Mackay (20% of sites) and peripheral wetlands (38% of sites) (Table 9-15). This taxon is a common component of hypersaline environments around the world and throughout Australia (Borowitzka 1981, Oren 2005). The peripheral wetlands also supported several unicellular chlorophyte taxa under flooded conditions, including *Scenedesmus* sp., *Cosmarium* sp., *Chlamydomonas* sp. and *Closterium* sp. (Appendix J). These genera are typically associated with freshwater conditions (Entwistle).

There were a number of filamentous cyanobacteria recorded, including *Nodularia* sp. 2 and *Phormidium amoenum,* which were abundant in rewetting trials at lake sites, and to a lesser extent in peripheral wetlands. These genera are considered salt tolerant (Handley 2003, Taukulis 2007a). However, in flooded conditions, green algae and cyanobacteria were generally depauperate, with higher productivity associated with diatoms, which are widespread throughout Australian salt lakes (Campagna and John 2003, Gell and Gasse 1994, Taukulis 2007a).

While no submerged macrophytes were recorded the propagules of the charophyte (large green alga) *Chara* sp. were prevalent in the sediment of peripheral wetlands. This genus typically has a low salinity tolerance and is associated with freshwater (Garcia 1999). Propagules of the charophyte *Lamprothamnium* sp., more commonly found in salt lakes throughout Australia (Porter 2007), were also recorded from a limited number of peripheral wetlands.

Table 9-14: Summary of algal phyla recorded from Lake Mackay, the island claypan (rewetting trial data only) and peripheral wetlands

Algal Phyla	Lake Mackay	Peripheral Wetlands
Bacillariophyta	20	11
Chlorophyta	5	5
Cyanophyta	12	9
Diversity	37	25

Table 9-15: Number of records of common algal taxa (>10 records) from Lake Mackay and peripheral wetlands from rewetting trials and flood studies (percentage of site records in parentheses)

Algal Taxa	Lake Mackay	Peripheral Wetlands
Hantzschia sp. aff. *baltica*	28 (90%)	10 (77%)
Navicula sp. aff. *incertata*	15 (50%)	1 (8%)
Nodularia sp. 2	12 (40%)	2 (15%)
Amphora coffeaeformis	11 (37%)	2 (15%)
Phormidium amoenum	11 (37%)	1 (8%)
Dunaliella sp.	6 (20%)	5 (38%)
Amphora sp. 1	8 (25%)	3 (23%)

9.4.4.4.2 Diatoms

In total, 25 diatom taxa, comprising 12 genera, were recorded across Lake Mackay, the island claypan and peripheral wetlands, from field surveys and rewetting trials (Table 9-16). Of these, 14 taxa were identified from Lake Mackay, while 21 taxa were found in peripheral wetlands (Table 9-16). Five taxa were recorded from the island claypan (only sampled in flood) (Table 9-16).

Typically, there was greater variability in diversity observed in peripheral wetlands, compared to lake sites, reflecting differences in substrate composition and water quality (Battarbee et al. 2001; van Kerckvoorde et al. 2000; Wolfe 1996). At Lake Mackay, diversity ranged from one to seven taxa during rewetting trials, and from two to five taxa during flooded conditions. In comparison, diversity at peripheral wetlands ranged from one to five taxa during rewetting trials, and from zero to 10 taxa during flooded conditions.

The most common diatom taxa of Lake Mackay in flooded conditions and rewetting trials were *Hantzschia* sp. aff. *baltica*, *Navicula* sp. aff. *incertata* and *Amphora coffeaeformis* (Table 9-17). *Hantzschia* sp. aff. *baltica* was particularly common, recorded from 84% of Lake Mackay sites (Table 9-17). All three taxa are typically associated with salt lakes in WA and have documented salinity tolerance limits above 100,000 mg/L (Taukulis 2007). *Amphora coffeaeformis* is also considered to be one on the most widespread saline water diatoms in Australia (John 1998). Representatives of the *Hantzschia* genera are aerophilic, known from non-submerged habitats (Ehrlich 1995), reflecting the predominantly dry conditions of the lake.

These common taxa were also relatively abundant within peripheral wetlands (Table 9-17). There were also several genera unique to peripheral wetlands and the island claypan, reflecting a greater diversity of diatoms and characteristic of low salinity and freshwater conditions. These included *Pinnularia*, *Achnanthidium*, *Neidium* and *Stauroneis* (Table 9-17), with the latter typically known from relatively pristine, freshwater habitats (John 2000).

Table 9-16: Summary of diatom genera recorded from Lake Mackay, the island claypan and peripheral wetlands, incorporating both flood survey and rewetting trial data.

Diatom Genera	Lake Mackay	Island Claypan	Peripheral Wetlands
Achnanthidium	0	0	1
Amphora	2	0	2
Caloneis	1	0	1
Craticula	1	0	1
Hantzchia	3	1	3
Luticola	1	1	1
Navicella	1	0	0
Navicula	5	1	5
Neidium	0	0	1
Nitzschia	0	0	1
Pinnularia	0	1	3
Stauroneis	0	1	2
Taxa Richness	14	5	21

Table 9-17: Number of records of common diatom taxa (>10 records) from Lake Mackay and peripheral wetlands from rewetting trials and flood studies (percentage of site records in parentheses)

Diatom Taxa	Lake Mackay	Peripheral Wetlands
Hantzschia sp. aff. baltica	28 (84%)	14 (88%)
Navicula sp. aff. *incertata*	27 (82%)	7 (44%)
Amphora coffeaeformis	19 (58%)	5 (31%)

Note: Island claypan not included as only one site was sampled during flooded conditions.

9.4.4.4.3 Aquatic invertebrates

In total, 53 aquatic invertebrate taxa from fiver higher level taxonomic groups were recorded from Lake Mackay and peripheral wetlands (Table 9-16), based on consolidated data from rewetting trials, surveys during flooded conditions (Appendix J) and historic studies (Invertebrate Solutions 2018b). The groups included Insecta, Bivalvia and the crustacean classes of Branchiopoda, Maxillopoda (Copepoda) and Ostracoda (Table 9-16). Of these, branchiopods, maxillopods and ostracods were the most abundant, while insects were the most speciose.

Lake Mackay was characterised by relatively low diversity, with 13 taxa, primarily halotolerant crustaceans, recorded from the various studies (Table 9-16). Surface water salinity was identified as a governing factor, with the lake failing to yield any aquatic invertebrates during hypersaline conditions of the 2017 survey. In predominantly mesosaline conditions during the 2021 flood, the diversity of most sites ranged from two to four taxa. This corresponded to the general pattern of low diversity from rewetting trials and assessment of the invertebrate egg bank. The island claypan supported five taxa; the majority aligning with peripheral wetlands. Abundance varied across the lake during flood, primarily in response to site morphology, a factor shown to influence invertebrate distribution at other ephemeral salt lakes in WA (Gregory *et al.* 2009).

The invertebrate community of Lake Mackay was generally dominated by halophilic branchiopods and copepods. This included the anostracan (brine shrimp) *Parartemia laticaudata* (Timms 2012). This is a widespread species, which represented a major component of the invertebrate community during flooded conditions and also hatched during rewetting trials. Another taxon frequently recorded from the lake under flooded conditions was the broadly distributed cyclopoid copepod *Meridiecyclops platypus* freshwater (Timms *et al.* 2006), while the notostracan (shield shrimp) *Triops australiensis* and several ostracod species were also common. The latter also hatched during rewetting trials and was a dominant component of the invertebrate egg bank in the lake sediment.

One of the hatched ostracod taxa from rewetting trials; *Reticypris* `BOS1371`, was a new species, known from the lake from several sites. A second new ostracod taxon; *Billcypris* n.sp. `BOS1509`, was also recorded from the lake, from multiple sites along a gypsiferous belt trending north-south near the WA-NT border. Both taxa are considered likely to have a broader distribution in the lake, extending into the NT section.

The total diversity of peripheral wetlands was substantially higher than Lake Mackay, totalling 45 aquatic invertebrate taxa (Table 9-16), reflecting the heterogeneous conditions. Insects were the most speciose group (18 taxa), followed by branchiopods (14 taxa) and ostracods (9 taxa) while maxillopods (copepods) and bivalves contributed to a lesser extent. Diversity and abundance between peripheral wetlands were highly variable, in response to differences in water quality, substrate, and allochthonous inputs, with the assemblage typically distinct from Lake Mackay. This was likely in response to low surface water salinities, with the island claypan also comparable to peripheral wetlands.

Peripheral wetlands supported a higher proportion of opportunistic (insect) taxa, *Branchinella* as the dominant anostracan and diplostracans from the orders Cladocera (water fleas) and Spinicaudata (clam shrimp). Ostracods also contributed to the assemblage of peripheral wetlands, with eight new taxa represented, some of which may be locally restricted. However, most of the aquatic invertebrate taxa from peripheral wetlands are also known to occur more broadly.

Lake Mackay supports a relatively low diversity of aquatic invertebrates, primarily comprising common and widespread halophilic taxa, along with a limited number of new species. These taxa are currently only known from the lake, or the lake and peripheral wetlands. As the primary ephemeral salt-lake in the region, the lake represents important habitat for aquatic invertebrates during major flood events, which in turn provide a food source for waterbirds. Peripheral wetlands contain a higher diversity of aquatic invertebrates, some of which have also been identified as new and potentially restricted.

Table 9-16: Summary of aquatic invertebrate taxa recorded from Lake Mackay and peripheral wetlands based on consolidated data (Appendix J).

Aquatic Invertebrate Group	Lake Mackay	Island Claypan	Peripheral Wetlands
ARTHROPODA			
Branchiopoda			
Anostraca	2		4
Diplostraca		1	9
Notostraca	1	1	1
Insecta			
Coleoptera	1	1	6
Diptera	1		6
Hemiptera			4
Odonata			1
Trichoptera			1
Maxillopoda			
Calanoida	1		2
Cyclopoida	2		1
Ostracoda			1
Podocopida	5	2	8
MOLLUSCA			
Bivalvia			1
Diversity (Higher Taxonomic Group)	4	3	5
Total Diversity	13	5	45

9.4.4.4.4 Riparian vegetation

Two habitat types have been identified with the riparian zone comprising the lake/island margins and saline peripheral wetlands (saltpans), with the latter having a similar assemblage to the fringes of Lake Mackay. Vegetation of the riparian zone was dominated by chenopod shrubland, comprising three broad floristic formations, associated with three vegetation types, characterised by halophytic genera including *Tecticornia, Frankenia* and *Eragrostis*.

In total, 96 riparian vegetation taxa from 25 families have been recorded from Lake Mackay, the islands and peripheral wetlands, 46 of which were recorded during the baseline aquatic ecology study (Stantec 2021) (Table 9-17). Chenopodiaceae was the most diverse family (21 taxa) and *Tecticornia* aff. *calyptrata* (NT form) was the most widespread verified taxon, occurring at 18 sites across the playa, islands and peripheral wetlands. *Tecticornia calyptrata* is widespread throughout inland regions of WA and is commonly associated with salt lakes (WAH 2020). However, while displaying morphological affinities with *Tecticornia calyptrata*, the Lake Mackay specimens were distinct from the type known from the Wiluna region and were more analogous with the NT form. Therefore, the Lake Mackay taxon may be considered flora species of other significance ("affinity species"), based on regulatory guidance (EPA 2016).

Frankenia cordata and *Lawrencia viridigrisea* were also common, recorded at nine and seven sites, respectively (Table 9-17). These species are widespread throughout inland regions of WA and are associated with a range of habitat types including saline flats and floodplains. Representatives of the family Poaceae, likely belonging to *Eragrostis falcata* were also prevalent along the lake margins. One introduced taxon; **Tribulus terrestris* (Caltrop) was recorded at one of the lake sites, and is a rapidly growing species known from throughout WA (WAH 2020). In addition, several taxa of other significance were identified, which are described in detail in Section 5.3.

Riparian vegetation plant density, cover and health was comparable across Lake Mackay, the islands and peripheral wetlands. These indices were only recorded during predominantly dry conditions, with recruitment and improved plant health likely following substantial rainfall events.

There were 17 *Tecticornia* taxa (samphires) identified from the riparian vegetation zone of Lake Mackay, the islands and peripheral wetlands, representing approximately 85% of predicted species richness. Nine taxa were recorded on the lake margins, 13 on the islands, and two on the fringes of peripheral wetlands. Three of these taxa (*Tecticornia halocnemoides*, *Tecticornia halocnemoides* subsp. *longispicata* and *Tecticornia indica* subsp. *leiostachya*) are common and/or widespread (WAH 2021c;d;e).

One taxon; *Tecticornia globulifera*, is listed as a Priority 1 (P1) flora species under the BC Act. This species was recorded by ecologia Environment (2017b) on an island of Lake Mackay, was locally abundant and was associated with saline lake margin habitat. Specimens recorded by 360 Environmental (2017a) were also recorded from the same island. *Tecticornia globulifera* tends to be found on moderately saline flats on red-brown gritty clay and in association with other *Tecticornia* species (Shepherd and van Leeuwen 2011), similar to the characteristics associated with the islands of Lake Mackay.

Five *Tecticornia* taxa of other significance (affinity taxa or range extensions) have also been recorded from Lake Mackay. Eight taxa were sterile and likely belong to one of the verified *Tecticornia* species. None of the *Tecticornia* taxa identified from the lake, islands and peripheral wetlands have a locally restricted distribution, and occur more broadly throughout the area, or across bioregions.

Table 9-17: Species list and summary of riparian vegetation diversity recorded during the baseline aquatic ecology study

Riparian Vegetation Taxa	Transects/Quadrats		Targeted
	Lake Mackay	Peripheral Wetlands	Lake Mackay
Aizoaceae			
Trianthema pilosum	•		•
Trianthema triquetrum	•		
Amaranthaceae			
Surreya diandra	• •	•	•
Asteraceae			
Angianthus tomentosus	•		
Chenopodiaceae			
Atriplex vesicaria	•		
Chenopodiaceae sp.	•		•
Dysphania plantaginella			•
Eremophea spinosa		•	
Maireana luehmannii	•	•	
Maireana sp.	•		
Neobassia astrocarpa	•	•	
?Neobassia sp.	•	•	
Salsola australis	•		
Sclerolaena cuneata	•		
Sclerolaena fimbriolata	•		•
Sclerolaena sp.	•		
Tecticornia aff. *calyptrata* (NT form)	• • •	• •	• •
Tecticornia halocnemoides subsp. *longispicata*	• •		• •
Tecticornia indica subsp. *leiostachya*		• •	

Riparian Vegetation Taxa	Transects/Quadrats		Targeted
	Lake Mackay	Peripheral Wetlands	Lake Mackay
Tecticornia sp. sterile 1	•		
Tecticornia sp. sterile 2	•		
Tecticornia sp. sterile 3	•		
Tecticornia sp. sterile 4	•		
Tecticornia sp. sterile 5	•		
Tecticornia sp. sterile 6	•		
Tecticornia sp. sterile 7	•		
Euphorbiaceae			
Euphorbia wheeleri	•		
Fabaceae			
Acacia ligulata	•		
Acacia sp. Lake Mackay			•
Acacia melleodora	•		
Acacia trachycarpa	•		
Acacia sp.	•	•	
Frankeniaceae			
Frankenia cordata	••	•	•
Goodeniaceae			
Goodenia collaris	•		•
Scaevola spinescens	•		
Lauraceae			
Cassytha capillaris	•		
Malvaceae			
Lawrencia aff. *viridigrisea*			•
Lawrencia viridigrisea	••	•	
Lawrencia sp.			•
Myrtaceae			
Melaleuca lasiandra	•	•	
Poaceae			
? Eragrostis falcata	•••	•	
Eragrostis lacunaria			•
Eragrostis sp.	•	•	
Eriachne aristidea			•
Paractaenum refractum			•
Poaceae sp.	••	••	•
Triodia pungens	••	•	
Triodia ?pungens			•

Riparian Vegetation Taxa	Transects/Quadrats		Targeted
	Lake Mackay	Peripheral Wetlands	Lake Mackay
Yakirra australiensis var. *australiensis*	•		
Portulacaceae			
Portulaca decipiens			•
Proteaceae			
Grevillea stenobotrya		•	
Santalaceae			
Exocarpos sparteus	•		
Zygophyllaceae			
Roepera aurantiaca subsp. *aurantiaca*	•		
Roepera sp.			•
Tribulus sp. saline flats	•		
**Tribulus terrestris*	•		
Diversity	43	16	19

*Note: * indicates weed species;* • indicates sparse (<10 records), •• indicates common (11-49 records), ••• indicates dominant (>50 records).

9.4.4.4.5 Waterbirds

The findings of previous waterbird surveys are detailed in Section 7, with a high-level summary provided here. Lake Mackay, its islands and peripheral wetlands provide important foraging and/or breeding habitat for one threatened waterbird and up to eight migratory waterbirds during major flood events (Table 9-18). However, these events need to be of sufficient magnitude and duration to substantially inundate the lake for an extended period, which appears to occur on average, once every 10 years.

In late 2001, flooding was likely equivalent to a 1 in 40-year event, during which time aerial and ground surveys were conducted at Lake Mackay. A high abundance and diversity of waterbirds were recorded, comprising more than 42,000 individuals from 27 species (Duguid *et al.* 2005). This included more than 1% of the population of Banded Stilts, Black-winged Stilts and Red-necked Avocets. The islands of Lake Mackay are also likely to have provided important breeding habitat (and refugia from predators) for some of these species.

A second waterbird survey conducted in May 2017, following rainfall equivalent to a 1 in 10-year event, found a high abundance of waterbirds inhabiting peripheral wetlands, comprising 26 species and 2,591 individuals. In contrast, while large parts of the lake were inundated, only seven species and less than 700 individuals were recorded on the playa. This is likely attributed to the availability of the foraging habitat, with aquatic invertebrates abundant in the claypans and absent from the playa during this survey. However, one individual of the Australian Painted Snipe, listed as Endangered under the BC Act and EPBC Act, was recorded (Table 9-18).

In March/April 2021, during flooding, Stantec undertook a waterbird survey in the WA portion of the lake (Appendix G.1). A total of 42,194 individuals representing 12 bird species (with one additional unconfirmed species), were reported (Table 9-18, (Figure 9-12). This included four conservation significant (migratory) species. The survey coincided with a period of high aquatic invertebrate productivity. During the survey, the central southwest area of the lake supported large congregations of up to 35,058 individuals of foraging waterbirds (in one observation). Species largely comprised the Whiskered Tern (*Chlidonias hybrida*) and/or White winged Black Tern (*Chlidonias leucopterus*) (12,426), Banded Stilt (5,886) and Sharp-tailed Sandpiper (*Calidris acuminata*) (3,758 to 10,000 per observation). The Sharp-tailed Sandpiper observations equated to 4.4% to 11.8% of the estimated East Asian Australasian Flyway Population.

Table 9-18: Consolidated summary of significant and migratory waterbirds from Lake Mackay.

Common Name	Cons. Status		Records
	BC Act	EPBC Act	
Threatened Species			
Australian Painted Snipe (*Rostratula australis*)	EN	EN	1 in 2017
Migratory Species			
Gull-billed Tern (*Gelochelidon nilotica*)	Mi	Mi	14 in 2001, 39 in 2017, 125 from nine observations in 2021
White-winged Black Tern (*Chlidonias leucopterus*)	Mi	Mi	83 from one observation in 2021
Glossy Ibis (*Plegadis falcinellus*)	Mi	Mi	110 in 2001
Gull-billed Tern (*Gelochelidon nilotica*)	Mi	Mi	339 in 2001 (identification could not be confirmed)
Caspian Tern (*Hydroprogne caspia*)	Mi	Mi	
White-winged Black Tern (*Chlidonias leucopterus*)	Mi	Mi	4,602 during 2001, 14,583 from three observations in 2021 (identification could not be confirmed; Whiskered Tern is not a threatened species)
Whiskered Tern (*Chlidonias hybrida*)	-	-	
Common Greenshank (*Tringa nebularia*)	Mi	Mi	1 in 2001, 3 in 2017
Red-necked Stint (*Calidris ruficollis*)	Mi	Mi	502 in 2017
Sharp-tailed Sandpiper (*Calidris acuminata*)	Mi	Mi	3,758 to 10,000 per observation in 2021, 37 in 2017
Marsh Sandpiper (*Tringa stagnatilis*)	Mi	Mi	6 from one observation in 2021

9.4.4.4.6 Summary of ecological values and significant taxa

Lake Mackay is a predominantly dry, highly episodic saline playa, that when inundated, supports a relatively low number of resilient, halophytic aquatic biota, comparable to other inland salt lakes throughout Australia. Peripheral wetlands associated with the lake comprise larger saltpans, with similar characteristics to the playa (Table 9-19). While the island claypans and freshwater claypans are more diverse, most of the taxa recorded from the lake and peripheral wetlands are considered widespread, having been documented from regional salt lakes in WA.

The algae and diatom communities comprised common, ubiquitous, and cosmopolitan genera and species, with no significant taxa recorded, and a high degree of similarity was evident in the community structure from the playa and saltpans. Aquatic invertebrate communities were more variable, with higher diversity in the freshwater claypans, attributed to a broader range of habitat types. A total of 10 new taxa were identified, comprising two spinicaudatans (clam shrimp) and eight ostracods (seed shrimp) (Table 9-19). Two of these taxa were widespread throughout the playa and likely occur across the border into the NT. The peripheral wetlands to the south of the lake, also support eight new aquatic invertebrate species (two spinicaudatan and six ostracod taxa).

The productivity of algae, diatoms and aquatic invertebrates throughout the lake and peripheral wetlands during flooded conditions provides important foraging conditions, as well as breeding habitat for waterbirds. One threatened waterbird species (Australian Painted Snipe; En) and up to eight migratory waterbird species have been recorded from Lake Mackay and surrounds during field surveys (Table 9-19). Suitable breeding conditions occur for waterbirds, specifically Banded Stilts during inundation events that last for >65 days, with only six of these events recorded since 2000, according to assessment of satellite imagery. The largest of inundation events only occur on average, once every 20 to 50 years. The longer duration events create prolonged inundation on the lake and drive large congregations of birds (>10,000) to the lake, allowing for multiple breeding cycles.

Increased productivity during the smaller inundation events is associated with areas of the lake on the WA side that hold water, corresponding to small pockets including the north-western arm and central southern area of the lake adjacent to a small island. The predominant area of the lake with the greatest water retention time is the south-eastern portion of the lake, although it is likely the NT side holds water for longer, and may therefore provide higher ecological values, particularly for waterbirds.

Regardless, the south-eastern portion on the WA side of Lake Mackay is important in providing deeper, stable conditions for aquatic biota and waterbirds during the largest flood events. Lower salinities at the beginning of the hydroperiod provide a cue for aquatic biota to emerge, providing a food source for higher order consumers including waterbirds (boom phase). During these initial stages, water quality conditions are relatively homogenous, with salinities increasing as water levels recede, before drying completely (bust phase). When inundated, aquatic biota (algae and aquatic invertebrates) matures and reproduces, replenishing the egg bank, contributing to the recovery of the lake and peripheral wetlands during the next flood event.

The riparian zone of the lake, islands and peripheral wetlands host a flora assemblage characterised by chenopods and dominated by samphires. *Tecticornia* are likely to be supported by fresh and low salinity water associated with the vadose zone (as opposed to hypersaline groundwater). One taxon of significance was identified from a landform island on Lake Mackay; *Tecticornia globulifera* (P1), which was also a range extension. In addition, several *Tecticornia* taxa were of other significance, comprising another three range extensions and two affinity species (Table 9-19). These taxa were widespread within the riparian zone of the lake and islands and were not considered to be restricted.

Lake Mackay is predominantly dry, however, as with all inland wetlands in the arid zone of Australia, is subject to a boom phase during major floods. During the largest of these events (equivalent to 1:20 or 1:50 year events), the ecological values of the lake are considered highest, due to reduced surface water salinities. The lake, islands and peripheral wetlands support a diverse and abundant array of aquatic biota and waterbirds, while samphires in the riparian zone also flower prolifically under these conditions. In the last 20 years, however, rainfall and smaller inundation events at the lake have also become more frequent, likely attributed to climate change, with more intensive rainfall occurring during the wet season. These events tend to lead to partial filling of the lake only, with resulting elevated salinities limiting ecological values, which often exceed the tolerance limits required for the emergence of aquatic biota.

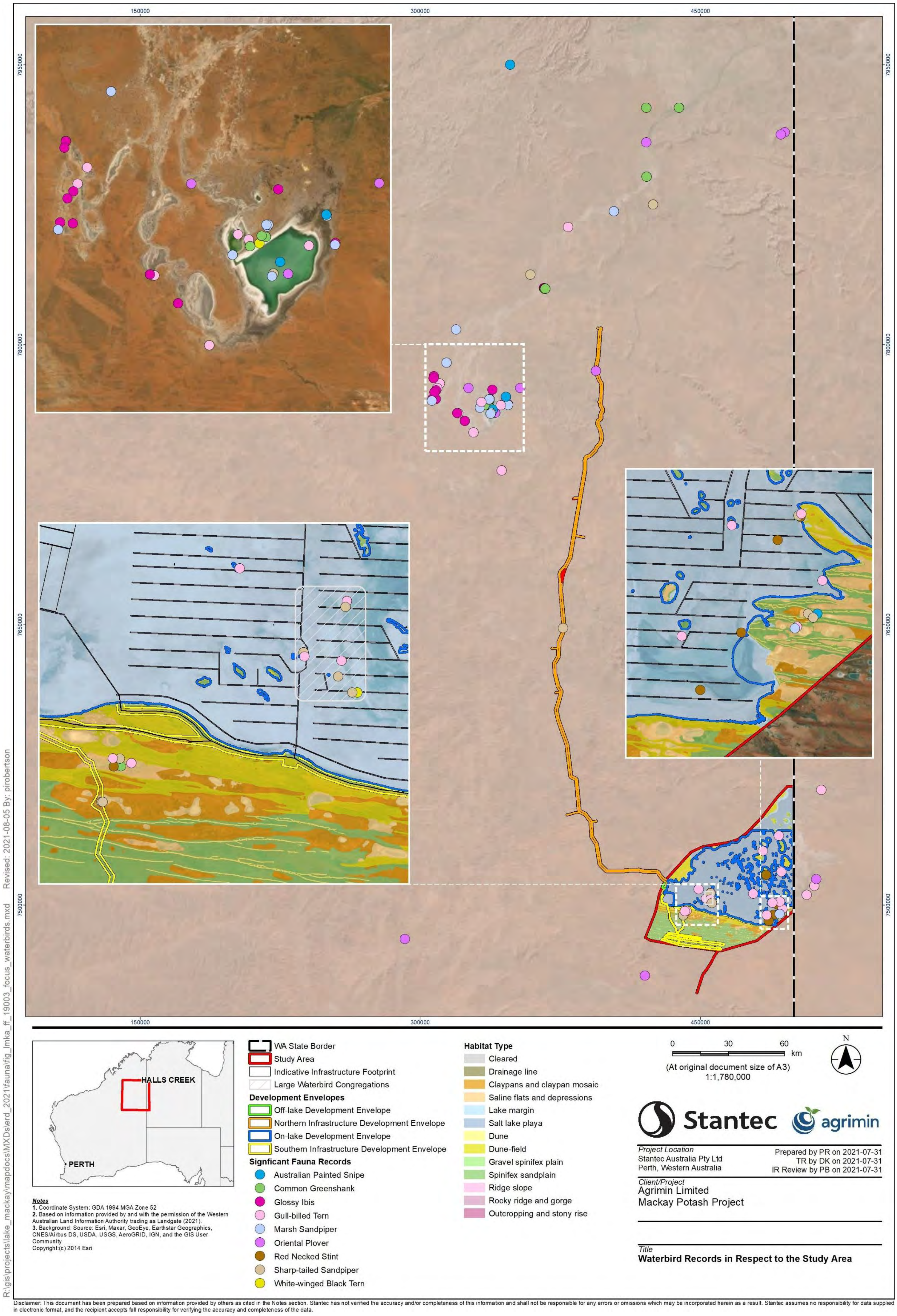

Figure 9-12: Location of migratory bird records from Lake Mackay and peripheral wetlands

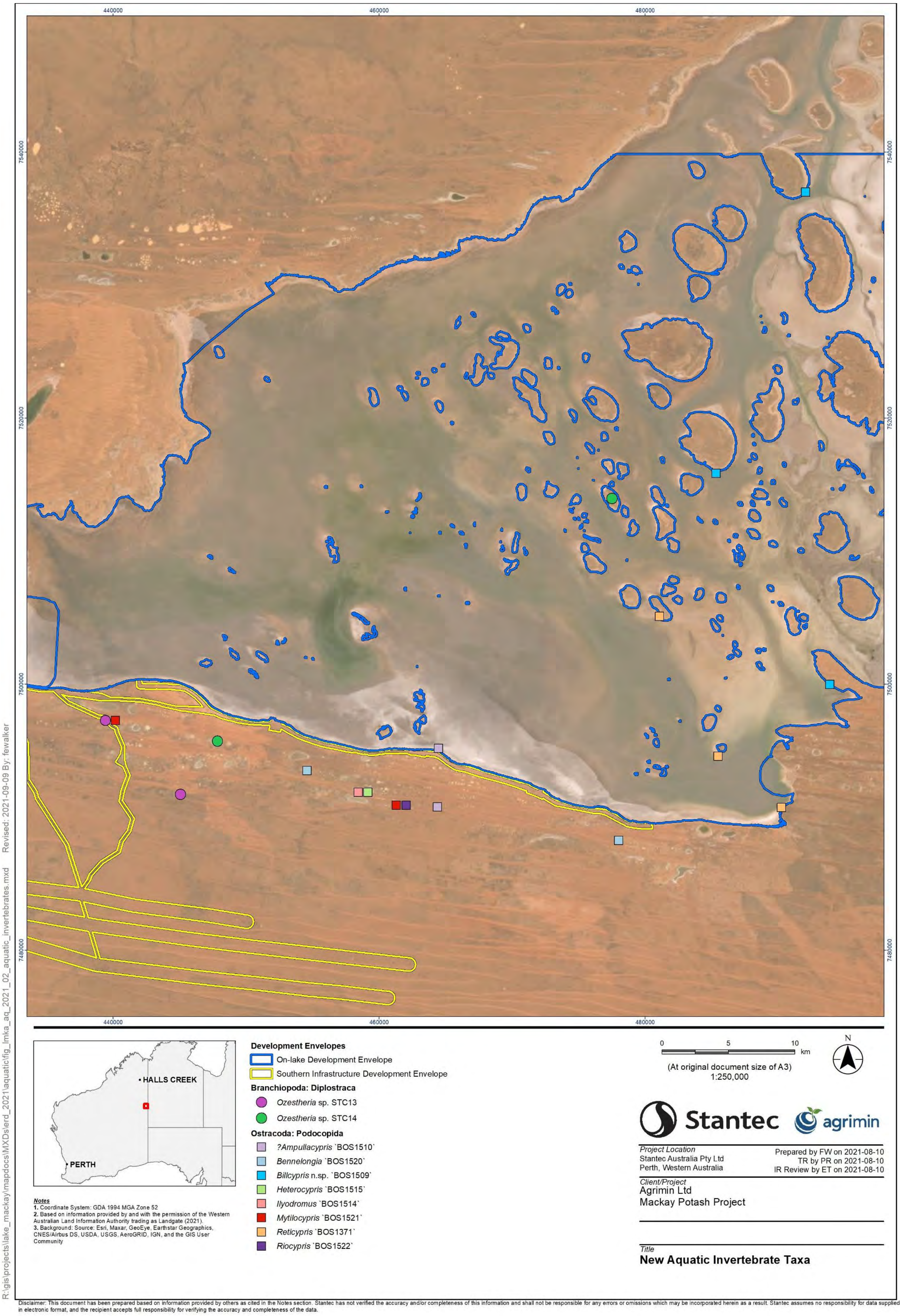

Figure 9-13: Location of aquatic invertebrate taxa of scientific interest from Lake Mackay and peripheral wetlands

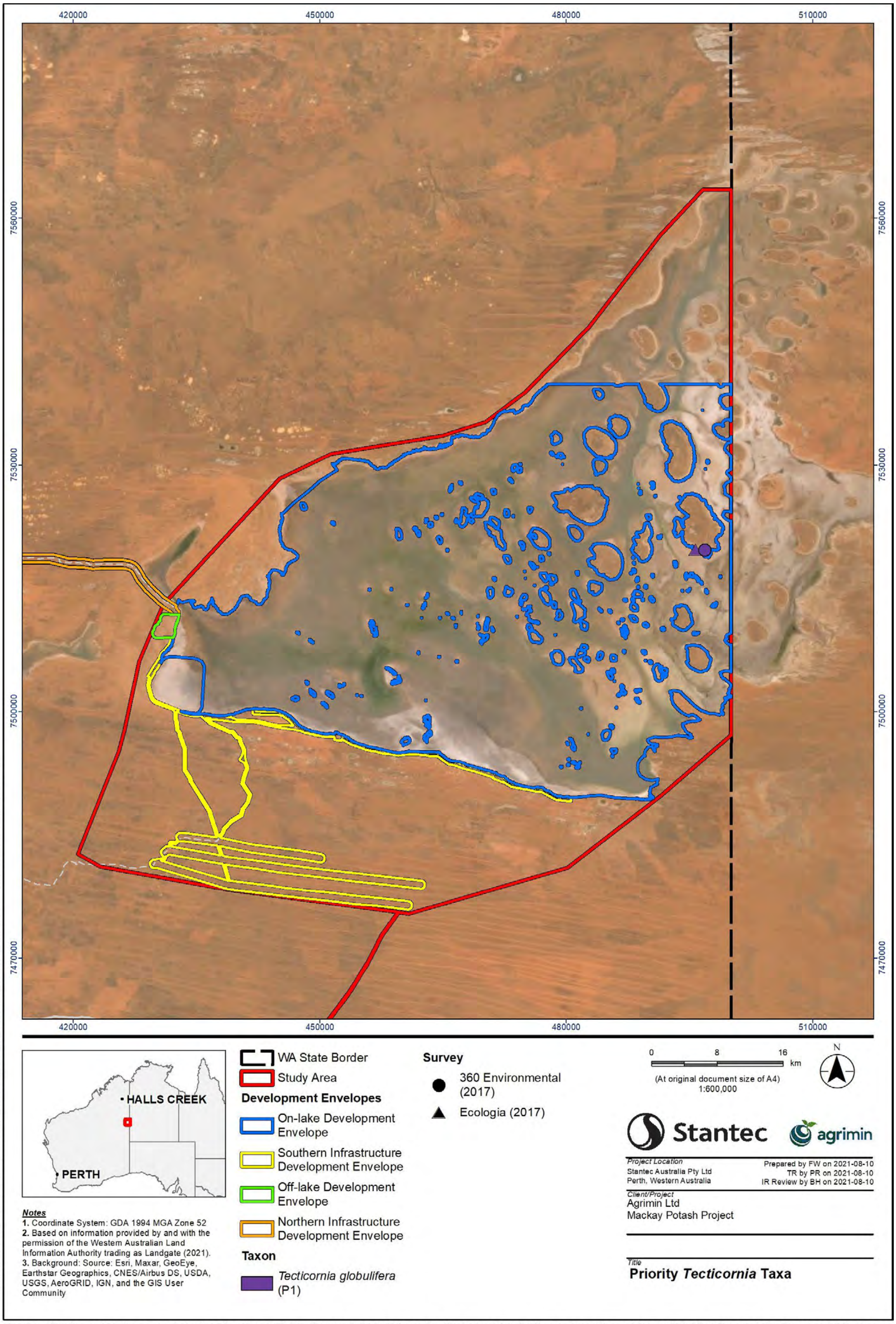

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Figure 9-14: Priority *Tecticornia* species records from Lake Mackay and peripheral wetlands during the Study

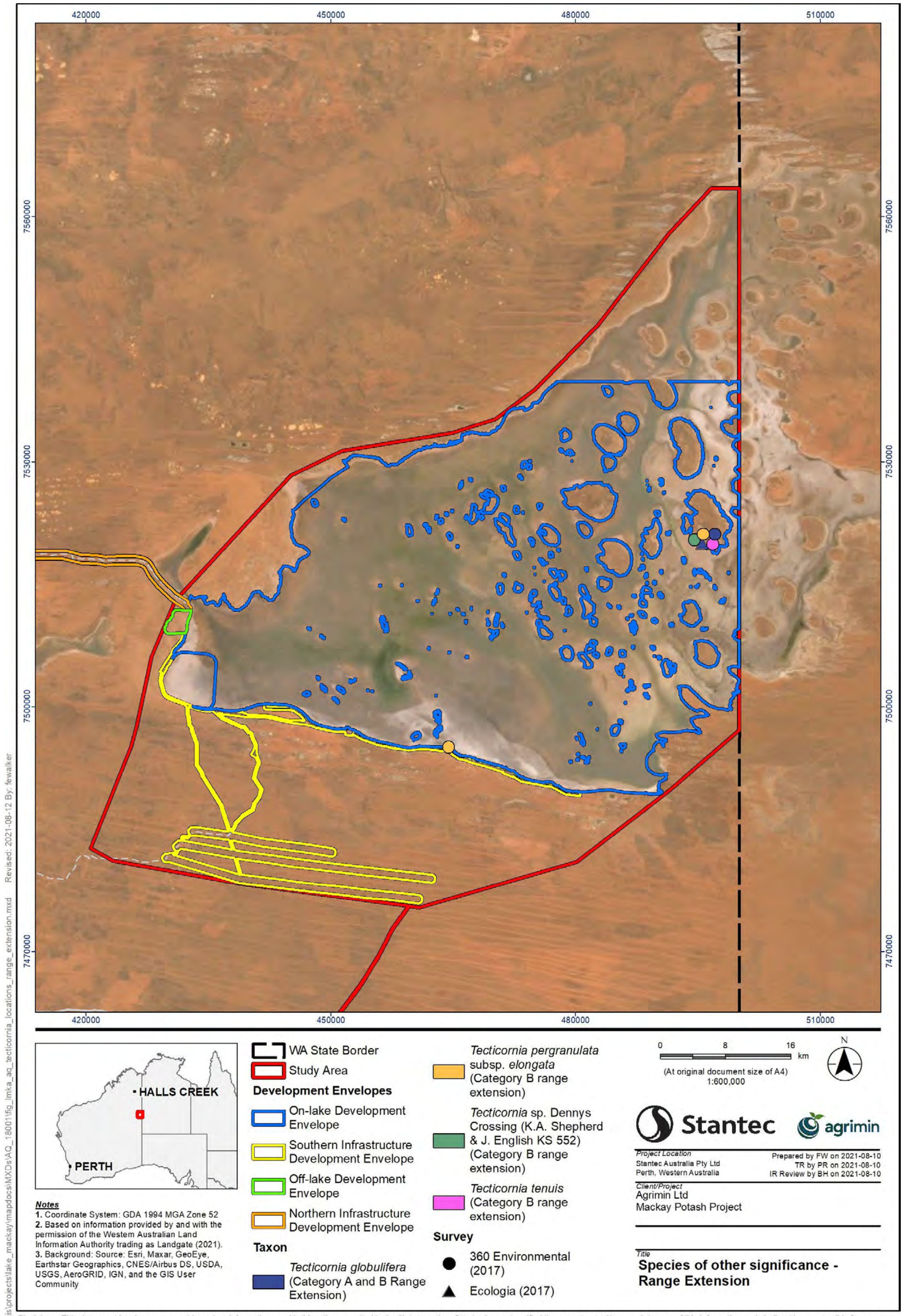

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Figure 9-15: *Tecticornia* records of other significance (range extension) from Lake Mackay and peripheral wetlands during the Study

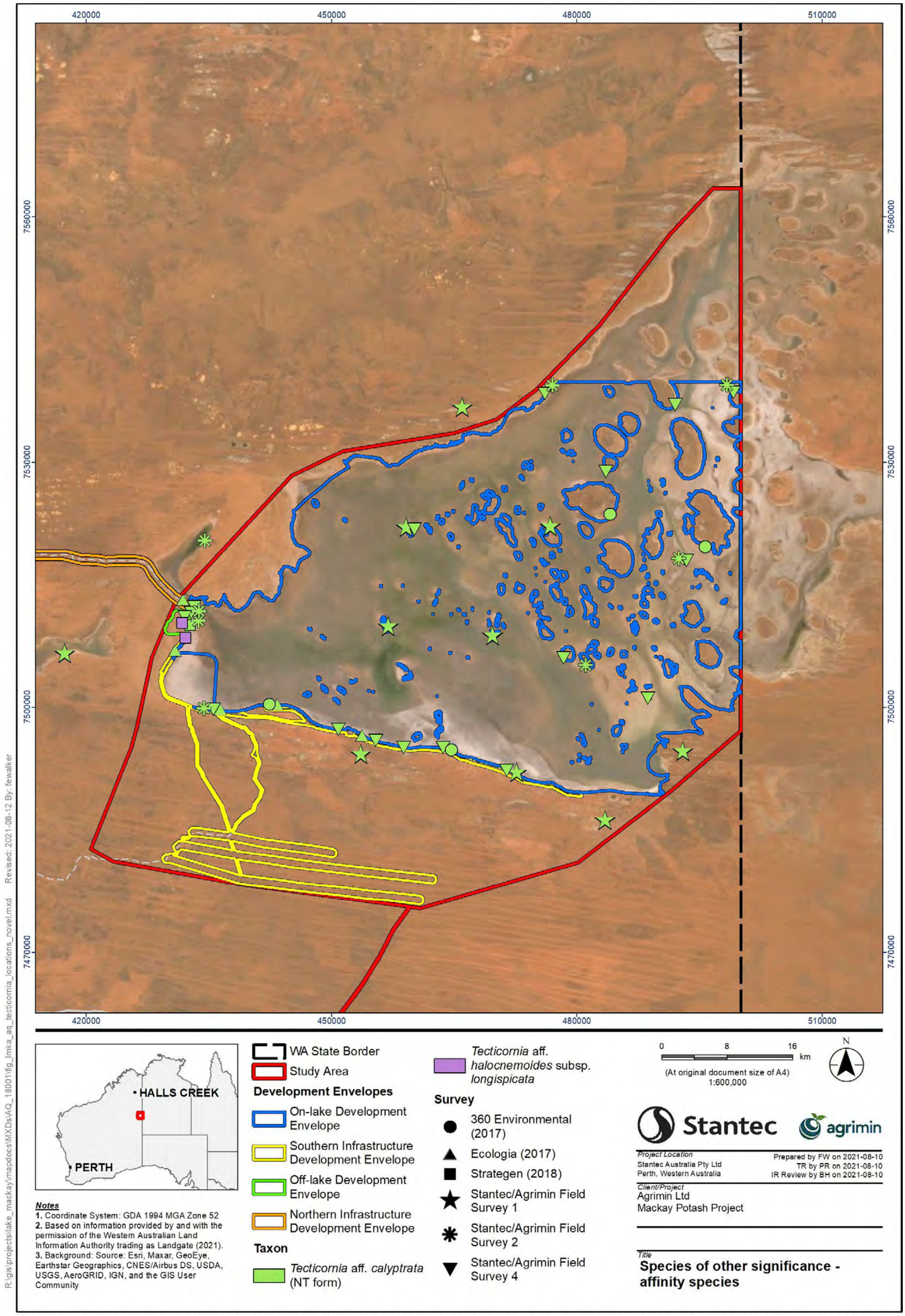

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Figure 9-16: *Tecticornia* records of other significance (affinity species) from Lake Mackay and peripheral wetlands during the Study

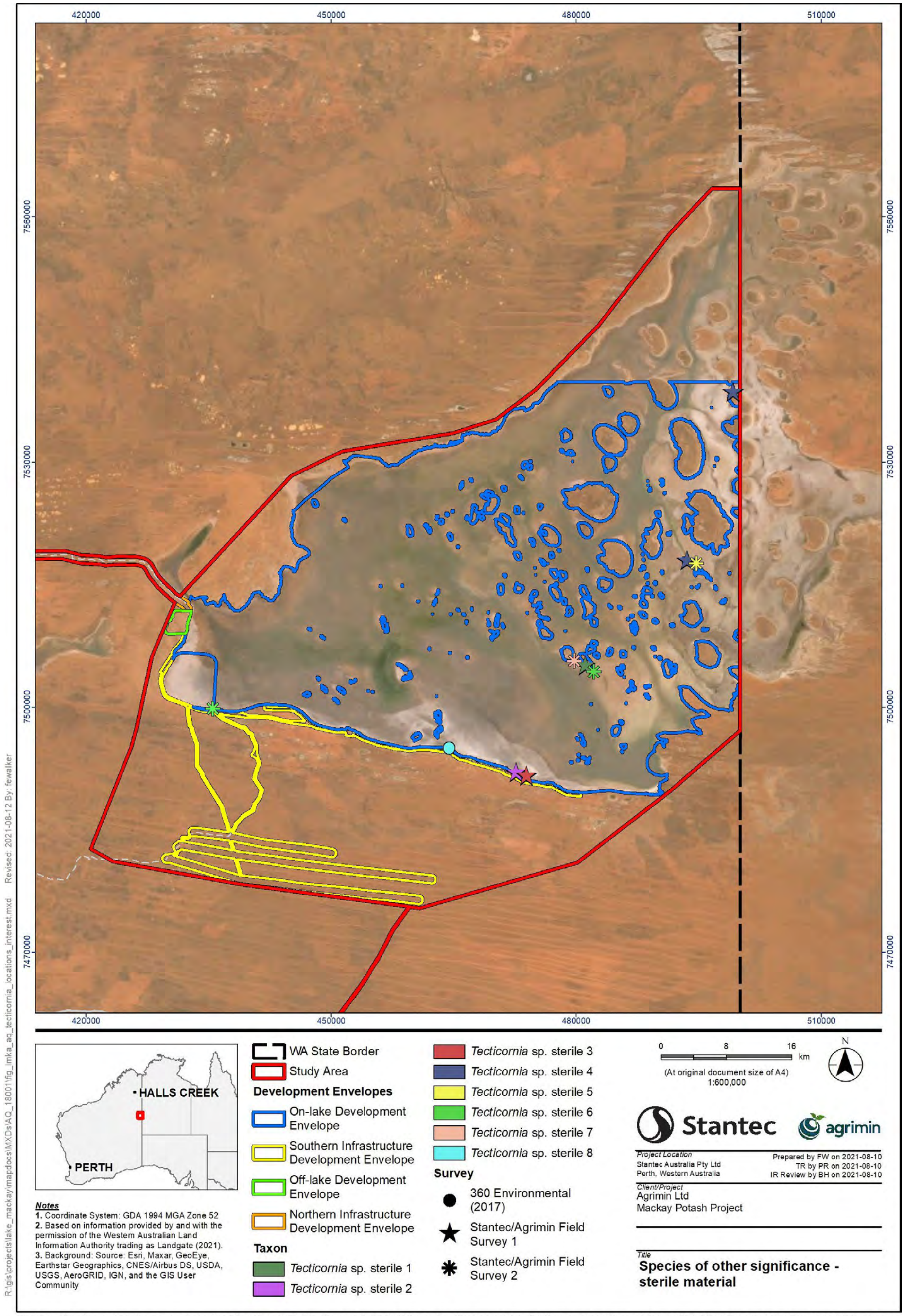

Figure 9-17: *Tecticornia* records of other significance (sterile material) from Lake Mackay and peripheral wetlands during the Study

Table 9-19: Summary of key findings and ecological values from Lake Mackay and peripheral wetlands

Ecological Aspects	Key Findings and/or Ecological Values	Dominant Taxa	Total Taxa	Lake Mackay Taxa	Peripheral Wetland Taxa	Island Claypan Taxa	Taxa of Scientific Interest / Other Significance	Taxa of Significance
Surface Hydrology	• Lake fills entirely (~2 m depth) on average once every 5 to 10 years, following rainfall events exceeding 250 mm, recharging groundwater levels to within 0.5 mbgl • Lake holds surface water longest in southeast corner, due to topographic relief, following rainfall events >150 mm	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Water Quality	• Lake Mackay slightly acidic and hyposaline to mesosaline, trending alkaline and hypersaline as the hydroperiod progresses • Nutrient and metals levels relatively low and homogenous • Peripheral wetlands generally fresh, with higher and more variable nutrient and metals levels compared to the lake	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Sediment Quality	• Lake Mackay acidic to neutral during dry conditions, trending moderately alkaline during inundation • Moderate to high salt loads and nutrient levels within Lake Mackay and peripheral wetlands, diluting substantially under flooded conditions • Metals below ANZG DGVs (Water Quality Australia 2018)	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Algae and Macrophytes	• Diatoms and blue-green algae dominant at Lake Mackay and peripheral wetlands, typical of temporary salt lakes • No true macrophytes recorded, though the spores of freshwater charophytes (large green algae) recorded at some peripheral wetlands	• *Hantzschia* • *Navicula* • *Nodularia* • *Phormidium* • *Amphora*	• 42	• 37	• 25	• N/A	• None	• N/A
Diatoms	• Assemblages at Lake Mackay and peripheral wetlands characterised by halophilic and aerophilic taxa, typical of inland saline water • Greater diversity at freshwater claypans attributed to differing water quality and substrate type, supporting additional species reflective of these conditions	• *Amphora coffeaeformis* • *Hantzschia* sp. aff. *baltica* • *Navicula* sp. aff. *incertata*	• 25	• 17	• 21	• 5	• None	• N/A
Aquatic Invertebrates*	• Relatively low diversity at Lake Mackay, generally dominated by common, halotolerant crustacean taxa • Higher diversity in the peripheral wetlands, comprising a resident crustacean community, opportunistic taxa (insects) and a single bivalve taxon • Greater variability in community composition between sites for peripheral wetlands compared to Lake Mackay, reflecting range of habitats, water quality and allocthonous inputs	• *Parartemia laticaudata* • *Meridiecyclops platypus* • *Branchinella* • *Ozestheria* spp. • *Triops australiensis* • *Eretes australis*	• 53	• 13	• 45	• 5	Clam shrimp • *Ozestheria* sp. STC13 • *Ozestheria* sp. STC14 Ostracods • *?Ampullacypris* `BOS1510 • *Bennelongia* `BOS1520` • *Billcypris* n.sp. `BOS1509` • *Heterocypris* `BOS1515` • *Ilyodromus* `BOS1514` • *Mytilocypris* `BOS1521` • *Reticypris* `BOS1371` • *Riocypris* `BOS1522`	• N/A
Riparian Vegetation*	• Composition dominated by chenopods • Assemblage typical of salt lake riparian vegetation • No declared rare flora or weeds	Confirmed taxa • *Tecticornia* aff. *calyptrata* (NT form) • *Frankenia cordata* • *Lawrencia viridigrisea*	• 96	• 77	• 16	• 45	Range extensions • *Tecticornia globulifera* (P1) – Category A / Category B • *Tecticornia pergranulata* subsp. *elongata* – Category B • *Tecticornia tenuis* – Category B	• *Tecticornia globulifera* (P1)

Ecological Aspects	Key Findings and/or Ecological Values	Dominant Taxa	Total Taxa	Lake Mackay Taxa	Peripheral Wetland Taxa	Island Claypan Taxa	Taxa of Scientific Interest / Other Significance	Taxa of Significance
							• *Tecticornia sp. Dennys Crossing* (K.A. Shepherd & J. English KS 552) –Category B Affinity species • *Tecticornia aff. calyptrata* (NT form) • *Tecticornia aff. halocnemoides subsp. longispicata [M. Stone LM01.04]* Sterile material • *Tecticornia* spp. (1-8)	
Waterbirds	• Lake, island formations and peripheral claypans provide important foraging and/or breeding habitat post flood	• Banded Stilts (*Cladorhynchus lecocephalus)* • Black-winged Stilts (*Himantopus himantopus*) • Red-necked Avocets (*Recurvirostra novaehollandiae*) • Whiskered Tern (*Chlidonias hybrida*) and/or White-winged Black Tern (*Chlidonias leucopterus*) • Sharp-tailed Sandpiper (*Calidris acuminata*)	• 34	• N/A	• N/A	• N/A	• N/A	Threatened species • Australian Painted Snipe (*Rostratula australis*) Migratory species • Gull-billed Tern (*Gelochelidon nilotica*) • White-winged Black Tern (*Chlidonias leucopterus*) • Glossy Ibis (*Plegadis falcinellus)* • Gull-billed Tern (*Gelochelidon nilotica)* and/or Caspian Tern (*Hydroprogne caspia*) • Common Greenshank (*Tringa nebularia*) • Red-necked Stint (*Calidris ruficollis*) • Sharp-tailed Sandpiper (*Calidris acuminata*) • Marsh Sandpiper (*Tringa stagnatilis)*

*Note: * indicates taxa diversity figures are based on consolidated datasets including previous surveys.*

9.5 Potential Impacts and Mitigation Measures

The potential exists for direct and indirect impacts from the Proposal to the On-LDE and the Inland Waters values that Lake Mackay supports. The risk for key activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of an environmental risk assessment, with a summary of potential direct and indirect impacts provided in Table 9-20. The key impacts associated with the development of the Proposal are discussed in detail in Sections 9.5.1 to 9.6 and provides local and regional ecological context for the impact assessment, and include:

- aquatic and riparian habitat loss, increased habitat fragmentation or modification, and loss of species of scientific interest or other significance, due to clearing and construction;
- altered surface hydrology associated with development (including under future predicted climate change scenarios), influencing surface water flows and inundation during major flooding, which may adversely affect aquatic biota and waterbirds;
- increased salinity due to runoff from evaporation ponds and salt piles, adversely affect aquatic biota and riparian vegetation;
- groundwater drawdown causing changes to hydraulic connectivity and/or reduction in moisture content of sediment, adversely impacting aquatic biota and riparian vegetation; and
- changes in salinity and/or ionic composition of groundwater from lake bed sediments abstraction, adversely impacting aquatic biota and riparian vegetation.

Additional potential indirect impacts were identified during the risk assessment which were ranked as lower risk (Table 9-20). These impacts were considered as having a risk level that can be appropriately managed and are not discussed in detail in the following sections; however, these risks will be addressed via management measures in the CEMP. These additional potential impacts to inland waters include:

- potential disturbance and exposure of ASS during trench excavation, adversely impacting aquatic and riparian habitat;
- potential for contamination of surface water and/or groundwater as a result of hydrocarbon and/or chemical spills, and landfill / wastewater treatment plant operations;
- changes in hydraulic connectivity and groundwater quality from abstraction of up to 3.5 GL/a of groundwater for processing from the SIDE borefield; and
- fugitive dust emissions (including wind-blown salts) may negatively affect aquatic and riparian habitats or riparian vegetation.

The mitigation hierarchy has been considered and applied so that the development of the Proposal will "maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected". This aligns with the EPA objective for the Inland Waters Factor (EPA 2018a).

Mitigation measures are summarised in Table 9-20, which largely avoid, mitigate, manage, monitor and rehabilitate significant impacts to Inland Waters, which may affect sensitive receptors including aquatic and riparian habitat and biota. Detailed impact assessment and mitigation measures for riparian vegetation, migratory waterbirds and subterranean fauna are also provided in Section 5.3, 7 and 8, respectively.

The mitigation measures are discussed in more detail in subsequent sections and will ensure the EPA objective for Inland Waters will be met.

Table 9-20: Mitigation hierarchy applied to mitigate impacts from the Proposal on Inland Waters

Key Proposal Impacts	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
Removal and/or loss of aquatic/riparian habitat and fragmentation, resulting in the loss of species of scientific interest or other significance due to clearing *Direct impact*	• Limit disturbance On-LDE (4.55%; <15,000 ha) • Avoid impacts to NT section of the lake (16.6%; 56,506 ha) • Exclusion heritage zones on WA side of the lake will remain undisturbed (9.5%; 32,261 ha) • Implement buffer zones around islands (up to 500 m) • Limit disturbance of riparian vegetation (33.13 ha) • Avoid impacts to peripheral wetlands • No expected disturbance of drainage features and claypans within the NIDE	• Detailed hydrological modelling of surface water flows, simulation 1:100-year events to determine impacts • Staged development of trenches via implementation of BMUs • Engineering design; 1 km distance between trenches, installation of crossovers to maintain hydrological processes	• Comply with CEMP • Comply with MCP • Develop a Ground Disturbance Permit System and Procedure • Comply with IWEMP	• Routine monitoring of aquatic biota resting stages during dry conditions through rewetting trials • Opportunistic monitoring of surface water extent, depth, quality and aquatic biota during flood conditions • Monitoring of riparian vegetation health	• Trench network and associated bunding will be breached as BMUs are progressively closed over LoM to allow natural flow paths to return to the lake • Evaporation pond embankment will be breached at closure to allow periodic pulsed flows and natural dissipation of salt piles to the lake over time	✓	No
Altered surface hydrology during major flood events (considering climate change), which may affect aquatic biota and waterbirds *Indirect impact*	• Limit disturbance On-LDE (4.55%; <15,000 ha) • Avoid impacts to NT section of the lake (16.6%; 56,506 ha) • Exclusion heritage zones on WA side of the lake will remain undisturbed (9.5%; 32,261 ha) • Avoid impacts to island including riparian vegetation (5.9%; 20,119 ha) • Avoid impacts to peripheral wetlands	• Detailed hydrological modelling of surface water flows, simulation 1:100-year events to determine impacts • Detailed long-term time series water balance modelling to determine baseline and operational scenarios and predicted climate change • Staged development of trenches via implementation of BMUs • Engineering design; 1 km distance between trenches, installation of crossovers to maintain hydrological processes • At closure, breaching of southern feeder canal, trenches to infill naturally within ~10 years, aided by flooding	• Comply with CEMP • Develop a Ground Disturbance Permit System and Procedure • Comply with IWEMP • Comply with MCP • Develop an Incident Reporting Procedure	• Routine monitoring of aquatic biota resting stages during dry conditions through rewetting trials • Opportunistic monitoring of surface water extent, depth, quality and aquatic biota during flood conditions	• Trench network and associated bunding will be strategically breached to allow natural flow paths to return to the lake • Trenches will in fill naturally within a period of ~10 years, aided by flood events • There are limited effects expected on the frequency, duration and extent of large inundation events on the lake, maintaining hydrology and ecology	✓	No
Increased lake salinity from runoff associated with evaporation ponds and salt piles, adversely affect aquatic biota and riparian vegetation *Indirect impact*	• Limit disturbance on the lake from evaporation ponds and salt piles (2.7%, <9000 ha) • Avoid islands with infrastructure located in western portion of the lake • Implement a buffer zone to the riparian vegetation of up to 250 m	• Natural attenuation of salts via dilution and dispersal during major flood events and some infiltration into the lake bed sediments • Staged development of evaporation ponds and salt piles • Evaporation ponds have been designed for a 1% AEP flood event, with minimum embankment height of 1.5 m, providing sufficient freeboard to limit saline runoff into the lake during major rainfall events • Evaporation ponds will be breached at closure, with salts gradually dissipating and returning to the playa over time	• Comply with CEMP • Develop an Emergency Response Plan • Comply with IWEMP • Develop an Incident Reporting Procedure	• Routine monitoring of aquatic biota resting stages during dry conditions through rewetting trials • Opportunistic monitoring of surface water extent, depth, quality and aquatic biota during flood conditions • Monitoring of riparian vegetation health	• Evaporation pond embankment will be breached at closure to allow periodic pulsed flows and natural dissipation of salt to the lake over time	✓	No
Groundwater drawdown causing changes to hydraulic connectivity and/or reduction in moisture content of sediment, adversely impacting aquatic biota and riparian vegetation *Indirect impact*	• Limit disturbance On-LDE (4.55%; <15,000 ha) • Avoid impacts to NT section of the lake (16.6%; 56,506 ha) • Exclusion heritage zones on WA side of the lake will remain undisturbed (9.5%; 32,261 ha) • Engineering design; 1 km distance between trenches to limit drawdown • Implement buffer zones around islands formations (up to 500 m)	• Large rainfall events (300 mm within one month) will recharge groundwater levels to within 0.4-0.8 m of the surface (baseline conditions	• Comply with IWEMP • Develop a Groundwater Monitoring Procedure (outlined in the IWEMP)	• Routine monitoring of groundwater levels during operations • Routine monitoring of aquatic biota resting stages during dry conditions through rewetting trials • Opportunistic monitoring of surface water extent, depth, quality and aquatic biota during flood conditions	• NA	✓	No

Key Proposal Impacts	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
	• Residual salt crust will prevent moisture loss limiting sediment mobilisation			• Monitoring of riparian vegetation health			
Abstraction of groundwater from lake bed sediments changing salinity and/or ionic composition of groundwater, adversely impacting aquatic biota and riparian vegetation *Indirect impact*	• Removal of potassium (K) will not alter the dominant ionic constituents in groundwater	• Large rainfall events (300 mm within one month) will recharge groundwater levels dissolving salts within the lake bed sediments and restoring the ionic equilibrium	• Comply with IWEMP • Develop a Groundwater Monitoring Procedure (outlined within the IWEMP)	• Routine monitoring of groundwater quality during operations • Routine monitoring of aquatic biota resting stages during dry conditions through rewetting trials • Opportunistic monitoring of surface water extent, depth, quality and aquatic biota during flood conditions • Monitoring of riparian vegetation health	• The dominant constituents of lake bed sediments, NaCl salts, will be returned to the salt lake playa over time • There are no expected changes to ionic composition or the natural nutrient cycling processes of the lake	✓	No
Potential disturbance and exposure of ASS during trench excavation, adversely impacting aquatic and riparian habitat *Indirect impact*	• Limited acid forming material exists within the lake bed sediments	• Development of ASS Management Plan (ASSMP) to enable identification and management of ASS • ASS neutralising material kept on site to respond to acid generating materials encountered during construction	• Comply with IWEMP • Comply with FVEMP • Comply with CEMP • Develop an ASSMP	• Routine monitoring of groundwater quality during operations • Monitoring of riparian vegetation health	• NA	✓	No
Potential for contamination of surface water and/or groundwater as a result of hydrocarbon and/or chemical spills, and landfill/wastewater treatment plant operations *Indirect impact*	• Avoid use of diesel for power generation by using LNG, solar and wind operation alternatives for the Proposal • Salt harvesters will be powered using reticulated power sources limiting diesel usage on the lake surface • Avoid fuel/chemical storage and transfer from occurring outside of designated areas • Prevent chemical/hydrocarbon spills from spreading • Avoid off-road driving and stay on approved access ways	• Signage and bunding on all unstable landforms • Spill response equipment available (including on all Haul Trucks) • Spill response training for all personnel and contractors • Maintain high standard of housekeeping around processing plant	• Comply with IWEMP • Develop a HSMP and Procedure • Develop a Refuelling Procedures of on-lake vehicles, plant and equipment • Develop a Spill Response Plan • Management of sites as per the Contaminated Site Act 2003 • Develop a Contaminated Sites Register • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process • If required, sampling of soils to ensure all contaminated material has been removed and *in situ* soils sediment have been remediated • If required, monitoring riparian vegetation in affected areas and adjacent areas	• If required, contaminated site rehabilitation	✓	No
Changes in hydraulic connectivity and groundwater quality from abstraction of up to 3.5 GL/a of groundwater for processing from borefield *Indirect impact*	• Avoid peripheral wetlands (claypans) with the implementation of suitable buffer zones	• Detailed hydrological modelling of surface water flows, simulation 1:100-year events to determine impacts • Groundwater investigations and modelling will be used to investigate drawdown extent and change in surface flows to minimise impacts to SIDE aquifers and associated subterranean fauna habitat, and demonstrate residual impact are not greater than predicted	• Comply with IWEMP • Comply with Groundwater Monitoring Procedure (outlined in IWEMP)	• Routine monitoring of groundwater levels during operations • Routine monitoring of groundwater quality during operations	• NA	✓	No
Fugitive dust emissions (including windblown salt from evaporation ponds/salt piles) may adversely affect aquatic and riparian habitats or riparian vegetation *Indirect impact*	• Implement suitable buffer zone between evaporation ponds and salt piles and riparian vegetation	• Salts blow naturally into dunes from the lake bed • Salts from evaporation ponds/salt piles have cohesive properties that will prevent movement	• NA	• NA	• NA	✓	No

9.5.1 Aquatic and riparian habitat Loss

The Indicative Footprint under the Proposal indicates that less than 5% or up to 15,000 ha of the lake surface will be directly disturbed (Table 9-21), considered a direct impact. On-LDE infrastructure will consist primarily of the trench network, associated bunding, evaporation ponds and salt piles. Habitat fragmentation or modification occurs as a result of On-LDE infrastructure and loss of continuity of the lake surface. However, a substantial area of the lake will remain undisturbed. In addition, there is no expected disturbance to peripheral wetlands habitat, avoiding impacts to aquatic biota, waterbirds and riparian vegetation (Figure 9-18). There is also no expected disturbance to the NIDE, with the haul road designed to avoid drainage features and claypans.

Table 9-21: Summary of lake habitat within the Proposal area, exclusion zones and the Indicative Footprint

Lake Mackay Total Area ha	On-LDE		Island Excl. On-LDE		WA Exclusion Zones		NT Exclusion Zone		Indicative Footprint	
	ha	%	ha	%	ha	%	ha	%	ha	%
339,471	216,252	63.7	20,119	5.9	32,261	9.5	56,506	16.6	15,000	4.55

Note: The above surface areas represent the playa surface.

Potential impacts (habitat loss, fragmentation or modification) to the aquatic and riparian habitat are considered minor in relation to the total surface area of Lake Mackay and will result in the loss of less than 10% of primary habitats. However, mitigation measures to reduce and manage impacts will include the following:

- exclusion zones are present on the WA side of the border, comprising three separate heritage areas (9.5%; 32,261 ha) and on the NT side of the lake (16.6%; 56,506 ha), which will remain undisturbed (Table 9-21, Figure 9-18);
- suitable buffer zones will be implemented around the lake islands (Figure 9-18), which support riparian vegetation and provide habitat for waterbirds, comprising 500 m for landform islands (>2,000 ha), 250 m for large (>500 to 1,500 ha) and intermediate (>100 to 500 ha) islands, and 100 m for small islands (<100 ha);
- staged development of trenches (BMUs) will occur over a 17-year period, with appropriate engineering design to avoid impacts;
- installation of crossovers (Figure 9-19), to prevent backflow and inundation of riparian vegetation along the southern margins of the lake; and
- disturbance to riparian vegetation on the lake margins will be limited to 33.13 ha within the Indicative Footprint (0.15% of riparian vegetation) in the Study Area, for nominal clearing along the lake margins (SIDE) for tracks to access the trench network, detailed in Section 6.6.

There have been 10 aquatic invertebrate taxa recorded from Lake Mackay and peripheral wetlands that are new (undescribed). In addition, one threatened waterbird species (EN), up to eight migratory species and one Priority riparian flora species are known to inhabit or frequent the playa and/or peripheral wetlands. Several riparian flora species of other significance have also been documented, including four range extensions and two affinity species, which are known to occur on a regional scale.

The new aquatic invertebrate taxa are currently only known from the lake and/or peripheral wetlands. However, those confirmed from the lake only, are widespread on the playa and are likely to occur across the border into the NT. They may also be associated with other salt lakes throughout the arid interior that have not yet been studied.

During major flood events, numerous salt lakes and peripheral wetlands become inundated throughout the arid interior, providing extensive habitat for aquatic biota and waterbirds, and allowing for the recruitment of riparian vegetation. Due to the provision of local and regional habitat within the lake and broader area, the Proposal is unlikely to have residual impact on aquatic and riparian habitat. Together with the implementation of mitigation measures, routine monitoring of aquatic biota and riparian vegetation is expected to be undertaken to confirm ecosystem health is maintained during operations.

The implementation of measures to mitigate the impact of aquatic and riparian habitat loss from development will meet the EPA objectives for Inland Waters.

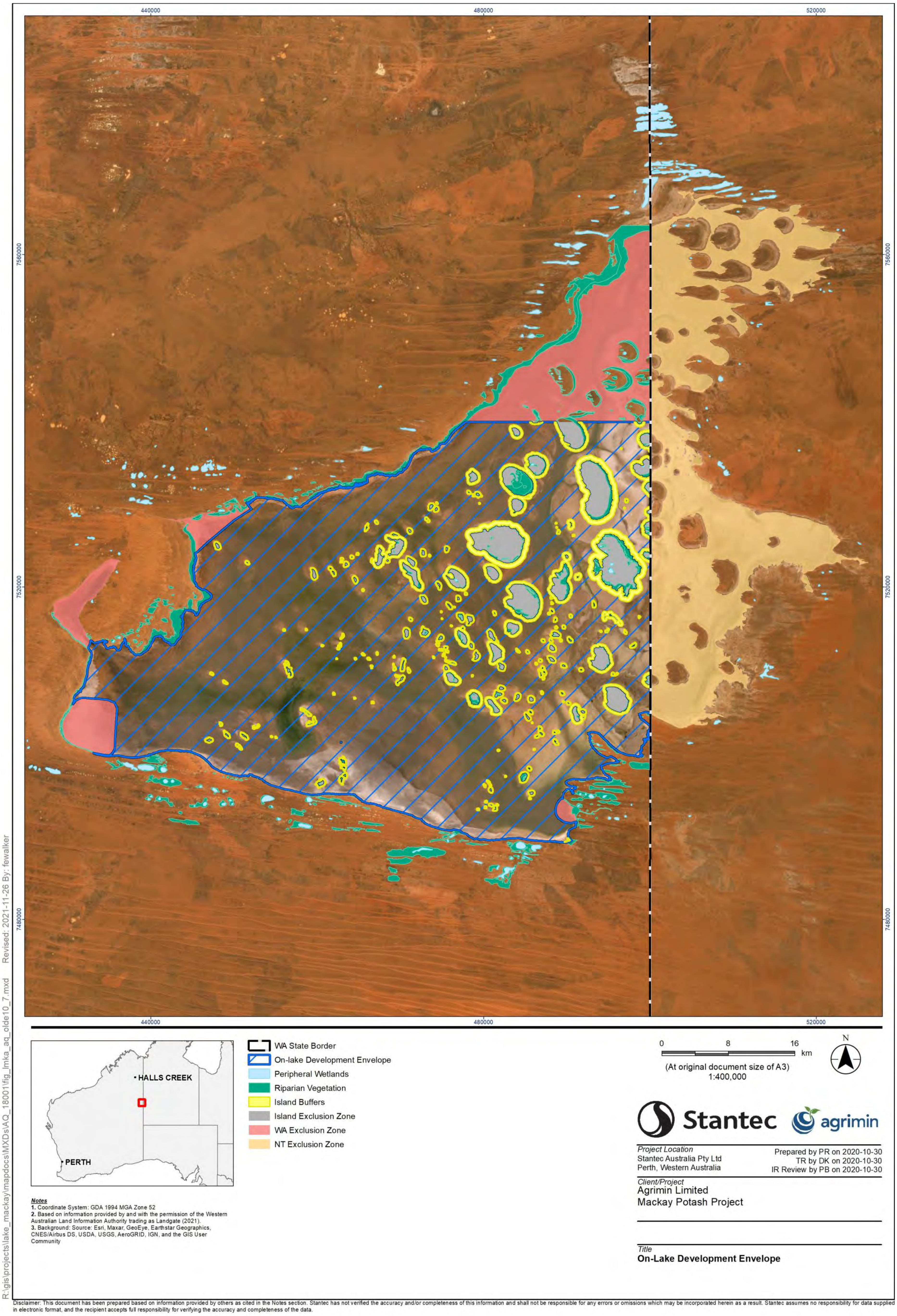

Figure 9-18: Aquatic (On-LDE) and riparian (Off-LDE) habitats occurring within the Proposal area, showing exclusion zones and the Indicative Footprint

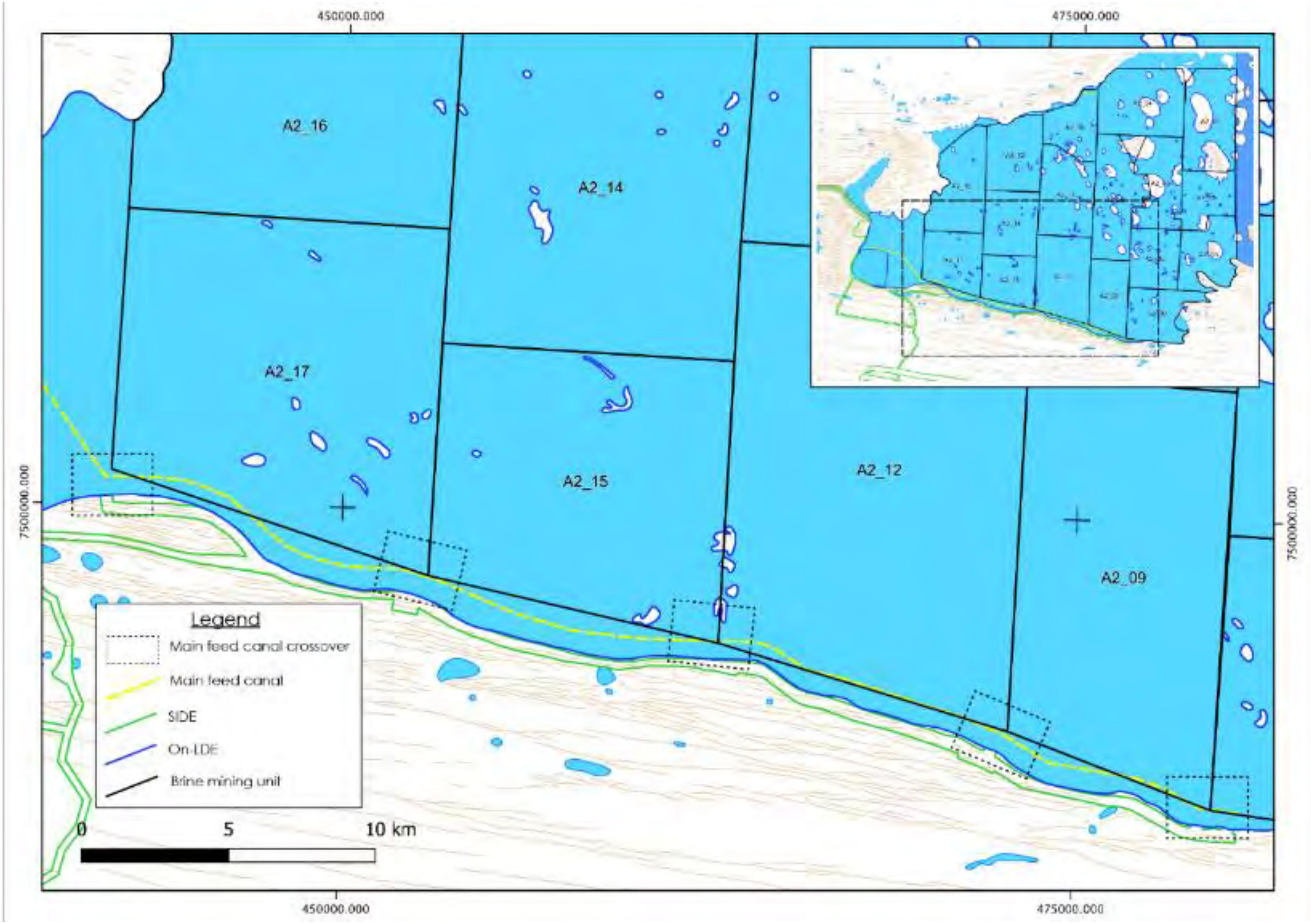

Figure 9-19: On-LDE BMUs, indicating crossovers to maintain hydrological processes

9.5.2 Altered surface hydrology

9.5.2.1 Inundation, velocity and depth

Although the Indicative Footprint for the On-LDE infrastructure represents a small portion of the total surface area of the lake, the linear trench network and associated bunding has the potential to alter hydrological processes. This may result in localised changes to surface flows and inundation patterns on the lake with indirect impacts to lake ecology. Hydrological modelling was undertaken to examine runoff and water levels under baseline conditions, compared to the 20-year LoM scenario for various rainfall conditions (Appendix I.11). Two rainfall events totalling 30 mm and 100 mm of excess rainfall were applied to the contributing catchment to compare surface water characteristics between baseline and developed conditions.

Baseline velocities for the 100 mm rainfall event on the lake bed are near zero, with some areas of concentrated flow between islands exhibiting maximum velocities of approximately 0.1 m/s (Appendix I.11). Where inflow from runoff enters the lake, velocities may increase up to 0.5 m/s. Following development of the Proposal there is a general reduction in velocity, due to the impediment caused by bunding around the trenches; however, in some areas, velocities increase where concentrated flow is confined between bunds or diverted along the perimeter of infrastructure (Figure 9-20). Similarly, velocities around the evaporation ponds (at Year 20) are predicted to increase near the shoreline during the modelled 100 mm rainfall event (Figure 9-21); however, baseline conditions also show higher velocities around the margins under this scenario (Figure 9-21).

The effect of trench bunding and the magnitude of changes in water surface elevation from the Proposal varies spatially and temporally (Figure 9-22). Where surface water flow is blocked by the presence of trench bunds, this typically results in a temporary increase in water levels around the outside (or upslope) of the trench network (Appendix I.11). In some areas, the bunds prevent downslope movement of water, which results in a decrease in surface water elevation within the trench network. Depths along the lake edges and between the evaporation ponds at Year 20 may also increase temporarily, during a 100 mm rainfall event (Figure 9-23).

However, more broadly, while maximum water depth and duration of inundation may temporarily change as a result of the construction of the trench network, the overall stage-volume and stage-area relationship of the lake does not change significantly relative to the baseline condition (Appendix I.11). Water ultimately ponds in the deepest parts of the lake under all scenarios modelled due to the presence of breaches in the trench network. In addition, ponded water levels that are temporarily impeded by the presence of bunds reduce over time in the LoM modelled scenario due to infiltration and evaporation, stabilising at similar levels to the baseline condition following storm events.

The most significant effect on surface water levels was observed along the east-west main feed canal of the trench network. This feed canal runs parallel to the southern lake shoreline approximately 300 m to 500 m from the shoreline over a length of approximately 50 km (Figure 9-22). Surface water runoff that enters the lake from the southern catchment areas impounds behind the bund and inundates additional shoreline area. Inundation depth and extent changes as a result of the trench network, with a maximum change of 10 cm and 30 ha in a 30 mm rainfall event, and 50 cm and 150 ha in a 100 mm rainfall event (Figure 9-24). However, this impact is restricted to the southern shoreline of the lake only. The total inundated area of the lake under various rainfall events effectively remains the same as baseline conditions, particularly during major flood events (Appendix I.11) (Figure 9-22).

Potential impacts to surface hydrology may result in a temporary change to hydrological processes during operations. Mitigation measures to reduce the risk of these impacts will include the following:

- staged development of trenches (BMUs) over a 17-year period, with appropriate engineering design, which will allow natural surface water flow and flooding in deeper parts of the basin (Figure 9-19), maintaining hydrological processes and ecological function;
- construction of trenches 1 km apart with the installation of strategic crossovers (and potential armouring), maintaining hydrologic flow paths and preventing backflow and inundation of riparian vegetation along the southern shoreline of the lake;
- implementation of suitable buffer zones surrounding the islands, which support riparian vegetation and provide habitat for waterbirds comprising 500 m for landform islands (>2,000 ha), 250 m for large (>500 to 1,500 ha)and intermediate (>100 to 500 ha) islands and 100 m for small islands (<100 ha);
- at closure, strategic breaching of the southern feeder canal and trench bunding to maintain hydrology, based on hydrological modelling results; and
- at closure, trenches to infill naturally, a process likely to occur within approximately 10 years, aided by flooding, which will redistribute salt and sediment across the playa.

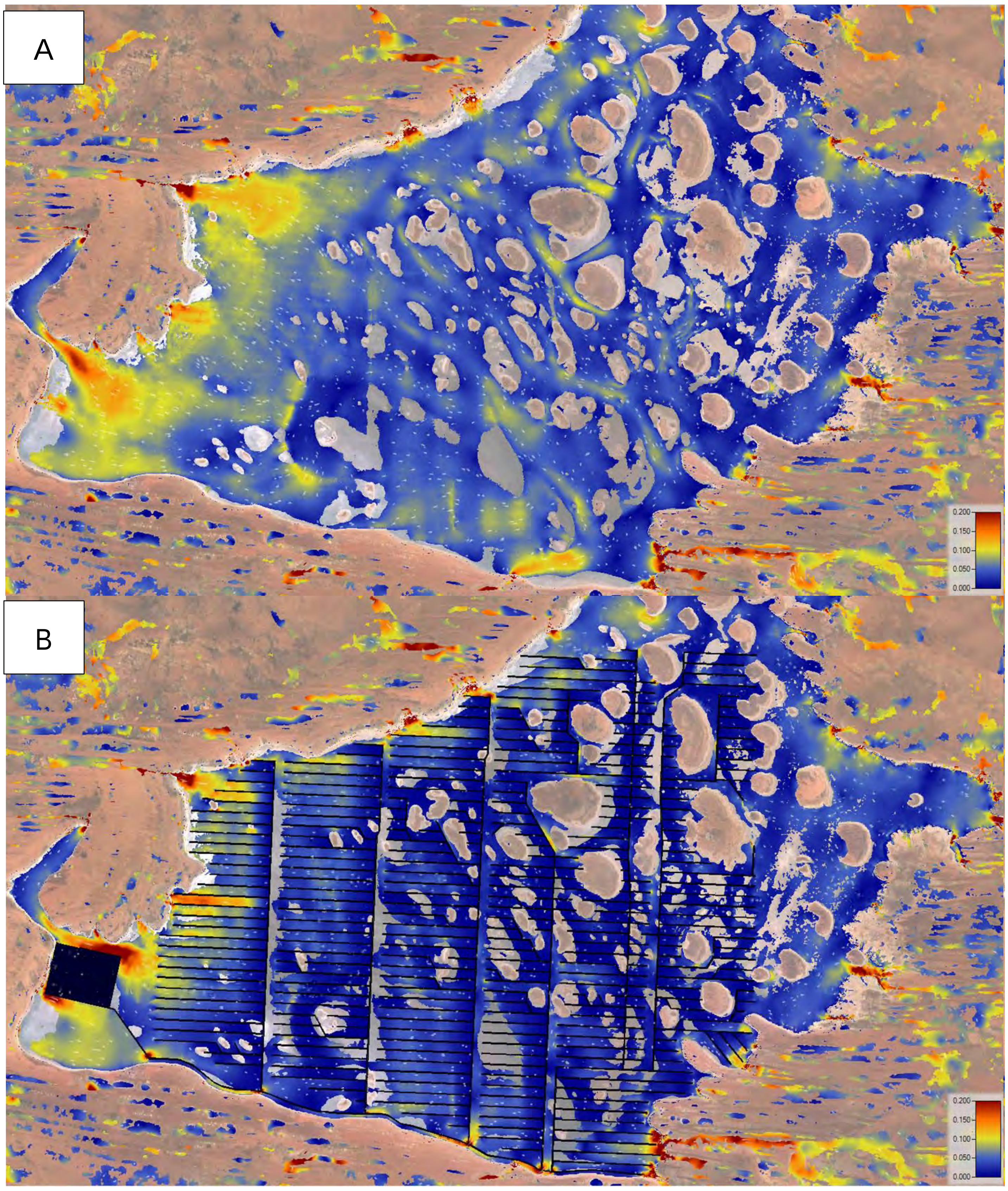

Figure 9-20: Maximum velocities for 100 mm rainfall event (T=9 hrs). (A) baseline conditions, and (B), year 20 trench network

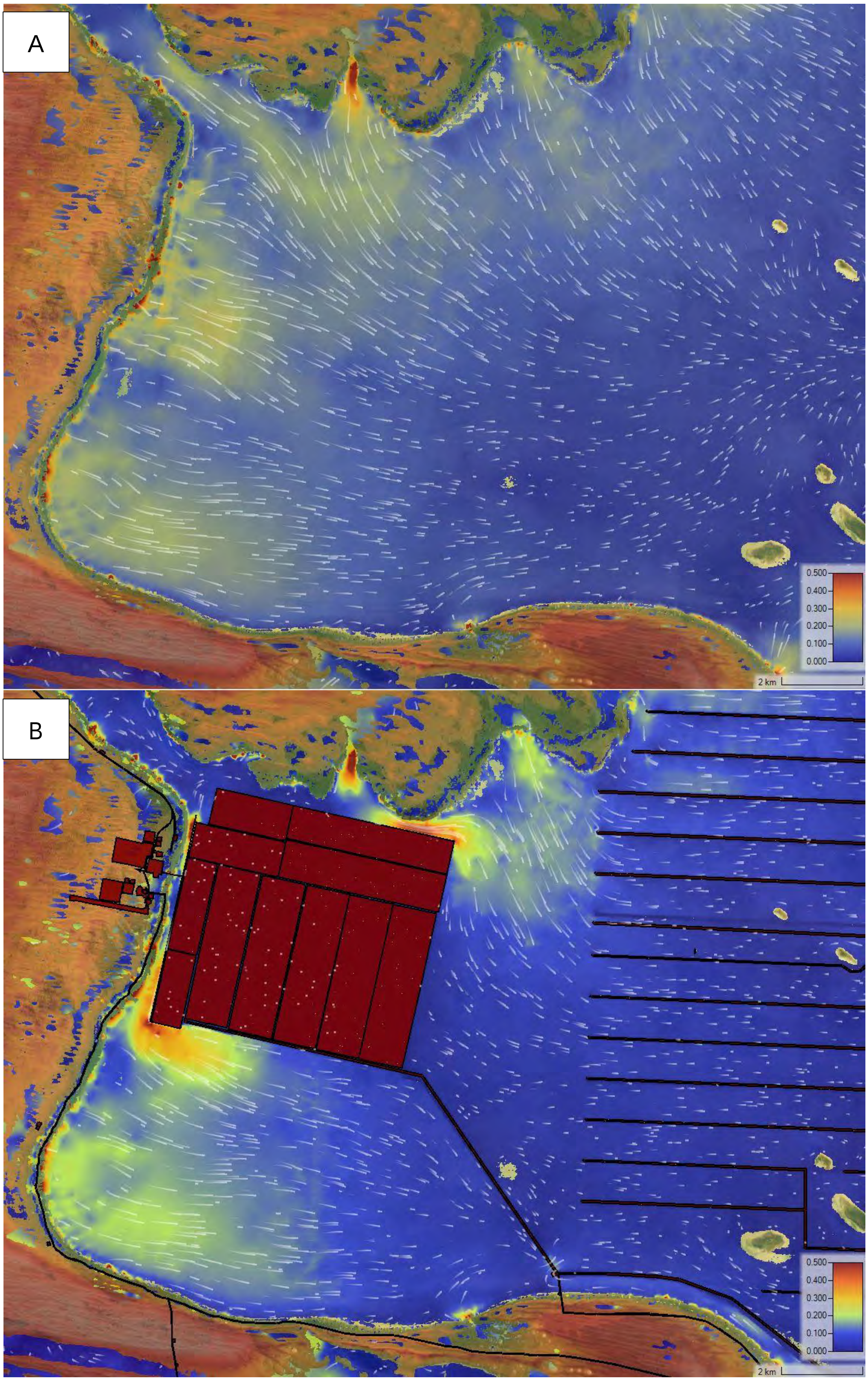

Figure 9-21: Maximum velocities for 100 mm rainfall event (at T=9 hrs) for (A) baseline conditions, and (B) year 20 trench network

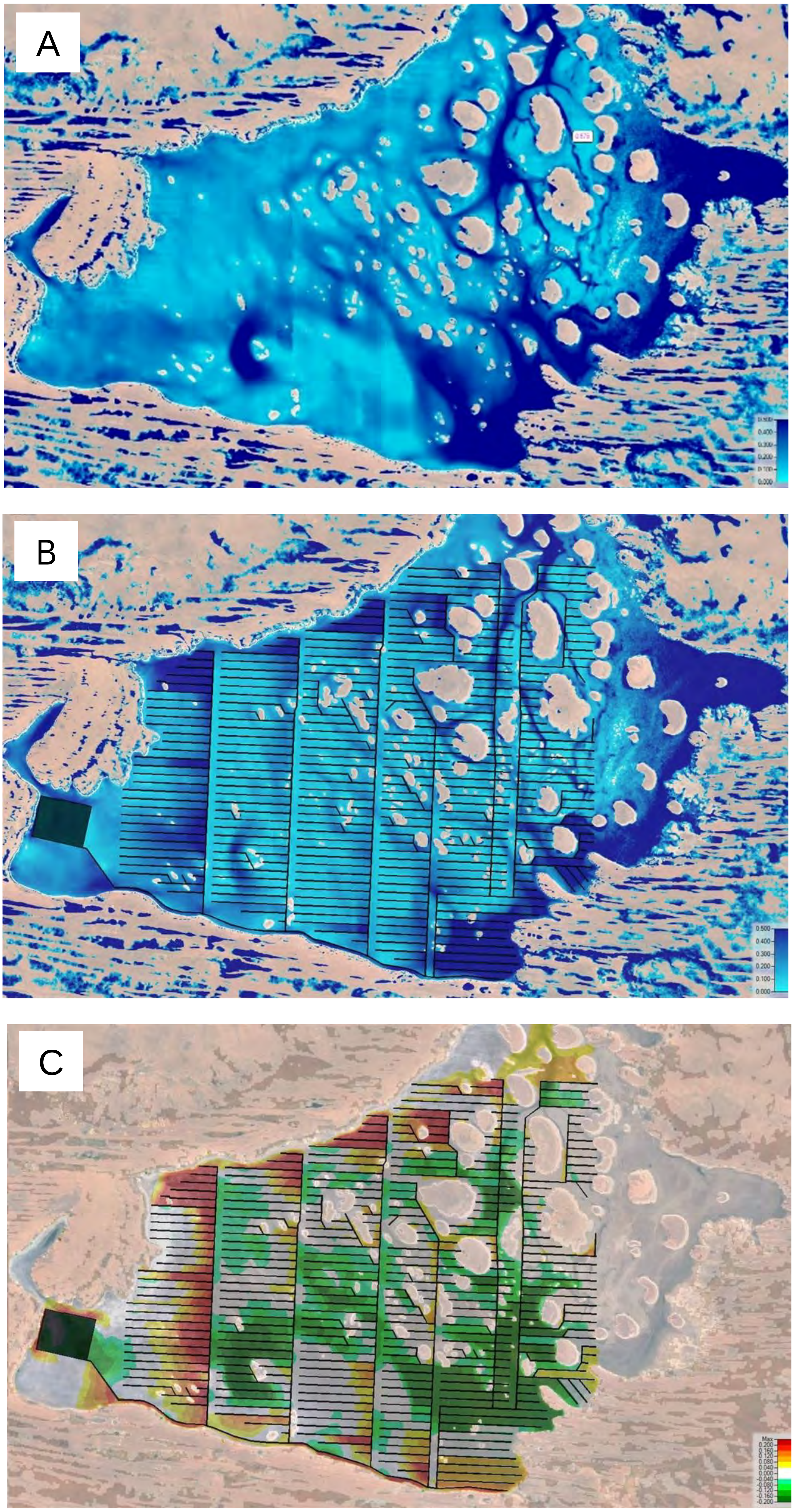

Figure 9-22: Maximum water depth during 100 mm rainfall event (72 hrs) for (A) baseline conditions, (B) Year 20, and Depth differential at (C) Year 20.

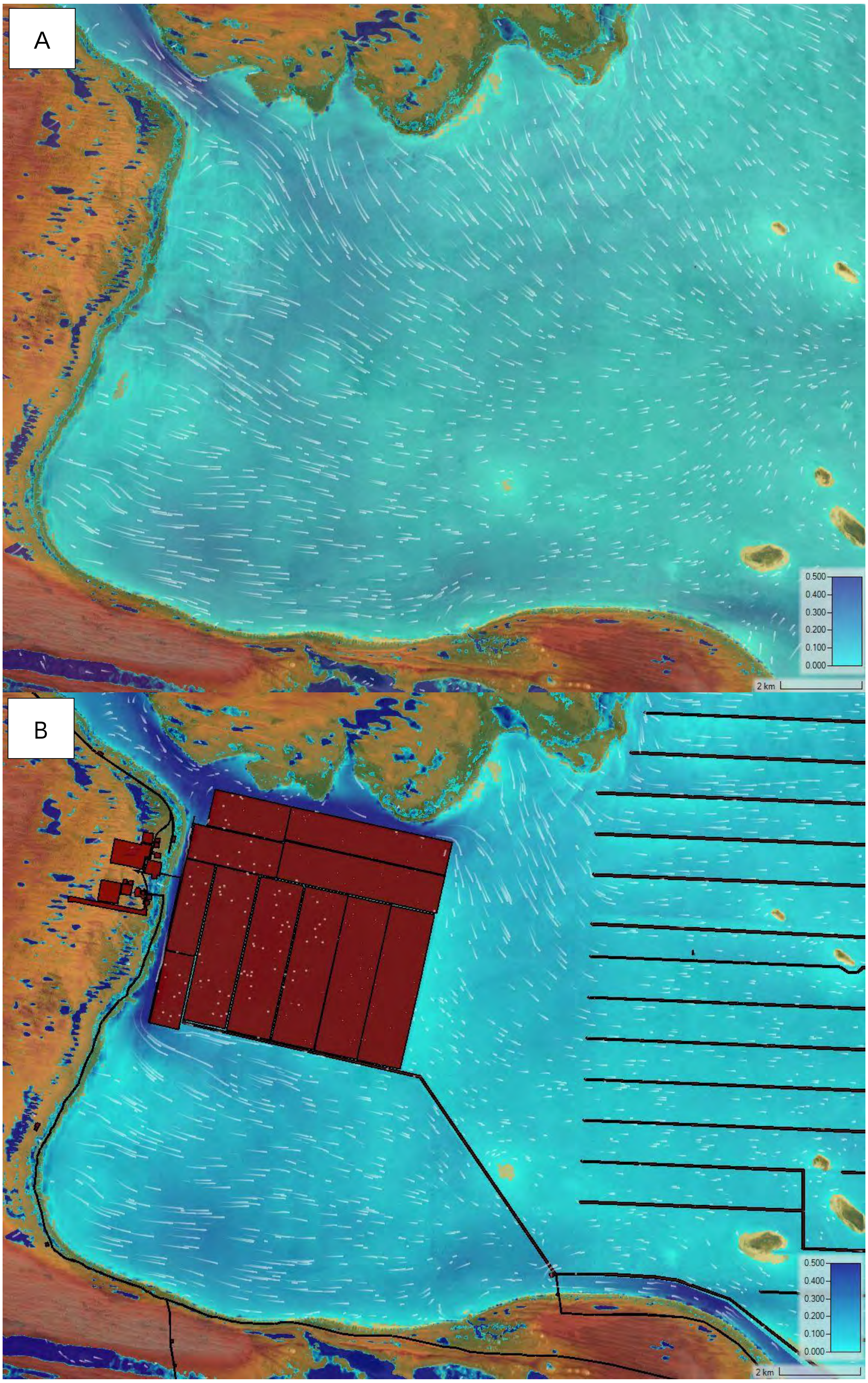

Figure 9-23: Maximum depth conditions during a 100 mm rainfall event (72 hrs), under (A) baseline conditions, and (B) 20-year trench network

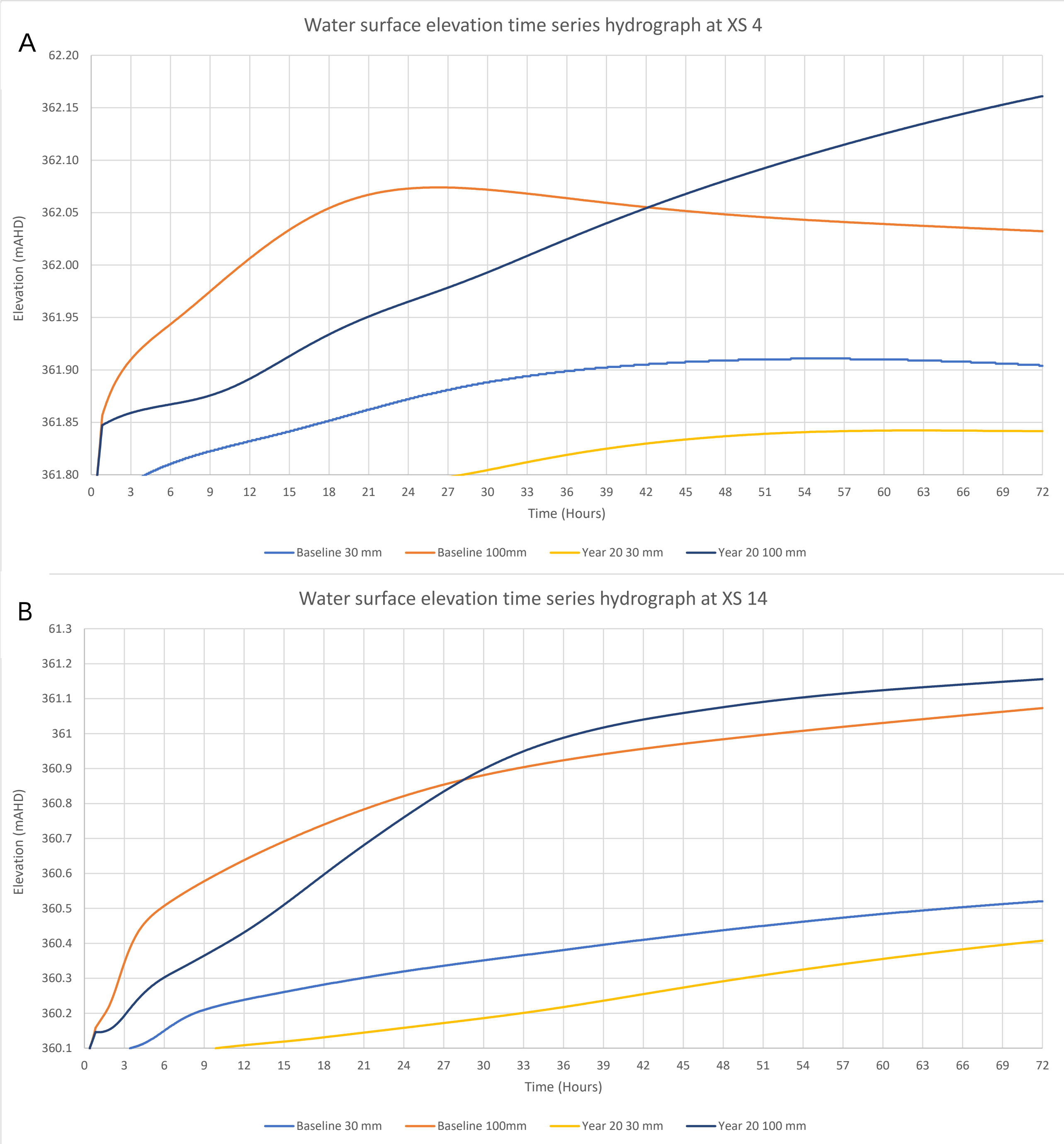

Figure 9-24: Time series hydrograph cross sections of lake surface elevation. (A) Western portion of the lake (XS04), and (B) eastern portion of the lake (XS14).

Based on modelling at Year 20 of mining, the results show that the installation of crossovers along the east-west main feed canal will result in a 50 to 70% reduction in the inundation depth and extent along the shoreline, mitigating impacts (Appendix I.11). This is expected to correspond to a decrease of 5 cm and 15 ha in a 30 mm rainfall event, and 20 cm and 60 ha in a 100 mm rainfall event (Figure 9-22). This negligible and temporary effect will occur along the southern shoreline and potentially along the northern lake margins in the vicinity of the evaporation ponds, during short-duration, individual storm events. However, there are no expected changes (direct or indirect impacts) to the majority of the lake periphery and associated riparian zone, based on the modelling of various rainfall events.

The total inundated area of the lake under the modelled rainfall events effectively remains equivalent to baseline conditions (Appendix I.11). Following larger rainfall events and major flooding, which are predicted to occur on average, once every 10 years, the deepest parts of the basin will continue to fill to approximately 2 m in depth. This will allow aquatic biota to emerge, develop and reproduce, replenishing the egg and seed bank in the lake sediment (Section 9.4.4.4), avoiding direct and indirect impacts. It is also expected that the productivity of algae and aquatic invertebrates in the lake, during major floods, will continue to be sufficient to support waterbird populations, discussed in more detail in Section 7.

At closure, the southern feeder canal and trench bunding will be strategically breached to return natural flow paths to the lake. Trenches are expected to infill naturally, within a period of approximately 10 years, based on field observations of test trenches for the Project. This process will be assisted by flood events, which will redistribute salt and sediment across the playa. Together with the implementation of mitigation measures, routine monitoring is expected to be undertaken during flood events, to verify modelling results and ensure hydrological processes and ecological function is maintained.

9.5.2.2 Inundation and climate

For the Lake Mackay region, climate change predictions include an increase in drought periods with moderate confidence, while increased intensity of extreme rainfall events is projected with high confidence (Appendix I.21). In addition, while not specific to Lake Mackay, long-term rainfall data across WA indicate statistically significant upward trends in summer rainfall over most of the northern and central regions of WA. This is likely related to increasing cyclonic activity and intensity off the coast.

According to the analysis of satellite imagery, completed as part of understanding the water balance, Lake Mackay remains dry approximately 60% to 75% of the time (Appendix I.21). When inundated, following large rainfall events, there is a high degree of variability in the frequency, extent and distribution of surface water, influenced by the spatial distribution and intensity of rainfall, as well as prevailing winds and evaporation. Interpolated inundation extent (%), based on the analysis of satellite imagery showed that prior to 2000, the lake was dry most years, with only short periods of surface pooling, usually occurring around February to March. Post 2000, inundation to various extents was more regular, with the lake typically beginning to fill in December, often peaking between February and March, with water levels gradually decreasing and drying out completely (Appendix I.21).

The five largest, discrete inundation events (based on SAD curves) occurred in early and late 2000, 2014, 2015 and 2016 (Appendix I.21). Of these, the largest and longest event was associated with well-above average annual rainfall recorded in the latter part of 2000 (>750 mm), with extremely wet conditions persisting throughout 2001 (Figure 9-25, Figure 9-26). Inundation extent reached 100% of the lake bed and was more than 80% for over six months during this period. It is also likely a similar event occurred in 1973 to 1974, which was not captured by satellite imagery. This was considered equivalent to a 1:20 or 1:50 year event (Appendix I.21).

The analysis of the number and duration of discrete inundation events at Lake Mackay at different percentage inundation thresholds since 1987 indicated there has been a general increase, which was most prominent at the 50% threshold. There have been more than 55 discrete inundation events recorded at the 20% inundation threshold, of which 21 and nine events exceeded the 50% and 75% thresholds, respectively (Appendix I.21). The average duration of these inundation events is more than 25 days for the 20% and 50% thresholds, and less than 20 days for the 75% threshold. In addition, at 50% inundation threshold, 20 of the 21 events occurred post 2000 (Figure 9-25, Figure 9-26). While there is a high degree of interannual variation, larger inundation events are considered rare, with smaller events occurring more frequently, with the lake typically drying rapidly unless top-up events occur over the course of the wet season (Appendix I.21).

In comparison to the satellite imagery analysis, the long-term time series water balance modelling typically followed similar trends in the inundation extent and duration on Lake Mackay (Appendix I.21). Base case and operational scenarios were also generally closely correlated, particularly during the largest events (Figure 9-28).

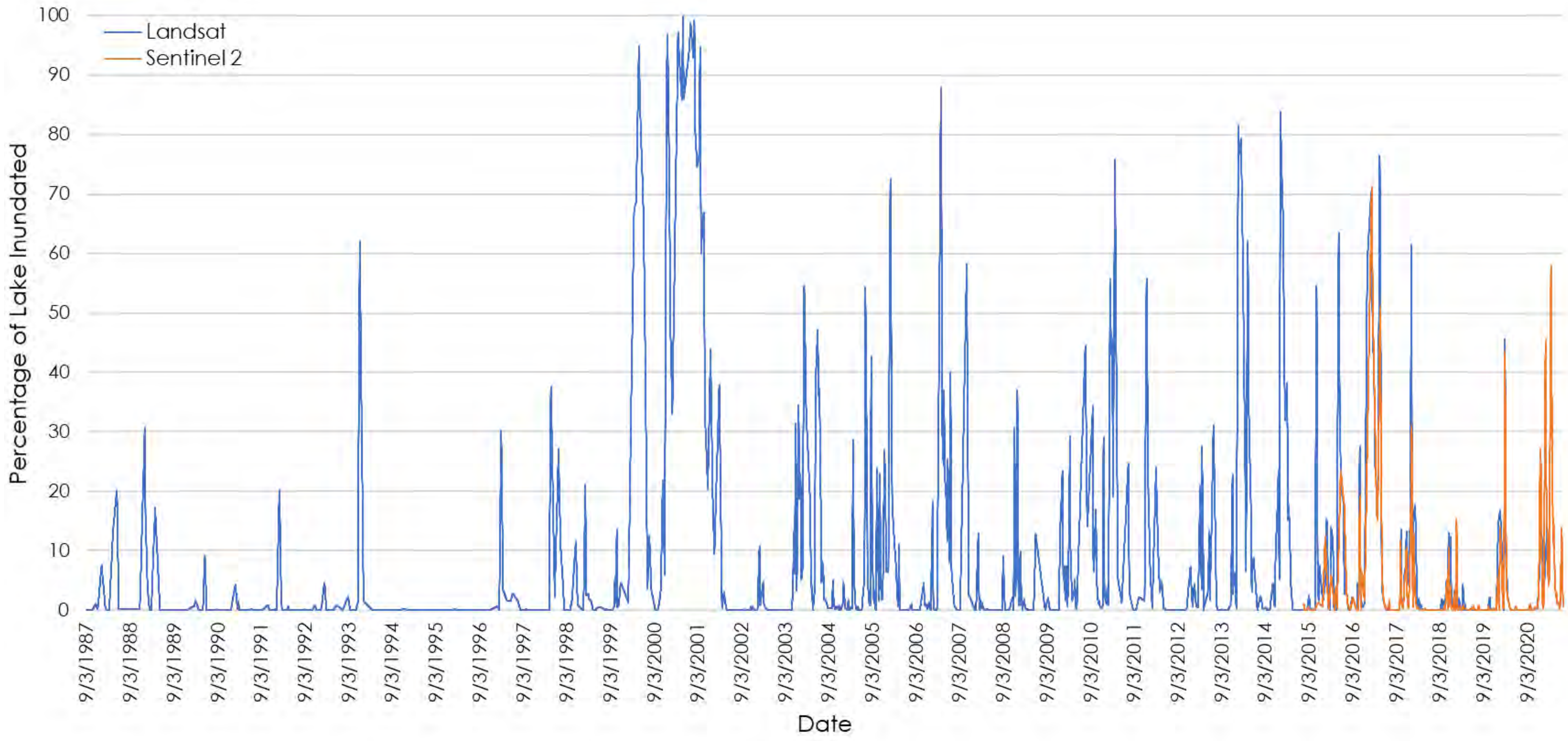

Figure 9-25: Comparison of percentage inundation values from Landsat and Sentinel imagery at Lake Mackay from 1987 to 2021.

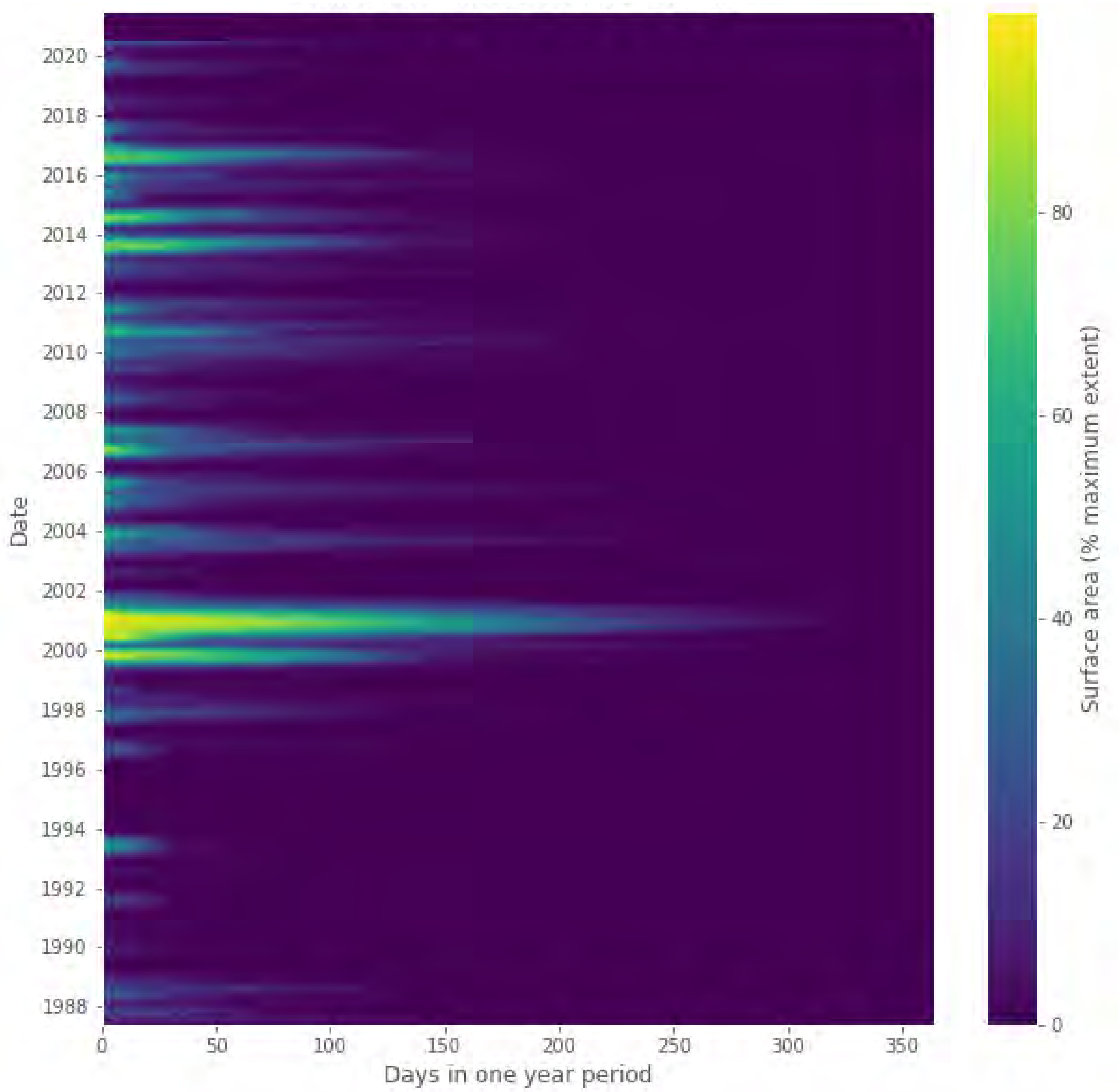

Figure 9-26: Satellite imager analysis showing Short-time Surface Area Duration (STSAD) plot for Lake Mackay (yellow is increased percentage surface area of inundation on the lake).

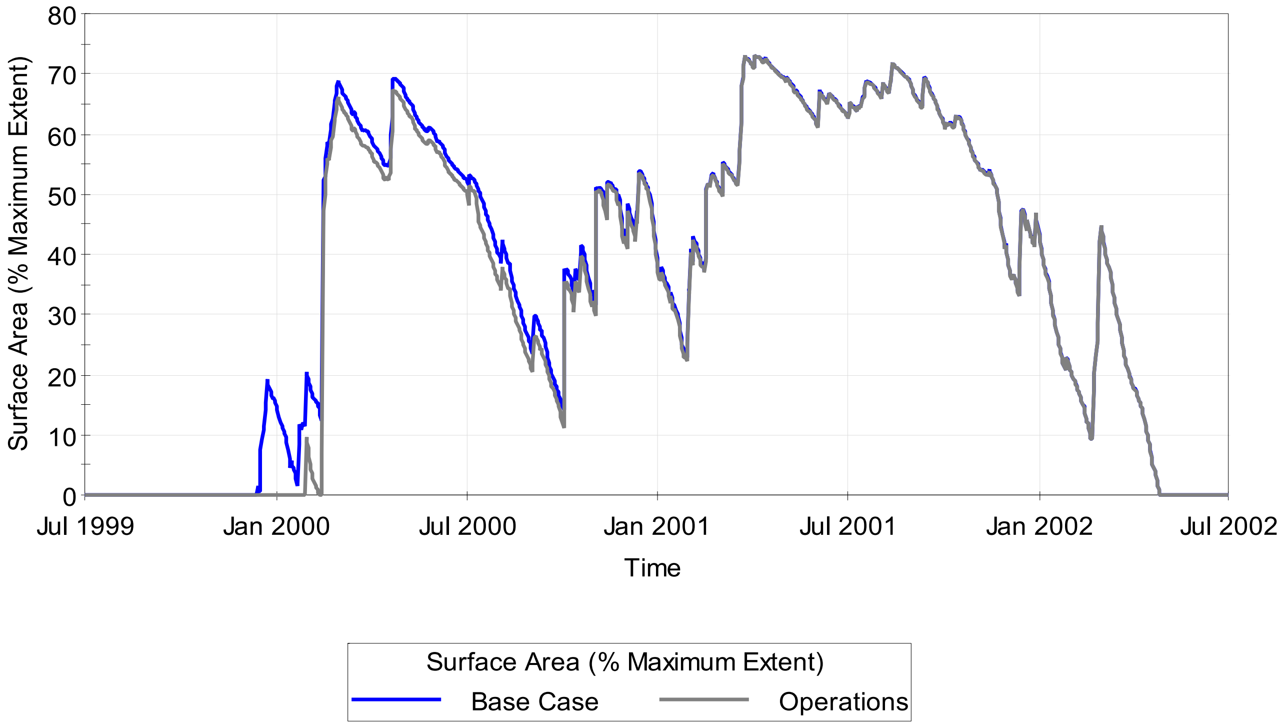

Figure 9-27: Water balance model results under base case and operational scenarios for Lake Mackay surface area extent (July 1999 to July 2002)

The outputs of the water balance model indicate that the proposed development and operations of the Proposal will not significantly impact Lake Mackay's overall water balance and can be summarised as follows:

- the lake is typically dry and only holds water for only approximately 27% of the time;
- There may be an average decrease in groundwater levels across the lake by approximately 0.7 m by year 10 of operations (Figure 9-27, Figure 9-29);
- a minor reduction may be observed in the number of smaller inundation events (<20% inundation extent) that cause ponding on the lake, corresponding to a 10% decrease in the time the lake holds water (Table 9-22); and
- during larger inundation events (which are rare), there will be negligible impacts on the frequency, maximum extent, depth and duration of surface water on the lake (Table 9-22).

Table 9-22: Modelled average number of inundation events under baseline and operational scenarios above varying thresholds (%) for 20-year LoM (plus a period of seven years of recovery).

Event Threshold (% extent of Inundation)	Base Case Scenario	Operational Scenario
20	10	7
25	7	5
30	6	4
50	3	2
60	1	1
75	<1	<1

Climate change predictions for the region include a projected increase in drought periods as well as an increased intensity of extreme rainfall events. Together with potential influence of operations from the Proposal, this may have a temporary effect in reducing the number of minor inundation events over the LoM. However, current projections indicate that large inundation events will not be substantially affected, maintaining the lake's hydrological processes, biological productivity and ecological values. These events are of particular importance in the provision of habitat waterbird foraging and breeding (Section 7.6).

The predicted increase in extreme rainfall events, which is also evident in rainfall and satellite imagery analysis (post 2000), may offset potential changes associated with operations and changes in soil moisture within the catchment. Recovery of groundwater levels to baseline conditions post operations is also expected to mostly occur within two years (complete recovery is expected by year 7) of cessation, corresponding to minor, temporary disturbance from the Proposal, which is not expected to adversely affect hydrology or ecology.

The implementation of measures to mitigate the impact of altered surface hydrology associated with the development and operation of infrastructure on the lake will meet the EPA objectives for Inland Waters.

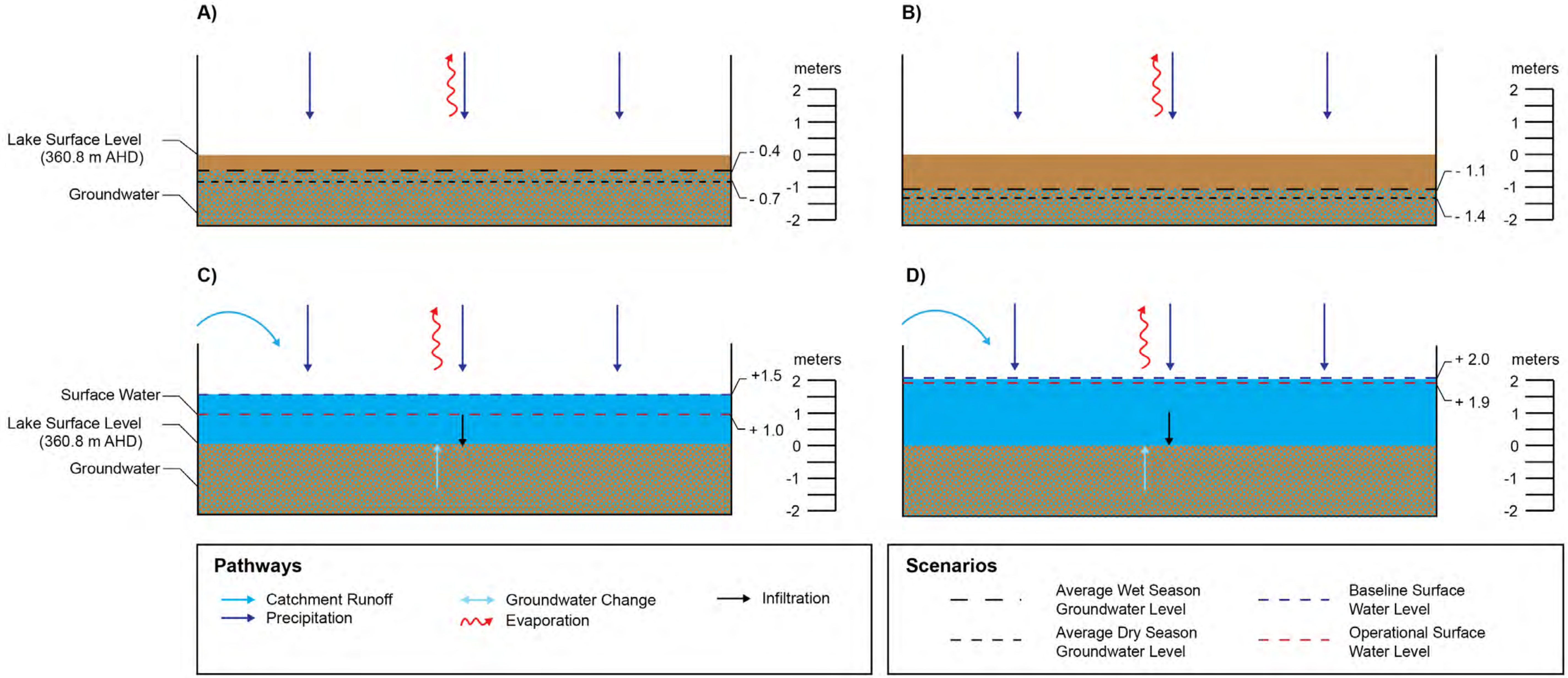

Figure 9-28: Conceptual diagrams for Lake Mackay during dry conditions under (A) baseline, and (B) operational (year 10) scenarios, and during inundated conditions under baseline and operational scenarios at (C) surface water level expected to be exceeded 25% of the time, and (D) maximum surface water level.

9.5.3 Increased salinity from evaporation ponds and salt piles

A salt balance assessment was undertaken (Appendix I.18) to support the surface water assessment (Appendix I.11) for the Proposal, with the potential for increased salinity from evaporation ponds to cause indirect impacts to the lake ecology. The Indicative Footprint is approximately 1.3% or up to 4,790 ha of the lake surface will be directly disturbed by evaporation ponds and salt piles at the end of mining. Staged development of the pond system for the first 10 years of operation is approximately 3,260 ha, increasing by another 1,530 ha by year 20 (Table 9-23). The ponds will have a final berm height of between 1 m to 6 m, depending on the engineering design and lake topography.

The evaporation ponds are anticipated to accumulate approximately 350 Mt of salt over the 20-years of operations (Table 9-23). This will comprise 120 Mt within the salt piles, which may reach up to 20 m high (Table 9-23). At closure, residual salts within all other preconcentration ponds are predicted to reach less than 5 m in height. It is anticipated that ponds P3, P4 and P5 will need to be replaced with new ponds at year 10.

Table 9-23: Evaporation ponds Indicative Footprint and accumulated salt deposition at mine year 20.

Pond No.	Indicative Footprint (ha)	Salt Pile Height (m)	Accumulated Salt (t)
P1	450	0.48	1,212,000
P2	410	5	12,822,000
P3	820	4.6	68,448,000
P4	820	4.6	68,238,000
P5	820	4.95	71,562,000
P6	410	0.15	1,200,000
P7	200	0.15	570,000
H1	180	0.15	470,000
H2	150	0.15	380,000
Salt piles	500	20	124,606,600
Total	4,790	NA	349,508,600

The evaporation ponds have been designed for a 1% AEP flood event, with a minimum bund height of 1 m for salt piles and 1.5 m for the ponds, providing sufficient freeboard (of at least 0.5 m), to limit saline runoff into the lake during major rainfall events. This will also prevent localised saline runoff into the riparian vegetation zone comprising *Tecticornia* shrubland. Minimal seepage or loss through the base of the evaporation pond to underlying lake bed sediments will occur due to the natural clay lined base, and high evaporation. Regardless, any potential seepage will be dominated by Na and Cl and is not expected to alter the salinity or ionic composition of groundwater within the lake bed sediments.

Lake Mackay is predominantly dry and is characterised by a naturally occurring salt crust several centimetres thick. Previous water quality data (based on limited records), indicates salinity ranges between 50,000 to 260,000 mg/L (Appendix J). There is contingency allowance for discharge of brine from evaporation ponds to the lake during operations. Discharge is likely to occur to a dry playa, or rarely, may be discharged into flood water. However, due to the substantial natural salt load and apparent naturally elevated salinity of surface water during inundation, temporary discharge is unlikely to impact on surface water quality. In addition, during major flood events, which occur approximately once every 10 years, the comparatively low discharge volume is unlikely to increase the salinity of lake water. Discharge is also not expected to impact riparian vegetation and will occur well onto the playa.

Salt pile tests have confirmed the potential dissolution rate from fully saturated brine (Knight Piesold Consulting 2018). Following cessation of mining, salt accumulated within the evaporation ponds and salt piles will gradually dissipate and return to the playa through dissolution, over a period of approximately 400 years (Appendix I.18). These salts may cause localised salinity increases in the south west portion of the lake during years with low seasonal rainfall. However, during exceptionally wet years with major flooding, the additional salt deposited will dissolve and be dispersed across the playa.

Residual salts in the evaporation ponds will be more than the natural 150 Mt of salt that enters the lake during average annual rainfall as inflow (approximately 2,700 GL). This is considered equivalent to approximately 2% of the incoming salt loads from inflows annually during the initial closure period, diminishing to less than 0.1% near the end of the dissolution period (Appendix I.18).

Potential indirect impacts resulting from dissolution of salt from the evaporation ponds and salt piles post closure will have minor influence on the overall salt balance of the system. Mitigation measures to reduce the risk of these impacts will include the following:

- staged development of the evaporation ponds with an initial pond area of approximately 3,060 ha, increasing by 1,230 ha for a total pond area of approximately 4,290 ha at year 20;
- staged development of the salt piles comprising approximately 200 ha at year 2, and 500 ha at year 20;
- evaporation ponds and salt piles designed for a 1% AEP flood event, with a minimum bund height of 1.5 m and 1 m, respectively, providing sufficient freeboard to limit saline runoff into the lake during large rainfall events;
- location of evaporation ponds to have at least a 250 m buffer zone from surrounding riparian vegetation; and
- breaching of the evaporation ponds embankments at closure will allow periodic, pulsed flows and gradual dissipation of accumulated salt to return to the playa over a 400-year period.

Relative to the natural inflows from rainfall, the brine from the salt ponds will be substantially more saline. However, relative to the existing natural salt loads within the basin, the addition of salts is not significant and will not impact the overall salt balance. Residual salt loads may remain in the lake within the evaporation ponds and salt piles, until mobilised by infrequent, major flood events. Ongoing monitoring and hydrogeological investigations across the lake will continue to build knowledge on the natural spatial and temporal variability in surface water and groundwater quality and detect operational changes from the baseline condition.

The implementation of measures to mitigate the impacts of increased salinity from the evaporation ponds and salt piles on the lake meet the EPA objectives for Inland Waters.

9.5.4 Groundwater drawdown

9.5.4.1 Lake

Groundwater drawdown resulting from brine abstraction within the lake bed sediments (up to 100 GL/a) will be progressive, facilitated by the implementation of BMUs over the 20-year operation of the Proposal. This may result in indirect impacts to lake ecology. The BMUs will initially commence in the southern portion of the lake, traversing east, west and northwards by mine year 17. Over the LoM, pumping schedules and abstraction rates will vary across BMUs to maximise potassium concentrations for production.

Groundwater monitoring indicates that baseline groundwater levels range from 0.4 to 0.7 mbgl within the lake bed sediments, and from 3.4 to 4.0 mbgl beneath the larger islands. The average year-round depth to groundwater is approximately 0.5 mbgl (Appendix I.16) and average annual groundwater level fluctuations are 0.3m across the wet and dry seasons. During prolonged dry conditions, a decrease of up to 0.2 mbgl was recorded within the lake bed sediments, while a reduction of up to 0.6 mbgl was observed beneath the larger islands (Figure 9-5). This corresponded to a general lake wide decrease in groundwater levels (Appendix I.16).

Numerical groundwater modelling (Appendix I.13) indicates predicted drawdown will vary spatially and temporally across the lake during operations, associated with differences in hydrogeological properties (Figure 9-29). The regional lake drawdown extent is limited to the lake bed sediments and no drawdown extends beyond the lake (On-LDE). Generally, trench water levels within the BMUs will be drawn down to a sustained level of approximately 3 mbgl within two years after pumping begins, with an associated lowering of groundwater levels occurring laterally away from the trenches.

Drawdown extents and depths are more pronounced in the eastern portion of the lake within Zones 3 and 4, compared to the west (Zones 1 and 2). This is due to the higher permeability of lake bed sediments in Zones 3 and 4 (Appendix I.17). Drawdown over the production area of Lake Mackay after 10 and 20 years of groundwater abstraction is shown in Figure 9-29. As brine abstraction progresses into the southern and western portions of the lake over the first 10 years, drawdown of up to 3.0 m occurs in the immediate vicinity of the trenches. In the areas between trenches, drawdown generally ranges from 0.0 m to 1.5 m.

As abstraction of brine progresses to the north and east and into the higher hydraulic conductivity/lower recharge zones in the eastern portion of the production area (where landform islands are present), drawdowns of 3.0 m are expected at the trenches and between 0 m and 1.8 m are expected between trenches and islands (Figure 9-29). The deepest drawdown occurs within the trenches.

Lake wide drawdown statistics for the four infiltration recharge zones (Appendix I.9) are presented in Figure 9-29. The statistics for each zone provide a snapshot of drawdown levels at three-time intervals throughout the operational mining period (year 5, 10 and 20). The percentage of aquifer impacted by drawdown is calculated based on a brine aquifer thickness of 10.5 m of the lake bed sediments. Over the 20-year LoM and across all four net recharge zones, the saturated thickness of the brine aquifer is reduced by 4-8%.

Two examples of drawdown and recovery over time in the central and eastern portions of the lake within a BMU) are presented in Figure 9-29. Brine abstraction from this BMU commences in mine year 4 and hydrograph A shows drawdown in the trench increasing over the initial 2 years of operation until pumping water levels are reduced, resulting in recovery and less drawdown. Water levels continue to recover gradually until mine year 20 at which time brine abstraction ceases and groundwater levels recover to pre-abstraction water levels within one year.

In Figure 9-18 (B) the example shows drawdown in the eastern portion of the lake (Zone 4). Although brine abstraction from this BMU only commences in mine year 10, some initial drawdown occurs due to the higher hydraulic conductivity values representative of this area. Once brine abstraction commences, maximum drawdown of 1.23 m is recorded after 3 years at which time drawdown levels start to reduce due to lower abstraction rates and reduced pumping water levels. Water levels recover to pre-abstraction water levels over a period of five to 10 years. Drawdown modelling undertaken to understand potential changes in the lake bed sediments on the NT side of the border, indicated groundwater changes were limited spatially (to approximately 1 km) and were well within the known natural variation of groundwater levels (Stantec Consulting Services 2021).

Recharge modelling indicates that as groundwater levels decrease from abstraction, recharge increases (Appendix I.9). The most recharge will occur in the southwest portion of Lake Mackay. While infiltration in the northeast of the lake is high, stored water in the profile rapidly evaporates, with the net effect of reducing recharge potential. Modelling also assumed that recharge beneath the islands is the same as the lake bed sediments in the eastern portion of the lake. Under natural conditions, the percentage of rainfall on the islands resulting in recharge is likely to be higher, due to the more permeable dune sands.

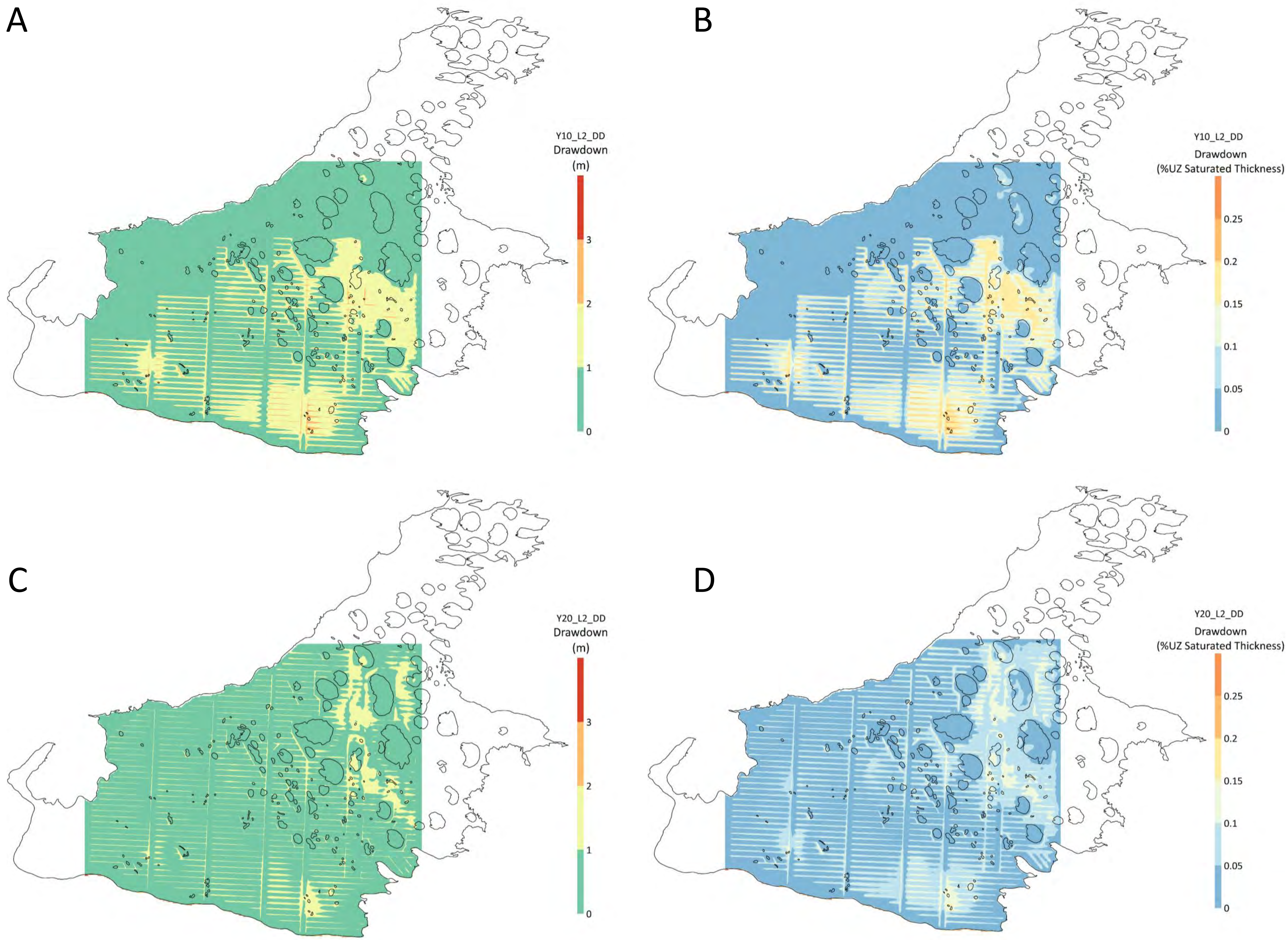

Figure 9-29: (A) 10 years LoM drawdown, (B) 10 years LoM saturated thickness, (C) 20 years LoM drawdown, and (D) 20 years LoM saturated thickness.

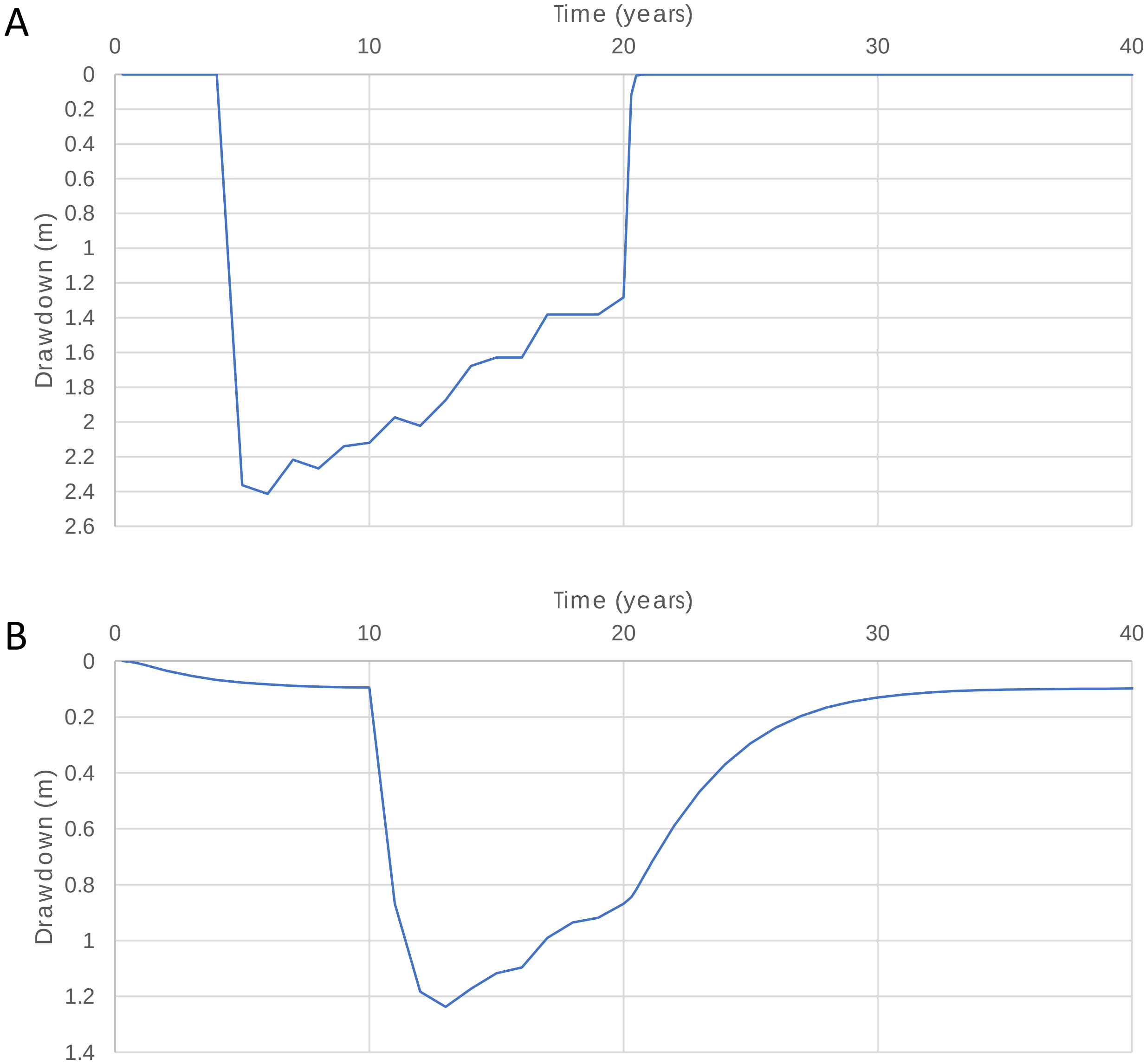

Figure 9-30: Variability in drawdown conditions and water level recovery over the LoM. (A) high net recharge in central portions of the lake, and (B) low net recharge in the east

Riparian vegetation associated with the lake, islands and surrounding peripheral wetlands has been assessed during numerous surveys (Appendix J and Appendix F). The riparian zone is dominated by *Tecticornia* species, including the widespread *Tecticornia* aff. *calyptrata* (NT form); considered to be a txon of other significance. Representatives of the *Tecticornia* genus, while affiliated with the salt lake margins, require freshwater to germinate (Datson 2002). A recent study by study by (Botanica Consulting 2017) also found that the root system of *Tecticornia* was restricted to the upper horizon of the soil profile (<30 cm) and are therefore most likely to opportunistically access low salinity of freshwater within the vadose zone. Water within vadose aeolian sands, is recharged by rainfall and subsequently bound and stored in pore spaces. This water is likely to support the shallow root systems of *Tecticornia* during dry conditions (Figure 9-31), independent of the hypersaline water within the lake bed sediments, which well-exceeds the tolerance limits of these group of flora. Therefore, *Tecticornia* are considered unlikely to represent groundwater-dependent vegetation (Appendix J), with no indirect impacts expected from drawdown (Appendix F).

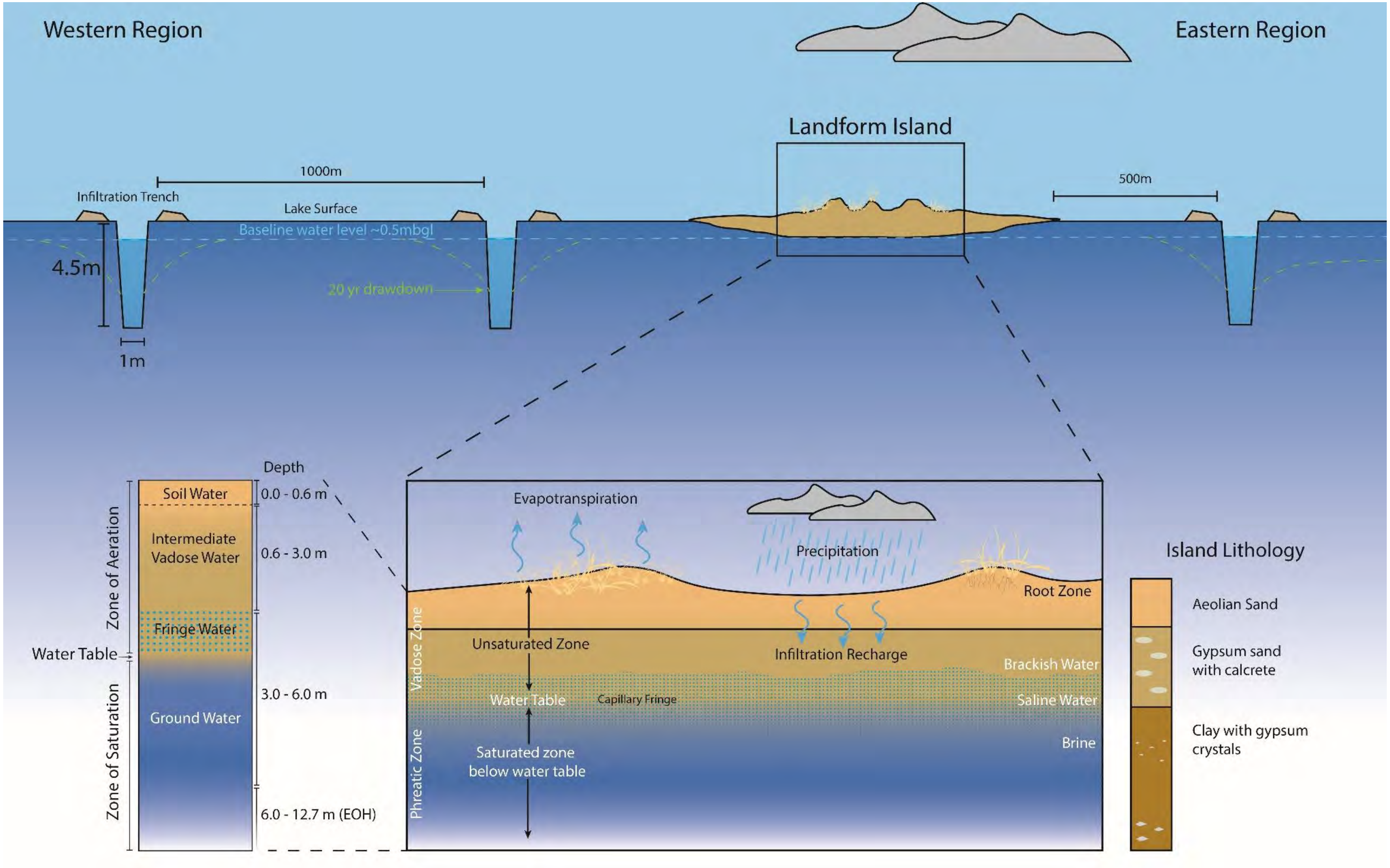

Figure 9-31: Conceptual schematic cross section of drawdown across Lake Mackay and the islands

Table 9-24: Summary of groundwater drawdown across zones for the Proposal

Zone and Drawdown		Year 5	Year 10	Year 20
ZONE 1	Maximum drawdown (m)	2.79	2.54	2.07
	Average drawdown (m)	0.57	0.52	0.41
	Percentage of aquifer impacted	5%	5%	4%
ZONE 2	Maximum drawdown (m)	3.00	3.00	2.73
	Average drawdown (m)	0.58	0.57	0.47
	Percentage of aquifer impacted	6%	5%	4%
ZONE 3	Maximum drawdown (m)	2.90	2.65	2.43
	Average drawdown (m)	0.53	0.81	0.59
	Percentage of aquifer impacted	5%	8%	6%
ZONE 4	Maximum drawdown (m)	2.64	2.39	1.68
	Average drawdown (m)	0.75	0.73	0.74
	Percentage of aquifer impacted	7%	7%	7%

An assessment of sensitive groundwater receptors including subterranean fauna is presented in Section 8. The results of baseline surveys (Appendix H) indicated that the lake bed sediments were not conducive habitat for stygofauna, due to elevated salinities exceeding known tolerance limits, high clay content and limited interconnected voids. However, the lower salinity groundwater (vadose water) on the larger islands of Lake Mackay was found to support new stygofauna species of scientific interest (Appendix H). Potential risk and mitigation measures to these sensitive groundwater receptors from the impacts of drawdown of the lake bed sediments is detailed in Section 8, including the application and justification of buffer zones.

The indirect impacts from drawdown of groundwater within the lake bed sediments are predicted to be localised, progressive and temporary over the LoM, with sensitive receptors absent from the playa and recovery predicted within a short time period (approximately seven years) post-closure. Additional mitigation measures to reduce the risk of impacts will include the following:

- avoidance, with large portions of the lake unimpacted by drawdown due to the abstraction schedule and exclusion zones within the WA side and NT portion of the lake (combined 88,767 ha or 26.1%);
- progressive development of trenches and implementation of BMUs to limit the rate and magnitude of drawdown; and
- implementation of suitable buffer zones to mitigate potential drawdown beneath island formations (271), comprising 500 m for landform islands (>2,000 ha), 250 m for large (>500 to 1,500 ha) and intermediate (>100 to 500 ha) islands and 100 m for small islands (<100 ha).

Drawdown of the lake bed sediments is also not expected to result in reduced moisture on the playa or increased mobilisation of surficial sediment. The lake bed is covered by a natural, cohesivemitigationsalt crust several centimetres thick that is expected to retain moisture on the surface of the playa. Therefore, gypsum and halite are not expected to be mobilised during operations, and airborne sediments, salts and minerals will pose a negligible risk to riparian vegetation.

While drawdown is associated with abstraction of groundwater for the Proposal, it has been estimated that a rainfall event of more than 300 mm within one month will result in a groundwater level rise of 0.4 to 0.8 mbgl across the entire lake. These 300 mm monthly rainfall events may occur several times during the LoM, as well as following the cessation of abstraction (Appendix I.9). The results of numerical modelling also predicts recovery of groundwater levels to within 95% of baseline conditions (Figure 9-30), within two to five years post closure (Appendix I.9). Ongoing groundwater level monitoring and further hydrogeological investigations will continue to build knowledge of the natural spatial and temporal variability in groundwater levels and confirm modelled drawdown extent and duration across the lake.

The implementation of measures to mitigate the impact groundwater drawdown will meet the EPA objectives for Inland Waters.

9.5.4.2 Southern regional area

The final borefield configuration for groundwater abstraction selected for the SIDE is a single line of 28 bores at a spacing of 1 km along the southern most line of the Development Envelope. The majority of the bores (23 from 28) abstract water from the shallow aquifer hosted within the Neogene alluvials, with groundwater salinity ranging from 1,200 mg/L to 6,300 mg/L TDS. The remaining five bores predicted to source water from the deep aquifer of the Angas Hills formation, primarily comprising conglomeritic sand and gravel. The nominated area of the SIDE borefield represents only a small proportion of the overall Neogene alluvials/Angas Hills aquifer occurrence in the Proposal area. At the predicted abstraction rate of 3.5 GL/annum, current modelling suggests a maximum groundwater level drawdown of 6 m immediately adjacent to the bores, and a groundwater level drawdown of 0.1 m at a distance of 6 km from the bores following a pumping period of 20 years (Figure 9-32). Following this Agrimin will need to expand the borefield further south from year 20 to 40 of mining. Groundwater drawdown beneath SIDE will not impact Inland Waters, with risk to sensitive groundwater receptors from borefield abstraction detailed in Section 8.

9.5.5 Groundwater quality changes

Abstraction is not expected to significantly alter the salinity and/or associated ionic composition of the groundwater within the lake bed sediments, which may result in indirect impacts to lake ecology. Long term (>6 months) pump tests were undertaken at two locations, to account for the contrasting hydrogeological properties of the surficial lake bed sediments (up to 11 m deep) across the east and west portions of Lake Mackay, and in proximity to the islands (Appendix I.14). Groundwater salinity is hypersaline typically ~250,000 mg/L, with cation dominance following Na>Mg>K>Ca, and a cation sequence of Cl>SO_4. Background concentrations of Na and Cl are approximately 100,000 mg/L and 145,000 mg/L, respectively, while potassium concentrations range from 3000 mg/L to 3,350 mg/L (Appendix I.12).

Over the duration of the pumping test, a total of 257 groundwater samples were collected. Groundwater quality data for the trenches and surrounding piezometers showed that whilst the chemical composition of lake bed sediments changes from Na>Cl>K>SO_4>Mg to Na>Cl>Mg>SO_4 with the removal of K_2SO_4, salinity and total ionic concentrations remain similar and consequently no impact on the lake environment is anticipated (Table 9-6, Appendix I.13). This was attributed to high recharge rates, with steady-state trench flow rates of around 1.0 L/sec, with trench water levels rapidly recovering within a period of days to weeks (within 20 days).

During operations however, there will be a shift in the ionic composition of the water in the trenches as potassium (K) is gradually depleted. Most BMUs will be in operation for at least 10 years (Appendix I.17), before K concentrations are reduced (<2,200 mg/L) to the point it is no longer economically viable for production. It is also expected that while overall salinity of water in the trenches will decrease slightly over a 20-year period, Na and Cl will remain the dominant ionic constituents (reducing to concentrations of approximately 60,000 mg/L and 95,000 mg/L, respectively). This represents a minor, temporary difference following abstraction and closure of a given BMU.

It is also expected that recharge events (equivalent to a rainfall event of 300 mm within one month), will cause the system to reset (to within 0.6 mbgl), dissolving salts within the lake bed sediments and restoring the ionic equilibrium. Regardless, no sensitive environmental receptors have been identified from groundwater within the lake bed sediments, with no impacts from the Proposal. Groundwater is not conducive to subterranean fauna due to the elevated salinities, the high clay content, and limited, interconnected voids (Section 8).

Substantial rainfall events will naturally dissolve and disperse these salts during flooding. While larger rainfall events may result in lower salinities in surface water, as the hydroperiod progresses, the water levels will naturally recede, with salinity concentrations naturally reaching saturation point, prior to entering the drying phase (Boulton and Brock 1999). In addition, there is no expected changes to the nutrient cycle of the lake, with the hydrological regime to allow natural processes to occur the course of the hydroperiod, with temporary water showing natural fluctuations in response to wetting and drying (Boulton and Brock 1999).

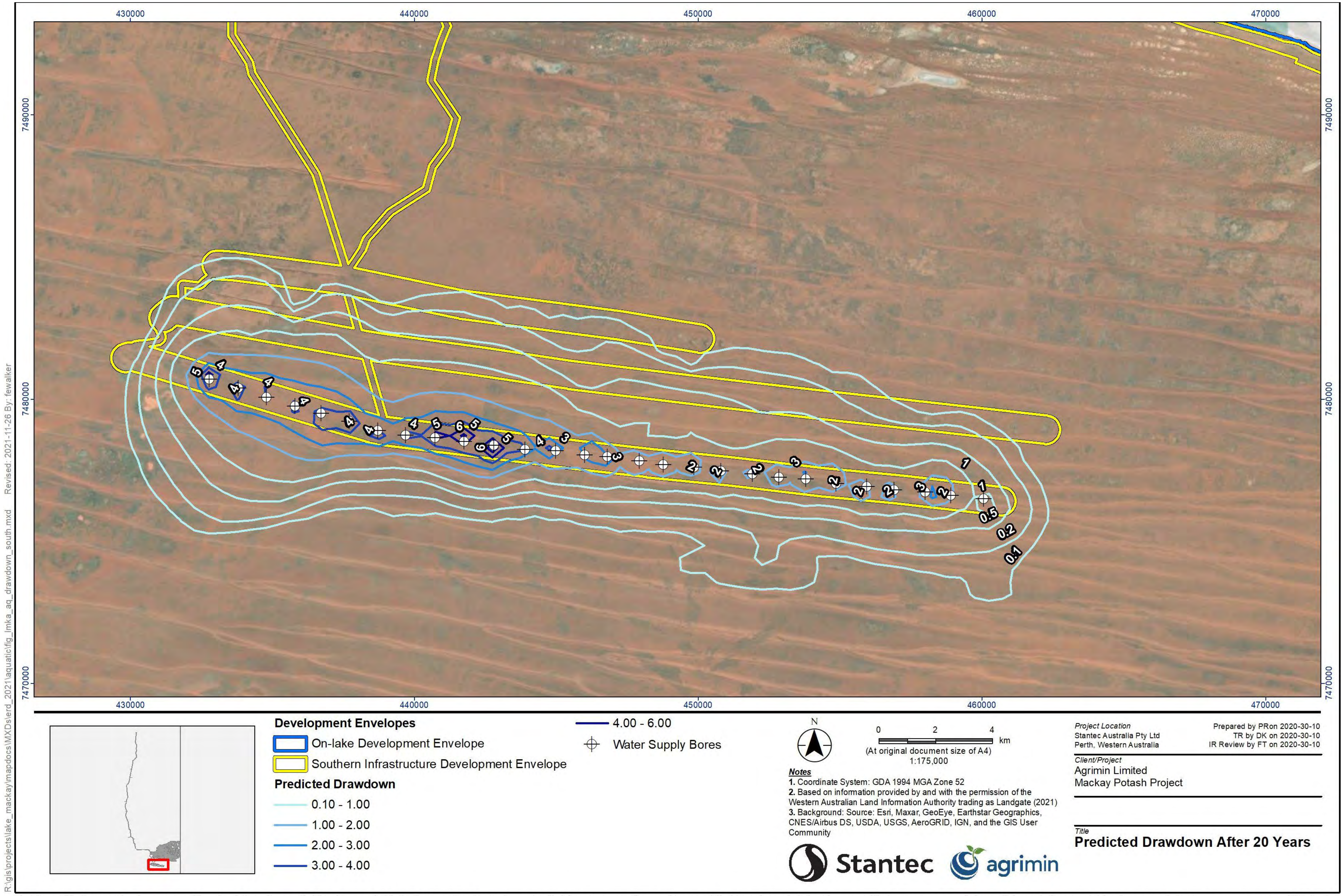

Figure 9-32: Maximum predicted drawdown conditions for the SIDE (at year 20)

Potential impacts (drawdown of lake bed sediments) to groundwater quality are predicted to be minor with negligible change of major constituents, temporary over the LoM, and recovering within a short time period (approximately seven years) post-closure. Mitigation measures to reduce the risk of impacts will include the following:

- large portions of the lake will remain unimpacted by drawdown due to the abstraction schedule, as well as exclusion zones within the WA side and NT portion of the lake (combined 88,767 ha or 26.1%);
- progressive development of trenches and implementation of BMUs to limit the rate and magnitude of drawdown, with a variable pumping regime from 3 mbgl at year 1, gradually increasing to 1.7 mbgl by year 17 until year 20; and
- dominant constituents of lake bed sediments, NaCl salts, will be returned to the salt lake playa post-closure, over a period of approximately 400 years.

In addition, groundwater drawdown and infiltration modelling (Appendix I.9) has indicated:

- major rainfall events (>300 mm) which occur on average every 5 to 10 years will effectively reset groundwater levels to baseline conditions, dissolving salts within the lake bed sediments and restoring the ionic equilibrium.

Ongoing water quality monitoring and further hydrogeological investigations across the lake will continue to build knowledge on natural spatial and temporal variability in groundwater quality and monitor Proposal related change from baseline condition.

The implementation of measures to mitigate the impact of abstraction on groundwater quality will meet the EPA objectives for Inland Waters.

9.5.6 Groundwater contamination

9.5.6.1 Acid sulphate soils

Construction of the trench network requires shallow lake bed sediments to be excavated with the resulting material to form bunds on either side of the trench. The abstraction of lake bed sediments will also result in localised, maximum drawdown of up to 3 mbgl in the immediate vicinity of the trenches. Assessment of the lake bed sediments from test trenches and the pilot pond (Appendix L) to depths up to 10 mbgl did not detect ASS, with only two samples potentially comprising ASS from an anoxic microbial layer in the lake sediment. This was based on testing of more than 100 samples.

In addition, inherently elevated acid neutralising capacity (ANC) across all soil types tested, suggests that the sediment have high self-buffering ability and were considered to have a low risk of acid generation. All heavy metal concentrations across all lithologies were below their relevant Ecological Investigation Levels (EILs), indicating they pose a low risk to the receiving environment (Appendix L).

An ASSMP will be developed to enable identification and management of potentially acid forming material, if encountered during construction and operation. ASS neutralising material will also be kept on site for use as required. Routine groundwater monitoring during the LoM will provide early detection of any water quality changes. Given the absence of ASS, high ANC, low concentrations of metals within the lake bed sediments, and proposed mitigation measures for PASS, no impacts to water quality are expected under development of the Proposal.

No mitigation measures are required due to absence of ASS, which will meet the EPA objectives for Inland Waters.

9.5.6.2 Hydrocarbon or chemical spills

During the LoM there is potential for accidental spills of fuel or hydrocarbons leading to contamination of surface water and/or groundwater, with indirect impacts on lake ecology. Under the Proposal, all fuel and chemicals will be stored in a secure and appropriately bunded area in the Off-LDE, outside of the 1:100-year flood zone, to prevent release or spillage to the lake surface. Light vehicle workshop and washdown facilities will be located Off-LDE and constructed with concrete pads draining to a sump to allow the removal, storage and appropriate transportation of hydrocarbons for recycling. All activities will be conducted in accordance with relevant provisions of the *Dangerous Goods Safety Act 2004* and the Dangerous Goods Regulations 2007. Hydrocarbon spill kits will be provided at light vehicle workshops, refuelling locations, and bulk hydrocarbon storage facilities. Agrimin employees will be trained in the use of spill kits with an incident reporting procedure, including reporting of hydrocarbon or chemical spills, implemented and maintained for the LoM.

The implementation of measures for the to mitigate the impact of hydrocarbon or chemical spills to groundwater quality will meet the EPA objectives for Inland Waters.

9.5.6.3 Landfill and wastewater seepage

Development of the Proposal requires construction and operation of a putrescible waste landfill and wastewater treatment plant (WWTP). Both facilities will be located Off-LDE. Effluent from the WWTP will be reticulated to allow effluent to infiltrate or evaporate and prevent surface ponding or runoff from the irrigation area. The risk of contamination to groundwater as a result of seepage from landfill and/or the WWTP is low and may result in indirect impacts on lake ecology. The volume of black, grey and wastewater generated during operations is low, and conventional management measures and state of the art WWTP facilities will treat effluent to a high standard, to ensure no unacceptable impact to groundwater. Solid and putrescible waste will be disposed of in a locally established landfill site operated under full environmental licensing requirements. Wastes not suitable for general landfill will be reused and / or recycled.

The implementation of measures to mitigate the impact of landfill and WWTP facilities to groundwater quality will meet the EPA objectives for Inland Waters.

9.5.7 Cumulative impacts

The location of the Proposal is extremely remote with no cumulative impacts from other developments within or surrounding the Proposal area currently, or in the foreseeable future. Sensitive receptors (aquatic biota, riparian vegetation and waterbirds) are not expected to be significantly impacted by the Proposal or by potential changes to hydrological processes and water quality, or drawdown.

9.6 Predicted Outcome

Potential direct and indirect impacts on the Inland Water factor and proposed mitigation measures are outlined in Table 9-20, with detailed impact assessment provided in Section 9.5. The majority of these are considered indirect impacts, with the only direct impact of habitat loss limited to <5% disturbance of the total Lake Mackay area. Agrimin is of the view that the potential environmental impacts of the Proposal can be effectively managed effectively and are unlikely to result in long-term (or significant), residual impact to hydrological processes, groundwater and surface water quality, ecological function and associated sensitive environmental receptors. Therefore, no offsets, as defined in *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) are required for the Inland Waters factor.

The lake supports a relatively low number of resilient, halophytic aquatic biota, when inundated. During major events, which are rare, there is a boom cycle consisting of primary producers (algae) and aquatic invertebrates, which provide important foraging resources for waterbirds (including listed and migratory species). While several new aquatic invertebrate taxa have been recorded from the lake, they occur more broadly throughout the playa, and likely across the border into the NT. There are Priority and *Tecticornia* species of other significance known from the riparian zone, however these are also widespread throughout the area and are not considered groundwater dependent. Additional survey work of salt lakes in the broader region may also lead to additional records being found of the same taxa, due to the limited study of waterbodies in the area. Regardless, there are no expected direct or indirect impacts that will affect the ecological function and persistence of aquatic biota and waterbirds inhabiting Lake Mackay during major flood events.

Surface water modelling indicates engineered crossovers for the trench network will assist with maintaining hydrological processes and ecological function. Crossovers will also substantially reduce flooding of the riparian zone during larger rainfall events, while an adequate buffer zone will be provided between evaporation pond infrastructure and lake margins, to allow flow and movement to occur in major floods. In addition, strategic breaching of bunds following cessation of mining will return flows to the lake (Appendix I.18). Suitable buffer zones will also be implemented for the islands, which will maintain habitat and reduce the indirect impacts of drawdown.

Long-term time series water balance modelling also suggests there will be limited effects on the frequency, maximum extent, depth and duration of surface water on the lake in the larger inundation events. The lake is typically dry and only holds water <30% of the time, with only a minor reduction predicted in the number of more frequent, smaller inundation events that support limited ecological values due to hypersaline conditions. There will be a negligible impact on the larger events (which are rare) and cause the lake to fill completely, and important in supporting aquatic biota and maintaining ecological function. In addition, the predicted increase in extreme rainfall events, which has been evident in the last 20 years at Lake Mackay, may offset any potential changes associated with development and operation of the Proposal.

The Proposal is not expected to impede biological productivity of the lake during major flood events, while large rainfall events will assist with naturally mitigating drawdown. During 1 in 5 or 10-year floods, the entire surface of the lake will continue to be inundated at depth (up to 2 m), allowing for the emergence of aquatic biota that support, albeit it rarely, waterbirds on the lake. At closure, it is expected that groundwater levels will recover completely within seven years, and that salts from the evaporation ponds and salt piles will gradually dissipate and return to the playa (within 400 years), without affecting the overall salt balance of the system. In addition, the trenches used for brine extraction are expected to mostly infill within a period of approximately 10 years, also aided by flooding, which will redistribute salts and sediments across the playa, promoting a return to natural hydrological processes.

Agrimin understand that the EPA's Guidelines for Inland Waters identifies a number of key concerns of relating to potash proposals on salt lakes, including:

- disturbance of the lake surface that may change the flooding regimes leading to inundation of areas outside the lake surface with saline water that are not normally inundated;
- the impacts of the disposal of large amounts of excess salt from evaporation basins, which may be on the lake surface; and
- impacts on water quality and surface water flows on the lake in the long-term following closure of the Proposal

Specifically addressing these concerns, surface water modelling results (Section 9.5.2) (Appendix I.18) indicate a negligible and temporary effect along the southern shoreline of Lake Mackay only (largely mitigated by crossovers), with no expected changes to the majority of the lake, its periphery and associated the riparian zone. At closure, strategic breaches in the southern feeder canal and bunding trench network, as well as natural infilling of trenches will allow for direct rainfall and runoff to fill the deepest parts of the basin, redistributing salt and sediment, to maintain hydrological and ecological processes.

In comparison to the brine from the salt piles and relative to the existing natural salt loads stored within the basin, the proposed, gradual addition of salt from the Proposal to the playa is not considered significant (Appendix I.18). It is also not expected to alter the overall salt balance and ionic composition of the lake (Section 9.5.39). While residual salts may remain in the lake within localised areas associated with some parts of the trench bunding, during major flood events these salts will be mobilised and dispersed more broadly across the playa. Breaching of the evaporation ponds and bunding at closure will also assist with this process, reintegrating salts back into the environment.

Based on the implementation of all mitigation measures to limit the impact of the Proposal on the environment, the EPA objective for Inland Waters will be met.

10. Social Surroundings

10.1 EPA Objectives

The EPA's environmental objective for social surroundings is "*To protect social surroundings from significant harm*" (EPA 2016c).

10.2 Policy and Guidance

The State and Commonwealth legislative instruments, policy, guidelines, and advice relevant to the Proposal and their application are presented below. Table 10-1 also summarises the scope of each guide as relevant to the Proposal.

Table 10-1: Legislative instruments, policies and guidelines relevant to social surroundings impact assessment

Legislative instrument	
Aboriginal Cultural Heritage Act 2021	
Environment Protection and Biodiversity Conservation Act 1999	
Environmental Protection Act 1986	
EPA policy or guidance	**Considerations**
Environmental Protection Authority. (EPA 2004a). Guidance Statement No. 41: Assessment of Aboriginal Heritage	The EPA's advice in relation to consideration of impacts to social surroundings has been considered in the design of the Proposal to minimise impacts to Indigenous heritage values, cultural sites, and amenity.
Environmental Protection Authority. (EPA 2016c). Environmental Factor Guideline – Social Surroundings	The EPA's advice in relation to consideration of impacts to social surroundings has been considered in the design of the Proposal to minimise impacts to heritage values and amenity.
Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA.	This Statement provides guidance to ensure that a Proposal addresses the holistic view of its social impact relevant to the EP Act.
Environmental Protection Authority. (EPA 2021a). Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual Requirements under the *Environmental Protection Act 1986*	Describes the principles and practices of EIA within the context of Part IV of the EP Act and how these processed are applied to the impact assessment of the Proposal upon social surroundings.
Environmental Protection Authority. (EPA 2016a). Environmental Factor Guideline – Air Quality	The EPA's advice in relation to consideration of impacts to social surroundings has been considered in the design of the Proposal to minimise any adverse impacts to the chemical, physical, biological, and aesthetic characteristics of air.

10.3 Overview of studies

Social surroundings include the aesthetic, cultural, economic, and social values of the environment, which affect, or are affected by, physical and biological surroundings. They also include Aboriginal heritage and culture, natural and historic heritage, and amenity (EPA 2016c).

Agrimin has worked closely with Traditional Owners during the development of the Proposal to understand the heritage and cultural values of the Proposal area and surrounding environment. Numerous Aboriginal heritage surveys of the Proposal area have been undertaken to date, including a cultural heritage assessment within the Kiwirrkurra Native Title Determination Area, Ngurrupa Native Title Determination Area in 2019 (Cane and Wohlan 2019) and Tjurabalan (Table 10-2).

In February 2021, a pre-clearance survey was conducted with the Kiwirrkurra Native Title holders covering the southern extent of the NIDE and specific areas within the SIDE, which fall within the Kiwirrkurra Determination Area. Study details and key findings are summarised in Table 10-2.

Further pre-clearance survey work was undertaken in April 2021 within the Tjurabalan Native Title Determination Area covering the northern areas of the NIDE. The studies were carried out by a survey team nominated by the Tjurabalan Native Title Land Aboriginal Corporation. The findings of this study are detailed in Table 10-2.

A desktop review of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System for the Proposal area was undertaken in October 2020. The DPLH publicly available investigations and survey areas are detailed in Table 10-2 and Figure 10-1.

10.3.1 Survey Limitations

Agrimin has completed a range of surveys within the Project area and has confidence that this has resulted in a far improved understanding of the heritage values and their sensitivities. However, Agrimin acknowledges that it is possible that aboriginal artefacts or unregistered sites may be found during post-clearance surveys, and if this occurs it will consultant further with the relevant Traditional Owners.

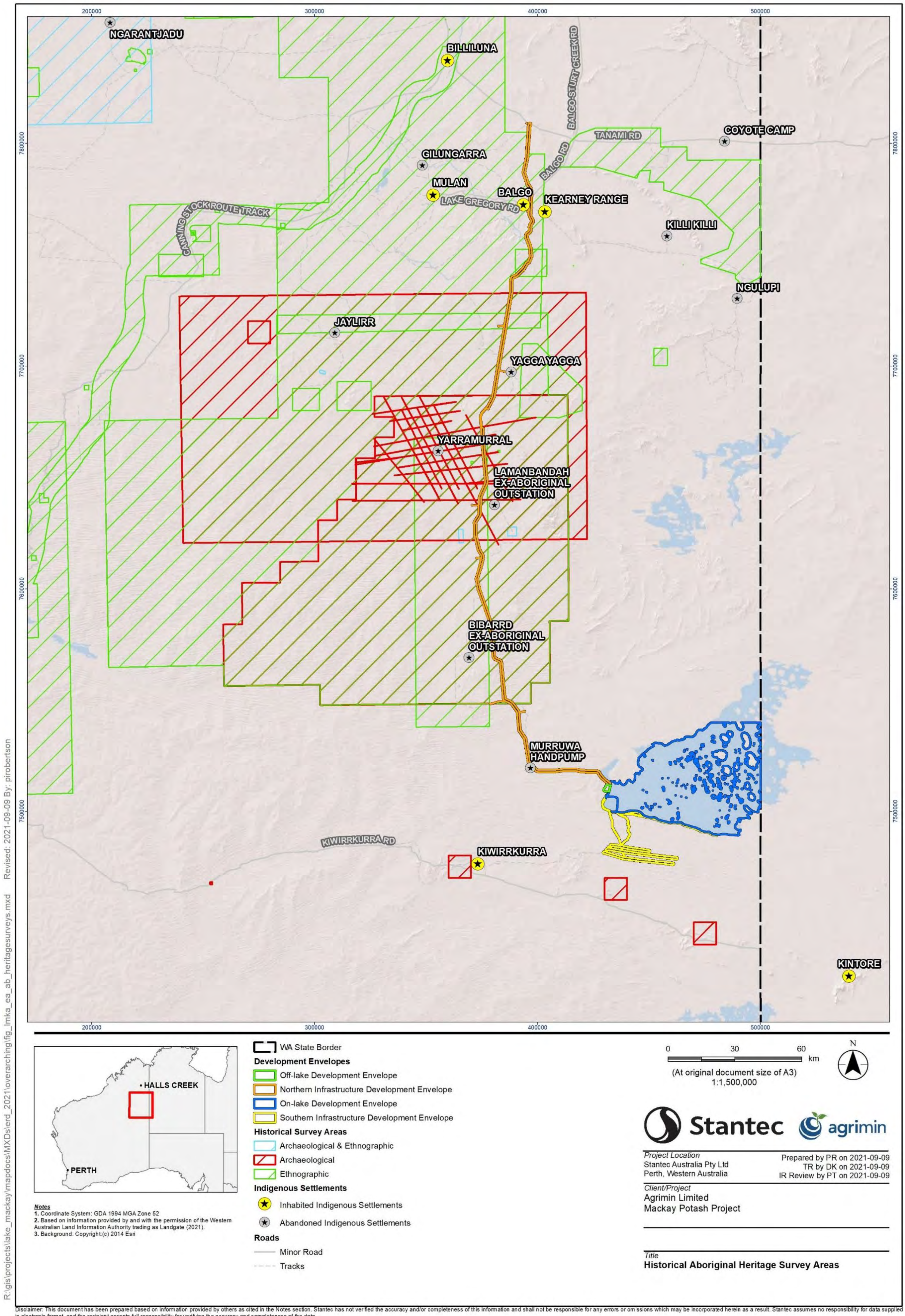

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Figure 10-1: DPLH Aboriginal Heritage survey areas (DPLH-080)

Table 10-2: Social Surroundings studies undertaken for the Proposal area

Reference	Study details	Scope	Survey / study effort	Key findings
Northern Infrastructure Pty Ltd – Haul Road Project Heritage Survey Report [open], Tjurabalan Native Title Determined Area, Western Australia (McDonald & Hayward 2021)	• Survey Dates: ○ April 2021 • Development Envelope(s): ○ NIDE	Ethnographic Works Program Clearance and a Helicopter Clearance Program	A physical examination of the survey area by means of helicopter and car with a team of Tjurabalan Traditional Owners nominated prior to the survey by the Tjurabalan PBC board of directors. Ethnographic fieldnotes and geospatial data were collected throughout the survey.	The survey team examined the survey area by means of helicopter and car. Throughout the one-day survey, the team identified a number of culturally significant sites within or near to the survey area. The survey area was cleared for the proposed works with conditions. These conditions include: • The women's law ground is a strict no-go zone. This includes no photos, no looking, no stopping, no videos and no slowing down. • There is to be no camping at any stage of construction or in the use of the road at sites identified in the report at Placemarks 12, 17, 19 and 20. • The company is to employ cultural monitors for the duration of the construction works to ensure that areas of cultural significance as outlined in the report are not disturbed. • Agrimin consult with Tjurabalan Traditional Owners as to the development and placement of signs and fences marking sensitive cultural sites. This will help to mitigate against the indirect impact of increased traffic (local and tourist) to sites of cultural significance to Tjurabalan Native Title holders that is anticipated from the easy access the sealed Haul Road will create.
Report of an Ethnographic Work Program Clearance within Agrimin Ltd's Sulphate of Potash (SOP) Project at Lake Mackay, Kiwirrkurra Native Title Determination Area, Western Australia (Gatti & Hodson 2021)	• Survey Dates: ○ February 2021 • Tenements: ○ E80/4889, E80/4995, E80/5055, E80/5108, L80/88 & L80/89 • Development Envelope(s): ○ NIDE ○ SIDE	Ethnographic Works Program Clearance and a Helicopter Clearance Program	A field survey conducted by heritage specialist and the Clearance Team (comprised of male and female Traditional Owners) and a liaison officer was undertaken to determine whether the proposed works are likely to damage or interfere with any areas or significance.	The Survey Team advised that the proposed work program is cleared to go ahead with the following exceptions: • Between 429965 7514574 and 427642 7517187, along the proposed haulage road the existing track cannot be widened in a north eastern direction. This is in order to preserve the integrity of the existing exclusion zone, the south west boundary of which abuts the existing track between these points. It is; however, permissible to widen the track toward the south west between these points for a distance of up to 1 km. in order to maintain a 1 km. wide corridor as requested in the work program. • The eastern Borefield Access Road (proposed to be located on the existing Balgo Track) between 440815 7492231 and 432419 7500168 is not cleared. • The Kiwirrkurra to Lake Mackay (Plant) Road – Proposed Through Cut, is not cleared as its current location impinges upon an existing exclusion zone.
A Cultural Heritage Assessment of the proposed NIDE through the Ngururrpa Native Title Determination Area (Cane and Wohlan 2019)	• Survey Dates: ○ October 2019 • Development Envelope(s): ○ NIDE	Heritage Survey Impact Assessment	A field survey was conducted by heritage specialists. The survey involved visiting known locations of cultural significance within the envelope to form a basis for assessing potential impacts and inspecting and assessing alignments of the NIDE against places of cultural value.	The section of the NIDE within the Ngururrpa Native Title Determination Area was 'cleared' for proposed activities. The relevant sections of the NIDE do not directly impact any discrete sites of significance, although it does pass through over 50 Aboriginal sites, 13 of which are connected to interrelated mythological narratives. The conclusion of the survey found that despite the recognised cultural sensitivity of much of the area, the potential impacts from the development of the haul road are either mitigated by activities that have preceded it or are sufficiently limited in terms of local cultural sensitivity and balanced by the potential community benefits. Therefore, there are no unmitigated impediments to the ongoing planning and development of the NIDE as currently aligned.
Report of Ethnographic Work Program Clearance within Agrimin Potash Pty Ltd Tenements E80/4889, E80/4995, E80/5055, E80/5108, L80/88 & L80/89, Kiwirrkurra Native Title Determination, Western Australia (Gatti and Hodson 2017)	• Survey Dates: ○ 21 to 25 June 2017 ○ 11 September 2017 • Tenements: ○ E80/4889, E80/4995, E80/5055, E80/5108, L80/88 & L80/89 • Development Envelope(s): ○ On-LDE ○ SIDE	Ethnographic Works Program Clearance and a Helicopter Clearance Program	A field survey, conducted by heritage specialist and the Clearance Team (comprised of male and female Traditional Owners) and a liaison officer, was undertaken to determine whether the proposed works are likely to damage or interfere with any areas or significance. This survey also aimed to complete the survey of the Access Track Corridor, Campsite 5, and Pilot Pond 2 which were not able to be surveyed in May 2017.	On the basis of this assessment the specific activities were determined by the clearance team to be considered either 'cleared' or 'not cleared'. Surveyed areas were all 'cleared' for progress, with the exception of a small section of land on the south-west lake margin. Agrimin committed to avoid disturbance to this 'not cleared' area.

Reference	Study details	Scope	Survey / study effort	Key findings
Report of an Ethnographic Works Program Clearance within Agrimin Ltd tenements E80/5055, L80/87 & L80/88 Kiwirrkurra Native Title Determination, Western Australia (Gatti and Hodson 2017)	• Survey Dates: ○ May 2017 • Tenements: ○ E80/5055, L80/87 & L80/88 • Development Envelope(s): ○ On-LDE ○ Off-LDE ○ SIDE	Ethnographic Works Program Clearance	A field survey conducted by a heritage specialist and the Clearance Team (comprised of male and female Traditional Owners) and a liaison officer, was undertaken to determine whether the proposed works are likely to damage or interfere with any areas or significance.	Six proposed bores located within the SIDE were 'cleared' to proceed. Some areas were not completed in the survey due to lack of time, leaving the Access Track Corridor, Campsite 5, and Pilot Pond 2, still to be surveyed and assessed to be considered cleared.
Report of Ethnographic Work Program Clearance within Agrimin Limited Tenements E80/4887, E80/4888, E80/4889, E80/4890 and E80/4893 Kiwirrkurra Native Determination, Western Australia (Mrvelj 2015)	• Survey Dates: ○ 3 to 4 June 2015 • Tenements: ○ E80/4887, E80/4888, E80/4889, E80/4890 and E80/4893 • Development Envelope(s): ○ On-LDE	Ethnographic Works Program Clearance	A field survey conducted by a heritage specialist and the Clearance Team (comprised of male and female Traditional Owners), was undertaken to determine if any areas of significance are likely to be damaged or encroached upon for each proposed works location. This survey entailed a helicopter clearance program, aircore and auger holes, trenches, a fuel drop off point, and a weather monitoring station.	All surveyed locations were determined to be 'cleared' for the proposed activities within the prescribed tenements, all within the On-LDE.
Heritage Survey Report Work Program Survey Toro Energy Ltd Works Program Survey (Gatti and Hodson 2011)	• Survey Dates: ○ 2011 • Tenements: ○ E80/3483, E80/3484, E80/3486 and E80/3519 (dead tenements held by Toro Energy, now tenements E80/5055, E80/5124 and E80/5172 held by Agrimin. • Development Envelope(s): ○ On-LDE	Work program survey to support Program of Works Exploration Activity	Not disclosed	Key findings incorporated into CHMP.
Heritage Survey Report Work Program Survey Holocene Pty Ltd E80/3748-51 (Hodson and Howard 2009)	• Survey Dates: ○ 12 to 13 June 2009 • Tenements: ○ E80/3748 – 3751 (dead tenements held by Holocene, now tenements E80/4887, E80/4888, E80/4889, E80/4890 held by Agrimin. • Development Envelope(s): ○ On-LDE	Work program survey to support Program of Works Exploration Activity	A clearance team undertook a Clearance of proposed works conducted in a helicopter. A men's team (two male Traditional Owners and a male anthropologist) and a women's team (two female Traditional Owners and a female anthropologist) conducted separate flights during which locations of proposed works were indicated to the Traditional Owners.	Key findings incorporated into CHMP. Only one proposed drillhole was 'not cleared' for any activities, all other locations indicated to the Traditional Owners were considered 'cleared'.

Table 10-3 Aboriginal survey history (DPLH Aboriginal Heritage Inquiry System)

Heritage Survey Area	Survey Type	Date	Development Envelope(s)	Survey Summary
18183	An Archaeological Survey of the Roberts Range Seismic Project Area (Aboriginal heritage survey areas DPLH080)	June 2005	NIDE	The survey area consists of a proposed seismic exploration zone located on EP 134 and EP 219. The survey areas are located on the Cornish, Lucas, Helena and Stansmore
17270	Preliminary Report on Ethnographic Site Survey Conducted with Female Traditional Owners of Balwina Reserve	September 1991	NIDE	The survey area consists of portions of the Balwina Aboriginal Reserve, located south of the Tanami Desert. A combination of aerial and ground surveys were carried out.
18278	Preliminary Anthropological Survey of the Balgo, Billiluna, Lake Gregory && Mt Bannerman Areas of the East Kimberleys	1983	NIDE	The survey area consists of the Ranger Permit Area
17606	An Archaeological Survey of the White Hills Prospect Area Ep134 North Western Australia	September 2005	NIDE	White Hills Prospect Area EP134. An area of approx. 5000sq.km
18934	Archaeological resources in the Balgo - Mobil Oil seismic survey area: interim report	March 2005	NIDE	The survey area consisted of a proposed exploration programme located approximately 120km south of Balgo. The total length of the seismic lines is roughly 700km, and the area sits between co-ordinates 540 E, 620 W, 330 S and 390 N on the Corinth, Lucas, Helena and Stansmore
104610	Archaeological Survey of Ep 134, West of Stansmore Range, W.A.	August 2005	NIDE	The survey area consists of the Permit Area EP134. The area is indeterminate as no boundaries have been defined in the HSR.
18025	1982 Survey of Sites of Ethnographic Importance, In the Area of Mobil Oil Australia Ltd., 1982 Seismic Programme in Eps 219 and 314	March 2011	NIDE	Area of Mobil Oil Australia Ltd., 1982 Seismic Programme in EPs 219 && 134
104610	Archaeological Survey of Ep 134, West of Stansmore Range, W. A	March 2011	NIDE	The survey area consists of the Permit Area EP134. The area is indeterminate as no boundaries have been defined in the HSR.
17390	A Preliminary Ethnographic Site Survey Balwina Reserve, Undertaken between 22/4/91 && 17/5/91 on Behalf of the Wirrimarnu && Yagga Yagga Communities	May 1991	NIDE	The survey area consists of portions of the Balwina Reserve intended for development by CRA.
18116	Report of a survey for Aboriginal sites White Hills area Gibson Desert	August 1990	NIDE	The survey area consists of the proposed development area, in the arid desert regions of the Gibson Desert. The dimensions of the survey area are approximately 120 km x 30 km
17395	Survey of sites of ethnographic importance in the vicinity of the proposed seismic lines in Mobil's Ep219	1981	NIDE	Proposed seismic lines in Mobil's EP219
104610	Archaeological Survey of Ep 134, West of Stansmore Range, W. A	March 2011	NIDE	The survey area consists of 18 seismic lines in Permit Area EP134, west of Stansmore Range. The seismic lines measure a total of approximately 900 km in length. A default corridor of 5 m has been used due to the limited information provided in the HSR. Survey area location and extent are as per Appendix 1.

10.4 Receiving Environment

Social Surroundings include the aesthetic, cultural, economic, and social values of the environment, which affect or are affected by physical and biological surroundings. They also include Aboriginal heritage and culture, natural and historic heritage and amenity (EPA 2016c).

10.4.1 Aboriginal Heritage

The Proposal area lies within three Native Title Determination Areas established under the Commonwealth NT Act (Figure 10-2):

- Kiwirrkurra Determination Area (Determination Number: WCD2001/002);
- Ngururrpa Determination Area (Determination Number: WCD2007/004); and

Tjurabalan Determination Area (Determination Number: WCD2001/001).Three Aboriginal Land Titles under the *Aboriginal Land Rights Act 1976* are located within the Proposal area, including the Kearney Reserve (26399), Ngaanyatjarra Central Australia Reserve (24923) and the Balgo Reserve (46573), shown in (Figure 10-2). A number of Aboriginal Communities and Pastoral Station are also located within, or adjacent to the NIDE (Table 10-4 and Figure 10-3).

Table 10-4 Aboriginal communities and pastoral stations

Receptor	Type	Development Envelope(s)	Distance to Development Envelope(s)
Kiwirrkurra Community	Aboriginal community	SIDE	60 km southwest
Balgo	Aboriginal community	NIDE	2.6 km west
Bililuna Station	Pastoral station	NIDE	6.3 km west
Lake Gregory Station	Pastoral station	NIDE	6.3 km west

Agrimin has worked closely with Traditional Owners within and surrounding the Proposal area to create Development Envelopes that, wherever possible, avoid disturbance to Aboriginal heritage sites and areas of cultural significance. Agrimin first began engaging with Kiwirrkurra Native Title holders in relation to the Proposal in 2014 when it applied for exploration tenure over Lake Mackay. Agrimin subsequently began engaging with the Ngururrpa and Tjurabalan Native Title holders in mid-2018 in relation to the Proposal's ancillary infrastructure (haul road) requirements.

In 2017, Agrimin became the first company to sign a Native Title Agreement (WAD6019/1998) with the Tjamu Tjamu Aboriginal Corporation (RNTBC) for the Kiwirrkurra People and have developed strong relationships that are mutually beneficial for all parties. By constructing and operating the Proposal, the agreement seeks to encourage jobs, economic benefits, and opportunities for the Kiwirrkurra People. Agrimin is in the process of negotiating Native Title Agreements with the Parna Ngururrpa and Tjurabalan Native Title holders for the haul road. Letters of support for ongoing engagement, consultation and the Proposal, from both the Parna Ngururrpa and Tjurabalan Native Title holders are provided in Appendix K.

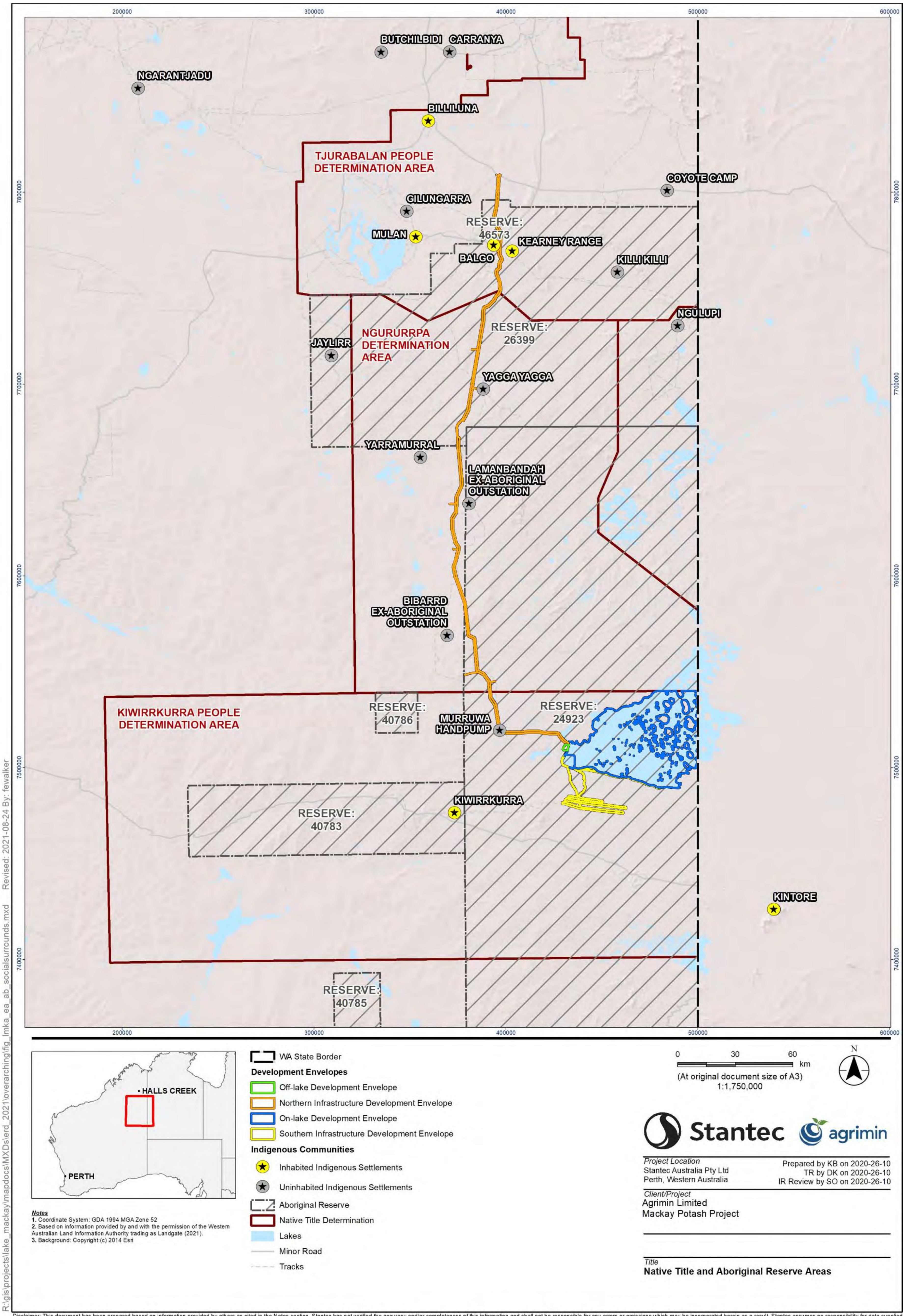

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Figure 10-2: Proposal Native Title and Aboriginal reserve areas

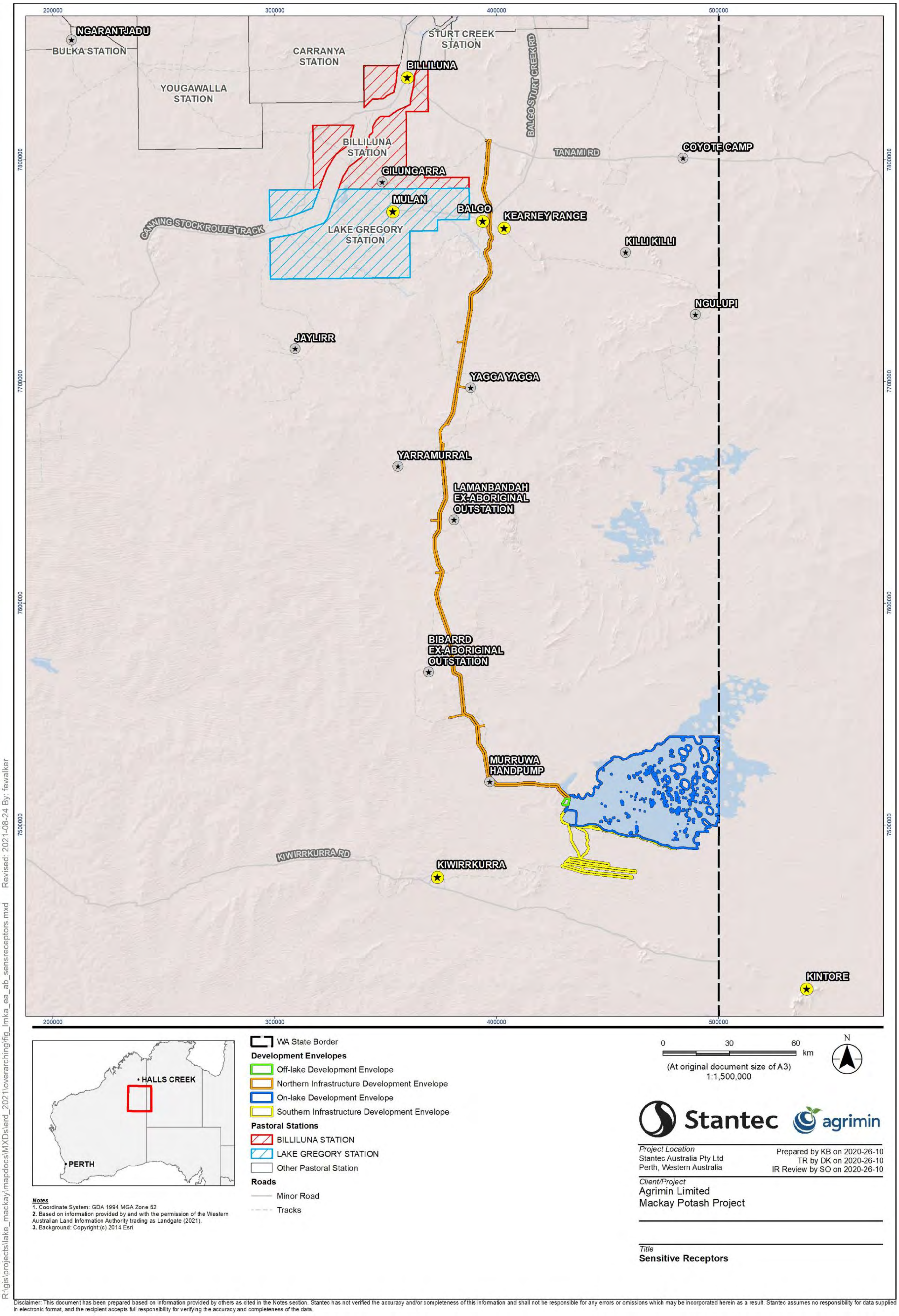

Figure 10-3: Proposal sensitive receptors

10.4.1.1 Aboriginal Heritage - On-LDE, Off-LDE and SIDE

The On-LDE, Off-LDE and the SIDE are located within Ngaanyatjarra Central Australia Aboriginal Reserve 24923 (Figure 10-2). The Kiwirrkurra People are located on an Aboriginal Settlement 60 km south-west of the SIDE. The Kiwirrkurra Native Title holders have exclusive rights to occupy, use and benefit from this Reserve. Agrimin has signed a Native Title Agreement (WAD6019/1998) with the Tjamu Tjamu Aboriginal Corporation (RNTBC) for the Kiwirrkurra Native Title holders that requires Agrimin to keep the Tjamu Tjamu and the Kiwirrkurra People informed about, and involved in, the proposed work at Lake Mackay. The desktop review of the Aboriginal Heritage Inquiry System for the Proposal area (DPLH 2020), one registered Aboriginal heritage site (Site ID 2033) was located 6.8 km south-west of the SIDE, while no sites were found to intersect with the On-LDE or the Off-LDE (Table 10-5).

Table 10-5 Registered and Lodged Aboriginal Sites near the On-LDE, Off-LDE and SIDE

Proposal	Place	ID	Status	Description	Distance
SIDE	Karkulpa	2033	Lodged	Mythological	within 7 km of Development Envelope

Pre-clearance Aboriginal heritage surveys of the On-LDE, Off-LDE and SIDE, identified two areas that may be of cultural significance and, as such, were excluded from the Development Envelopes to ensure there is no impact on these areas from Proposal activities. Agrimin has prepared a CHMP with the Kiwirrkurra Native Title holders that incorporates the findings of the surveys listed in Table 10-2 and includes the designation, management and annual monitoring of the exclusion areas (Table 10-7).

10.4.1.2 Aboriginal Heritage - Haul Road

The NIDE traverses all three Native Title Determination Areas, with the longest stretch of road corridor (approximately 220 km) located within the Ngururrpa Native Title Determination Area. Agrimin undertook a desktop review of Aboriginal heritage sites that may be impacted by the NIDE, utilising the DPLH Aboriginal Heritage Inquiry System. The Aboriginal Heritage Inquiry System review identified 13 Aboriginal heritage sites that directly intersected with the NIDE, four sites that were within a 500 m buffer area, and 11 sites that were located within a 1 km buffer of the NIDE (Figure 10-4 and Table 10-6). Results identified that the highest occurrence of registered Aboriginal heritages sites is within the NIDE, in the Ngururrpa Native Title Determination Area, warranting further cultural survey work to inform the impact assessment.

In October 2019, Agrimin's archaeological consultants undertook a cultural heritage assessment of the proposed NIDE located within the Ngururrpa Native Title Determination Area, in consultation with the Ngururrpa Native Title holders. The assessment focused on the haulage corridor in order to understand the potential for the proposed infrastructure to disturb any areas of cultural significance (previously known or otherwise), and, if required, assist with informing the re-alignment of the haulage corridor.

Agrimin's cultural heritage assessment noted that, despite the remoteness of the region, some locations around the Proposal area, had been subjected to historical disturbance from exploration and settlement activities, including extensive road networks, along with drill and seismic line construction (Cane and Wohlan 2019).

The cultural heritage assessment of the proposed NIDE concluded that the alignment of the NIDE passes through country that has elevated significance for mythological and ethnographic values. The sensitivity of the mythological landscape varied along the length of the NIDE, with three areas of notable sensitivity identified. The location of these areas has been discussed in Agrimin's cultural heritage assessment; however, the exact locations of sacred sites are considered confidential, including:

- Northern Section - ridge and mesa country between the Stansmore (Mangkayi) and Stretch (Kilikinti) Ranges;
- Central Northern Section - the plains and breakaways surrounding Point Moody (Parakurra and Kantjimarra); and
- Central Southern Section - Hill and plain country located between and including Carnegie Bluff (Pawapungu) and the Waterlander Breakaway (Piparr).

Outcomes of the cultural heritage assessment determined that NIDE's current alignment has reasonably attempted to avoid focal locations (sites of significance) within that broader mythological landscape (Cane and Wohlan 2019).

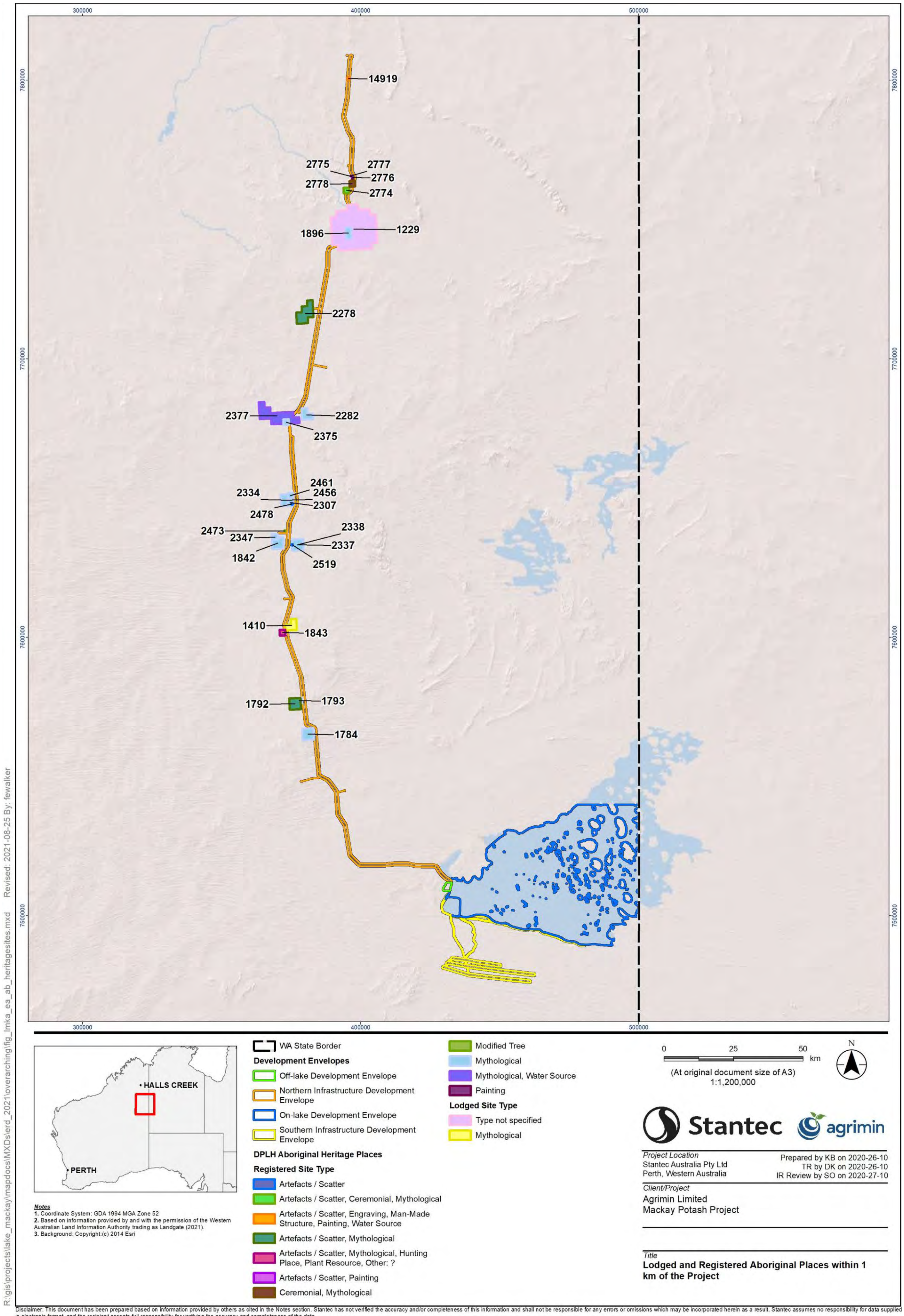

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Figure 10-4: Aboriginal Registered and Lodged Aboriginal Places within 1 km of the Proposal

Table 10-6: Registered and Lodged Aboriginal Places within the vicinity of the NIDE

The Proposal	Place/Site	ID	Status	Description	Distance
NIDE	Tanami Desert Complex	93	Lodged	-	Intersects with Development Envelope (NIDE)
NIDE	Barga	132	Lodged	Mythological	Intersects with Development Envelope (NIDE)
NIDE	Lakka.	238	Registered Site	Artefacts / Scatter, Mythological, Hunting Place, Plant Resource	Intersects with Development Envelope (NIDE)
NIDE	Puka / Tjurinyungu	344	Registered Site	Artefacts / Scatter, Mythological	Intersects with Development Envelope (NIDE)
NIDE	Giligini.	391	Registered Site	Mythological, Water Source	Intersects with Development Envelope (NIDE)
NIDE	Galna/Balgo	498	Registered Site	Artefacts / Scatter, Ceremonial, Mythological	Intersects with Development Envelope (NIDE)
NIDE	Wirimandu/Balgo	499	Registered Site	Ceremonial, Mythological	Intersects with Development Envelope (NIDE)
NIDE	Billiluna.	12583	Registered Site	Artefacts / Scatter, Engraving, Man-Made Structure, Painting, Water Source	Intersects with Development Envelope (NIDE)
NIDE	Kuppi	18198	Registered Site	Mythological	Intersects with Development Envelope (NIDE)
NIDE	Wauwiya Claypan	18206	Registered Site	Mythological	Intersects with Development Envelope (NIDE)
NIDE	Namaluk Rockhole 2	31502	Registered Site	Painting	Intersects with Development Envelope (NIDE)
NIDE	Namaluk Rockhole 1	31504	Registered Site	Artefacts / Scatter, Painting	Intersects with Development Envelope (NIDE)
NIDE	Mugari Gudjara	31101	Registered Site	Mythological	Intersects with Development Envelope (NIDE)
NIDE	Kuuku Kuuku	209	Registered Site	Mythological	Within 500 m of Development Envelope (NIDE)
NIDE	Gilagila	28314	Registered Site	Mythological	Within 500 m of Development Envelope (NIDE)
NIDE	Mulyutjurin	31087	Registered Site	Mythological	Within 500 m of Development Envelope (NIDE)
NIDE	Namaluk rockhole 3	31503	Registered Site	Painting	Within 500 m of Development Envelope (NIDE)
NIDE	Walguruwalguru	364	Registered Site	Mythological	Within 1 km of Development Envelope (NIDE)
NIDE	Dadjanangara	365	Registered Site	Mythological	Within 1 km of Development Envelope (NIDE)
NIDE	Gundjimara	421	Registered Site	Mythological	Within 1 km of Development Envelope (NIDE)
NIDE	Matjappi	18203	Registered Site	Mythological	Within 1 km of Development Envelope (NIDE)
NIDE	Nyaradju	18212	Registered Site	Mythological	Within 1 km of Development Envelope (NIDE)
NIDE	Balgoil 19	24632	Registered Site	Artefacts / Scatter	Within 1 km of Development Envelope (NIDE)
NIDE	Balgoil 34	29523	Registered Site	Artefacts / Scatter	Within 1 km of Development Envelope (NIDE)
NIDE	Pilli Pilli	31090	Registered Site	Artefacts / Scatter, Mythological	Within 1 km of Development Envelope (NIDE)
NIDE	Balgoil 29	31119	Registered Site	Modified Tree	Within 1 km of Development Envelope (NIDE)
NIDE	Galmanggu/Buldjunganu	31496	Registered Site	Mythological	Within 1 km of Development Envelope (NIDE)
NIDE	Namaluk Rockhole 2	31502	Registered Site	Painting	Within 1 km of Development Envelope (NIDE)
NIDE	Namaluk Rockhole 1	31504	Registered Site	Artefacts / Scatter, Painting	Within 1 km of Development Envelope (NIDE)
NIDE	Gundjimara	31686	Registered Site	Mythological	Within 1 km of Development Envelope (NIDE)

10.4.1.3 Indigenous Protected Area

The NIDE traverses three Indigenous Protected Areas (IPA). IPAs are voluntarily dedicated by Indigenous groups on Indigenous owned or managed land or sea country. They are recognised by the Australian Government as an important part of the National Reserve System, protecting the nation's biodiversity for the benefit of all Australians.

IPA management plans describe how Indigenous groups 'care for country' using a combination of traditional Indigenous knowledge and contemporary western science. These plans identify an International Union for Conservation of Nature (IUCN) management category to ensure that their management is in line with international standards.

The principles of the IUCN management categories, include:

- Protection of natural ecosystems and promotion of sustainable use must be integrated and mutually beneficial; category VI can potentially demonstrate best management practices that can be more widely used.
- New skills and tools need to be developed by management authorities to address the new challenges that emerge from planning, monitoring and managing sustainable use areas.
- There is also need for development of appropriate forms of governance suitable for category VI protected areas and the multiple stakeholders that are often involved. Landscape-scale conservation inevitably includes a diverse stakeholder group, demanding careful institutional arrangements and approaches to innovative governance.

10.4.1.3.1 Ngururrpa IPA (WA), Great Sandy Desert, WA

Located within the Great Sandy Desert bioregion and comprising a network of sandplains and dunefields, Ngururrpa IPA is known to contain a number of BC Act and EPBC Act listed threatened species, including the Greater Bilby and the Great Desert Skink. The IPA is connected to IPAs in the north, south and east, contributing to a contiguous network of protected areas in the region. On ground management will be undertaken by Indigenous rangers according to the Ngururrpa Indigenous Protected Area Plan for Country 2020-2025.

The Ngururrpa Indigenous Protected Area Plan for Country 2020-2025 (Parna Ngururrpa 2019) sets out strategies and actions aimed at conserving the Night Parrot and other threatened species, including:

- Rangers to work with elders and scientists to undertaken regular tracking surveys, and other surveys, to monitor fauna.
- Rangers to learn from other ranger groups that have experience in conservation of the same fauna.
- Carefully burn country to maintain good habitat.
- Manage feral animals including cats, foxes, rabbits, and camels.

10.4.1.3.2 Kiwirrkurra IPA (WA), Great Sandy Desert, WA

The IPA covers the whole of the Kiwirrkurra Native Title determination, an area of 42,857 square kilometres. It therefore contributes about 3.6% to Australia's National Reserve System (based on 2012 protected areas data). It shares its southern boundary with the Ngaanyatjarra IPA and most of its eastern boundary with the Southern Tanami IPA, thereby contributing to a continuous network of protected lands in the region. The Kiwirrkurra IPA increases the level of protection of the Great Sandy Desert bioregion from 15 to 20%, and that of the Gibson Desert bioregion from 36 to 51% (again based on 2012 data).

The Kiwirrkurra IPA is owned and managed by traditional owners through their prescribed body corporate, Tjamu Tjamu Aboriginal Corporation. The area is managed to protect biodiversity and cultural resources, based on Indigenous perspectives of connecting to and looking after country and complemented by Western knowledge and management principles (Tjamu Tjamu Aboriginal Corporation 2014).

The Kiwirrkurra IPA – Plan for Country sets out management actions to protect both natural and cultural values, and provide a range of economic, educational, health and wellbeing benefits for the community. The priorities for managing country are grouped into four key areas, although these are closely inter-related:

- Looking after Culture;
- Looking after Country;
- Keeping our People Strong; and
- Economic Development.

10.4.1.3.3 Paruku IPA (WA), Great Sandy Desert, Western Australia

The Paruku Indigenous Protected Area (IPA) borders the Great Sandy and Tanami deserts and is south of Halls Creek. Covering around 430,000 hectares it includes a collection of wetlands known as Paruku (Lake Gregory). Paruku has several groups of Traditional Owners, including Walmajarri, Jaru and Kukatja peoples and was dedicated as an IPA in September 2001.

10.4.2 Other Heritage Places

A search of the State Register of Heritage Places (Heritage Council 2021) did not identify any State Registered Places or Heritage Places within the Proposal area. The region has however, been subjected to high impact exploration activities historically, since the 1930s, particularly in the northern areas. Agrimin seeks to utilise the region's historical disturbance areas, including tracks, drill and seismic lines, which are detailed in Section10.4.1, to minimise clearing and ground disturbance impacts relating to the Proposal.

10.4.3 Infrastructure, Services and Roads

There is limited public access to the Proposal area. The current southern access route to the Proposal area is along the Gary Junction road, which runs from Alice Springs, past the townships of Papunya and Kintore, to Kiwirrkurra in WA; a distance of approximately 670 km. From Alice Springs, this route starts with a 20 km stretch north along the Stuart Highway and then 117 km along the Tanami Road, both of which are sealed roads and in excellent condition. The route then diverts onto the Gary Junction road, which is a wide and relatively well-maintained unsealed road. The Gary Junction road is a public road, but sections that cross Aboriginal lands require access permits.

Additionally, a single lane unsealed track traverses the Proposal area along the western edge of Lake Mackay, joining the Kiwirrkurra community in the south to Balgo in the north.

The Tanami Road to the north of the Proposal is currently an unsealed road that connects Halls Creek in WA to Alice Springs in the NT. The road is currently used to service a number of gold mines and cattle stations. It has several short, sealed sections across some of the water crossings; however, the majority remains unsealed.

The Commonwealth and State governments have allocated budget to upgrade the Tanami Road with works due to commence in 2021. Agrimin is proposing to use the western most 205 km section of the Tanami Road, from Balgo to the Great Northern Highway, to connect a new haul road to the Great Northern Highway.

A combination of historical exploration of the area has left 3000 km of road, track, drill and seismic line construction, notably establishing the original Pallotine Roman Catholic Mission at Balgo in 1943, geological mapping in search of oil in the 1950s, seismic surveys conducted by Mobil Oil in the early 1980s, followed by Shell Oil's seismic surveys in the late 1980s. Agrimin proposes to utilise some of this existing disturbed area for portions of the Development Envelopes.

10.4.4 Amenity / Land Use

The Social Surroundings Environmental Factor Guideline describes amenity as being a broad term referring to the qualities, attributes and characteristics of a place that make a positive contribution to quality of life (EPA 2016c). Within this ERD, amenity values are addressed in terms of visual amenity and the ability for people to live and recreate within their surroundings area without unreasonable interference to their health, welfare, convenience, and comfort, from Proposal activities (EPA 2016c).

Noting the above, the Proposal is located in the remote 'Great Sandy Desert of Central Australia', with the nearest communities being Balgo located approximately 2.6 km west of the northern section of the NIDE, and the Kiwirrkurra Community, located approximately 60 km to the southwest of the SIDE (Figure 10-3). The nearest public road is the Tanami Road to the north, which is currently an unsealed road that meets the northern tip of the NIDE.

Several sections of proposed disturbance for the haul road within the NIDE (approximately 20.5 ha) will follow the existing unsealed track that joins Balgo with the Kiwirrkurra community. The remaining sections (approximately 979.5 ha total) of the haul road will deviate to avoid low lying and drainage areas subject to flooding. Seismic lines and historical exploration tracks may also be used.

Local land uses are predominantly conservation and natural environment for traditional Indigenous uses, however, two pastoral stations, the Billiluna Station and the Lake Gregory Station, lie within 6 km of the Proposal area.

The closest active mine site to the Proposal area is the Halls Creek North/Guerinoni Open Pit mine located more than 180 km to the north of the NIDE.

10.4.5 Air Quality Emissions

Air quality modelling or monitoring has not been undertaken to inform the Proposal as there are no sensitive areas or other industries located in proximity to the Proposal area (Figure 10-3). The nearest pastoral station infrastructure is approximately 6 km from the Proposal area (Figure 10-3), while Balgo is located approximately 2.6 km west of the northern section of the NIDE. Background particulate concentrations are likely to be from natural sources including bushfires and airborne particulates from wind erosion during the dry season (May to October). However, to further ensure the maintenance of suitable air quality within Balgo, a targeted DMP has been prepared as part of the CEMP to ensure fugitive dust emissions during construction of the haul round within the area is minimised as low as practicable. Additional discussion on climate and background ambient air quality is provided in Table 11-3.

10.4.6 Recreation and Tourism

The Proposal area is extremely remote, therefore tourists and visitors in the area are limited. The unsealed track that joins the Kiwirrkurra community to Balgo is infrequently travelled by tourists, due to the limited facilities, the condition of the road, and remoteness of the area.

In addition to the remoteness, as the whole Proposal area lies within Aboriginal Determination Areas, entry permits from respective Traditional Owner groups are required to gain lawful access into this area. The proposed development of the haul road within the NIDE will connect to the Tanami Road to the north which may encourage interest from external parties to visit the area for tourism or recreational purposes. Tihis may continue post closure of the Proposal.

10.4.7 Socioeconomic

The entire Proposal area is established under Aboriginal Determination Areas therefore all socio-economic factors are associated with Traditional Owner community purposes or mining exploration. Agrimin hopes to provide a series of financial and non-financial benefits for the Traditional Owners and communities impacted by the Proposal, including employment, education/training, improved infrastructure, and community development opportunities.

10.5 Potential Impacts and Mitigation Measures

The potential exists for direct and indirect impacts as a result of the Proposal to the Development Envelopes, notably the NIDE, and the social surroundings values that these areas support. The risk for key activities associated with the Proposal has been determined, along with proposed mitigation measures, as part of an environmental risk assessment, with a summary of potential impacts provided in Table 10-7. The key impacts associated with the development of the Proposal are discussed in detail in Sections 10.6.1 and Section 10.6.2 and provides local and regional ecological context for the impact assessment, and include:

- unauthorised vegetation clearing and earthworks resulting in disturbance of Aboriginal heritage sites and / or mythological landscapes;
- disturbance to amenity values from wind turbines, salt stockpiles and fugitive dust emissions from construction, operations, and product haulage.

Additional potential impacts were identified during the risk assessment which were ranked as lower risk (Table 10-7). These impacts were considered as having a risk level that can be managed appropriately and are not discussed in detail in the following sections; however, these risks will be addressed via management measures in the CEMP, including the specific preparation of the Balgo Community Dust Management Plan (Appendix A of the CEMP). These additional potential impacts to social surroundings include:

- disruptive noise emissions, from aircraft or machinery;
- altered fire regime; and
- non-compliance with post closure commitments.

The mitigation hierarchy has been considered and applied to potential Proposal impacts 'to protect *social surroundings from significant harm*', aligning with the EPA objective for the Social Surroundings Factor (EPA 2016c). Mitigation measures, which largely avoid, mitigate, manage, monitor and rehabilitate significant impacts to Aboriginal heritage and amenity value to reduce the risks are presented in Table 10-7.

The mitigation measures are discussed in more detail in subsequent sections and will ensure the EPA objective for Social Surroundings will be met.

Table 10-7: Mitigation hierarchy applied to mitigate impacts from the Proposal on Social Surroundings

Key Proposal Impacts	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
Diminished value of significant Aboriginal Heritage values from native vegetation clearing outside approved clearing areas	• Roads and access tracks to be engineered to avoid registered Aboriginal Sites, listed heritage places and areas of significant cultural values • Culturally sensitive areas will be avoided using exclusion zones (demarcated) within the Off-LDE, On-LDE, NIDE and SIDE • Clearing will only occur in approved ground disturbance areas • Demarcation of heritage sites and exclusion zones created to avoid destruction of heritage values of landforms • Avoid clearing within drainage features and drainage lines where possible • Buffer zones established around heritage areas to be protected	• Delineate clearing boundary areas, and confirmed cleared areas via survey after clearing • Establish and maintain a geospatial Aboriginal Heritage Management Database to ensure any areas of concern, exclusion areas, sensitive areas and cleared areas in the Development Envelopes are readily identified, and effectively managed with fencing and/or signage of exclusions areas in accordance CHMP and CEMP • Haul road constructed to avoid impediments to surface water flows/sheet drainage during flooding events • Engagement and consultation with Traditional Owners regarding the hazards associated with construction and operations • If Aboriginal heritage artefacts or unregistered sites, are identified during post-clearance surveys, Agrimin will first consultant with the relevant Traditional Owners, and where appropriate, seek relevant approvals the *Aboriginal Cultural Heritage Act 2021*	• Development of CHMP's in consultation with Traditional Owners and Native Title Groups • Comply with CEMP • Develop a Ground Disturbance Permit System And Procedure • Develop cultural awareness training packages and inductions	• Post-clearance heritage surveys • Annual inspections of any exclusion areas within the Kiwirrkurra Native Title determination area with native holder	• NA	✓	No
Altered fire regimes resulting in disturbance and decline Aboriginal Heritage values	• Avoid off-road driving and stay on approved access ways.	• Engagement of Traditional Owners for understanding local fire regimes and fire management practices • Establish Emergency Response Plan and Emergency Response Team (ERT) • Fire response equipment maintained at site and in vehicles and machinery and Haul Trucks • Water trucks fitted with high pressure monitors and pumps for fire management • Implement a hot works permit system for high ignition risk work activities high ignition risk work activities • Develop education programs for haul road users (including Traditional Owners)	• Comply with FVEMP • Comply with CEMP • Develop a Fire Management Procedure • Develop an Emergency Response Plan • Develop a TMP • Develop a Hot Works Permit System • Develop an Incident Reporting Procedure	• Internal incident reporting and investigation process	• NA	✓	No
Changes to aesthetic values from native vegetation clearing	• Not applicable as remote area with no sensitive receptors and restricted public access, vegetation types well represented through the region	• NA	• NA	• NA	• NA	✓	No
Decreased amenity value from product haulage noise on residents in Balgo local communities	• NA	• The haul road will initially be unsealed; however, Agrimin plan to bituminise the haul road and this will subsequently reduce noise and vibration.	• Noise will be managed in accordance with the Environmental Protection (Noise) Regulations 1997 • Comply with CEMP • Develop a TMP • Restrict public access to haul road (Agrimin staff, contractors, and Traditional Owners only)	• Complaints Procedure and Register	• NA	✓	No

Key Proposal Impacts	Mitigation Hierarchy					EPA Objective Met	Residual Impact
	Avoid	Mitigate	Manage	Monitor	Rehabilitate		
			• Implement speed limits for all traffic at dawn/dusk and night time in habitats and areas of importance to significant species • Develop education programs for haul road users (including Traditional Owners)				
Decreased amenity values from aircraft noise	• Flights only operated during daylight hours to reduce nuisance impacts to local communities	• NA	• Noise will be managed in accordance with the Environmental Protection (Noise) Regulations 1997. • Compliance with CEMP • Develop awareness and training packages and inductions • Complaints Procedure and Register	• Complaints Procedure and Register	• NA	✓	No
Decreased amenity values from wind turbines	• Wind turbines will be located on the edge of Lake Mackay, with the nearest sensitive receptor over 60 km	• NA	• NA	• NA	• NA	✓	No
Fugitive dust emissions clearing from native vegetation and haulage activities impacting upon residents' local communities	• 30% of the haul road will be constructed on the existing cleared track reducing total clearing • Haul road will be sealed in the early stages of the Proposal, limiting dust emissions that would otherwise be likely from an unsealed haul road	• Use of dust suppression (water carts) during clearing activities and operations • Dust suppression measures to focus on areas in proximity to Priority flora, significant vegetation, and riparian vegetation • Vehicle speeds on construction roads will be reduced where necessary to minimise dust emissions	• Comply with FVEMP • Comply with CEMP • Develop a DMP • Develop a TMP • Develop a Complaints Procedure and Register	• Monitor daily wind conditions will be taken into consideration when clearing activities are proposed • Internal incident reporting and investigation process	• Rehabilitation of temporary cleared areas	✓	No
Decreased amenity values from salt stockpiles altering the landscape	• NA	• Salt stockpiles will be maximum height of 7m (excess salt stockpiles) and 20 m (process salt management area only). • Located in areas considered low impact regarding visual impact to community / tourism.	• Develop an Agreement with Traditional Owners regarding remaining stockpiles • Comply with MCP	• NA	• Salt stockpiles will remain at closure, unrehabilitated and passively assimilate into the surrounding landscape over the long-term.	✓	No
Non-compliance with MCP	• NA	• Removal of all equipment from site. • Agreement with landholder for any retained infrastructure.	• Comply with MCP (including topsoil management) • Scrap metal/metal to be buried in situ. • Triennial updates of MCP.	• Mine Rehabilitation Fund reporting and contributions	• Rehabilitation cost estimation and provisioning to IFRS Standard. • Rehabilitate bores, access tracks and burrow pit post haul road construction	✓	No

10.6 Assessment of Key Impacts and Mitigation Measures

10.6.1 Impacts to Aboriginal Heritage Values

In accordance with the Environmental Factor Guideline – Social Surroundings (EPA 2016c) and Guidance for the Assessment of Environmental Factors: Assessment of Aboriginal Heritage No. 41 (EPA 2004b), the impacts on Aboriginal heritage sites and cultural values have been identified and their risk level assessed. The high-risk impact pathways for Aboriginal heritage have been identified to include unauthorised disturbance to Aboriginal heritage sites through clearing and ground disturbance, and indirect impacts on ethnographic values through fugitive dust emissions and increased fire, diminishing the mythological landscape of the Proposal area (Table 10-7).

Agrimin, in consultation with relevant Traditional Owner groups, delineated the Development Envelopes and Indicative Footprint to avoid, where practicable, registered Aboriginal heritage sites and areas of elevated mythological significance.

No Aboriginal sites or mythological sites of significance occur within the Proposal area, with the exception of the NIDE. Wherever possible, Agrimin in consultation with the Traditional Owners have identified exclusions areas where Aboriginal heritage values do exist (i.e. Aboriginal heritage or mythological Sites exclusions areas have been developed and excluded from the Development Envelopes). However, Agrimin also commits to post-clearance surveys being undertaken for all areas of proposed ground disturbing activities (i.e. vegetation clearing and earthworks) within the Proposal area that have not already been the subject of a clearance survey, to ensure unregistered sites are identified and avoided. If Aboriginal heritage artefacts or unregistered sites, are identified during post-clearance aboriginal heritage surveys, Agrimin will first consultant with the relevant Traditional Owners and, where appropriate, seek relevant approvals under the *Aboriginal Cultural Heritage Act 2021*.

A desktop review and cultural impact assessment has demonstrated that the proposed NIDE does not directly impact any discrete Aboriginal heritage sites of significance, therefore the mythological landscape has become a key focus of this assessment. A cultural heritage assessment over the northern portion of the NIDE, determined the overall significance of the mythological landscapes to have already been diminished through historical disturbance and exploration activities in the Proposal area and surrounds (Cane and Wohlan 2019).

The cultural heritage assessment indicated that impacts associated with developing the Northern and Central Northern sections of the NIDE can be mitigated through Agrimin's approach to, where possible, use already disturbed areas, including tracks and drill lines. Within the central southern section, the Development Envelope is confined to sand plains and dunes, largely avoiding outcrops and other features associated with the core mythology of that area, and is therefore mitigated to a reasonable extent (Cane and Wohlan 2019). Other mythological or culturally sensitive areas associated with natural drainage lines have also been avoided through design of the NIDE. Noting the above, Agrimin's consultants described the NIDE's current alignment as having reasonably attempted to avoid focal locations (sites of significance) within that broader mythological landscape (Cane and Wohlan 2019).

The final alignment of Agrimin's haulage corridor within the NIDE will be informed through further consultation with relevant Traditional Owners, as well as post-clearance Aboriginal heritage survey work to ensure unregistered sites are identified and avoided.

Noting the above, the proposed NIDE has been assessed as having minimal cultural impact on the local and regional Aboriginal heritage values (Cane and Wohlan 2019).

Table 10-8 details the area of each IPA that the Proposal intersects and the proportion of areas that will be impacted by the implementation of the Proposal. The greatest impact will be to the Kiwirrkurra IPA, of which, 0.3% will be impacted by the Indicative Footprint. The remaining area of the Indicative Footprint represents less than 0.03% of each of the two IPAs.

Table 10-8 Proportion of IPAs that will be impacted by the implementation of the Proposal

IPA	IPA area (ha)	Intersecting DE(s)	Intersecting Proposal area		Intersecting IF	
			(ha)	(%)	(ha)	(%)
Tjurabalan	2,584,199	NIDE	6,354.06	5.51	179.66	0.007
Parna Ngururrpa	2,963,799	NIDE	21,628.20	0.73	653.13	0.022
Kiwirrkurra	4,276,341	NIDE, Off-LDE, On-LDE, SIDE	235,644.31	0.25	13,926.24	0.326

The construction of the haul road within the NIDE is beneficial to the surrounding Aboriginal communities in the area, particularly the Balgo and Kiwirrkurra People. The proposed work will provide haul road (vs existing four-wheel drive tracks) that directly connects these two communities, allowing for reduced travel time (by approximately 7 hours from 12 hours to 5 hours), safer travel between them, and subsequently greater connectedness that is favoured by these communities. The Proposal has the potential to provide substantial benefits, including support for several on-ground land management projects that are being implemented under the Kiwirrkurra Indigenous Protected Area (IPA) Plan for Country for the Kiwirrkurra region, such as actively managing the land through right-way burning, feral animal and weed mitigation, and keeping water places healthy. The Plan for Country also aims to keep knowledge and connections alive, passing on knowledge from elders to younger people, adding to potential mitigation measures by protecting the Aboriginal heritage values in and around the Proposal area.

The Ngururrpa and Tjurabalan Native Title holders have provided letters of support for the Proposal (Appendix K) to ensure ongoing consultation and discussions regarding for the Proposal, while Native Title negotiations are being finalised with Agrimin.

The implementation of measures to mitigate impacts upon Aboriginal Heritage values from the Proposal will not prevent the Proposal from meeting the EPA objectives for Social Surroundings.

10.6.2 Impacts to Amenity

Agrimin has considered the inherent disturbance caused by the construction and operational activities within the On-LDE, Off-LDE and SIDE, including increased emissions of noise, dust, odour, and potential impacts to visual amenity. The nearest sensitive receptor within the vicinity of these Development Envelopes is the Kiwirrkurra Community, located 60 km south-west of the Off-LDE (Figure 10-3). The Kiwirrkurra traditional owners have been consulted regarding the Proposal's design and have provided support for the positive on-going engagement undertaken to-date. It is reasonable to conclude that the distance to this community provides a suitable buffer from any environmental impacts that may occur through the implementation of the Proposal. Agrimin's on-going relationship with the Kiwirrkurra Community will ensure that any complaints received are resolved in an appropriate and timely manner.

The nearest sensitive receptor to the NIDE is Balgo, which is located 2.6 km west of the Proposal area (Figure 10-3). Although unlikely considering the distance from the haul road and limited traffic traversing the area, potential impacts caused by the haul road's construction and operations are considered limited to amenity impacts (not human health) through noise and dust emissions.

The Proposal may result in a reduction in visual amenity of the area from excess salt stockpiles altering the landscape. However, as discussed in Table 10-7, the salt stockpiles will be a maximum height of 7 m (excess salt stockpiles) and 20 m (process salt management area only). Salt stockpiles will remain at closure and passively assimilate into the surrounding landscape over the long-term (Appendix D). The impact to amenity values is considered to be low in terms of visual impact to local communities and impact to tourism is considered to be negligible, as access to the area is restricted by Aboriginal Conservation Reserves.

Through the development of the CEMP, mitigation measures have been identified and will be implemented to reduce the impacts of dust, odour, noise, and visual disturbances caused through construction activities proposed within the Proposal area.

The implementation of measures to mitigate impacts upon Amenity values from the Proposal will not prevent the Proposal from meeting the EPA objectives for Social Surroundings.

10.6.3 Cumulative Impacts

There are no predicted cumulative impacts to aesthetic, Aboriginal heritage or cultural values predicted from the implementation of the Proposal. The Proposal is extremely remotely located with no possibility of cumulative impacts from other proposed development within or surrounding the Proposal area.

10.7 Predicted Outcome

The Proposal has been designed to avoid recorded Aboriginal heritage sites wherever practicable and will utilise the previously disturbed areas wherever possible within the Proposal area, and in particular the NIDE.

Agrimin have undertaken extensive consultation with relevant Traditional Owners for the Proposal area, all of whom are supportive of the development of the Proposal and will benefit from improved infrastructure, increased connectiveness of communities and the generation of valuable long-term opportunities, including employment, for the Native Title groups and Indigenous communities throughout the Central Desert and the broader Kimberley region via employment and regional supply chain.

Agrimin is committed to undertaking further consultation with the relevant Traditional Owners to manage interactions and engagements and ensure the safety, protection, and sustainable cultural management of the landscape and environment within the Proposal area.

Based on the implementation of mitigation measures to limit the impact of the Proposal on social surroundings, the EPA objective for Social Surroundings will be met.

11. Other Environmental Factors

During the assessment of Proposal, other factors may be identified as relevant to the Proposal but are not of significance enough to warrant detailed assessment or the setting of conditions by the EPA or are impacts that can be regulated by other statutory processes to meet the EPA's objectives, outlined in the EPA's *Statement of environmental principles, factors, objectives and aims of EIA* (EPA 2021d). These factors are classed as 'other environmental factors'. The other environmental factors relevant to the Proposal are:

- landforms;
- terrestrial environmental quality;
- air quality; and
- greenhouse gas (GHG) emissions.

This Section describes the consideration of the 'other environmental factors' which are relevant to this Proposal and the existing management to ensure that the Proposal meets the EPA's objectives for these other environmental factors.

Further detail of each of the other environmental factors is provided in Table 11-1 through to Table 11-4.

11.1 Landforms

Table 11-1: Landforms

EPA Objectives	*To maintain the variety and integrity of significant physical landforms so that environmental values are* protected (EPA 2018b).
EPA Policy and Guidance	Key EPA Guidance • Environmental Protection Authority. (EPA 2018b). Environmental Factor Guideline – Landforms. • Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA. • Environmental Protection Authority. (EPA 2021a). Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual Requirements under the *Environmental Protection Act 1986*. Relevant Acts • Environmental Protection Act (EP Act). Application of Policies and Guidance • The Environmental Factor Guideline – Landforms (EPA 2018b) was considered for the Proposal, which are defined as distinctive recognisable features, defined by geology and morphology. Consideration of Inland Waters, Flora and Vegetation, Terrestrial Fauna and Subterranean Fauna as Key Environmental Factors and the assessment of impacts and mitigation measures each is considered adequate to protect environmental values of Lake Mackay.
Receiving Environment	Overview of receiving environment Landforms are a component of the landscape and are defined by the combination of geology (composition) and morphology (form) (EPA 2018b). The EPA considers landforms as distinctive, recognisable physical features of the earth's surface, having a characteristic shape produced by natural processes (EPA 2018b). Lake Mackay has not been determined by the WA EPA to be a significant landform that supports unique environmental values, such as unusual ecosystems, being sites of special scientific interest related to geology and geomorphology, and representing examples of important physical landscape processes, or of important aesthetic or recreational value. Within WA, the proposed disturbance from this Proposal comprises 0.5 % of the extent of salt lakes. The portion of Lake Mackay within the Proposal area comprises 7.6% of the extent of salt lakes by area in WA. Cumulative impacts from all approved salt lake potash projects and this Proposal will result in a disturbance comprising 0.9 % of the total extent of salt lake habitat within WA (Table 7-15, Figure 7-25). This will result in potash projects (based on Proposal area) operating on 9.5 % of salt lakes by area within WA. Lake Mackay Lake Mackay covers an area of approximately 3,513 km^2 and measures approximately 100 km east to west and 100 km north to south (Agrimin 2020). Lake Mackay hydrological cycle is a closed system with no outflow location or known historic evidence of spilling into adjacent basins. The lake lies within the internally draining Mackay Basin with a catchment area covering 87,000 km2 (Groundwater Exploration Services 2017). Lake Mackay and surrounding peripheral wetlands, within a 200 km buffer, are not declared as Ramsar wetlands under the EPBC Act or wetlands of national importance under the DIWA (DotEE 2020). The NT portion of Lake Mackay has been nominated for listing as nationally significant, and possibly internationally significant, by the NT Department of Environment, Parks and Water Security (DEPWS) (Northern Territory Government 2009;2020); however, the DAWE does not consider potential impacts to the site as being a MNES under the category of 'Ramsar wetlands of international importance'. A low-lying primary dune system typically surrounds the Lake and peripheral wetlands. The lake and fringing areas provide a variety of habitats (salt lake playa; saline flats and depressions; lake margin; claypans and claypan mosaic) that are important to conservation significant fauna species including Greater Bilby, Brush-tailed Mulgara, Night Parrot, Australian Painted Snipe, Fork-tailed Swift, Sharp-tailed Sandpiper, Gull-billed Tern, Red-necked Stint, Common Greenshank, Red-necked Stint, Common Sandpiper, Pectoral Sandpiper, Oriental Pratincole, Wood Sandpiper, Marsh Sandpiper. The ephemeral salt lake is subject to partial seasonal inundation in the wet season, typically confined to short time periods (less than 24 hours) following significant rainfall events, commencing in late December, and continuing through to March. Despite inundation being infrequent, during inundation the lake may support a range of waterbird species. There have been no direct observations of waterbirds on waterbodies of the islands. However, a broader literature review indicated that Banded Stilts may breed on the islands of Lake Mackay in substantial numbers (due to providing protection from predators (360 Environmental 2017b; Duguid *et al.* 2015). In addition, several species of significance have been recorded from the lake and its peripheral claypans, including the Australian Painted Snipe. Therefore, it is possible that these species may also utilise the islands and their waterbodies when foraging and/or breeding during major flood events. The riparian zone was typically characterised by a range of samphires (*Tecticornia*), and other salt tolerant chenopods, with most sites dominated by shrubs. Aquatic habitat types were limited and comprised open playa, embayments and the mouth of significant drainage lines. Environmental values of Lake Mackay have been considered in the impact assessment of Inland Waters, Terrestrial Fauna and Flora and Vegetation and Subterranean Fauna Key Environmental Factors. Geomorphology and Topography The primary drivers behind the geomorphological evolution of Australia's arid zone in which the Proposal and more specifically Lake Mackay is situated are long term geological processes and climate change. Climatic setting and hydrologic processes are important factors that contribute to the geomorphology and evaporite mineralogy of salt lake systems. Lake Mackay and the surrounding area contain a diverse range of different landform types. Geomorphological features identified in the On-LDE include strandlines from former high-lake stands, islands of gypsiferous aeolian landforms, playa-fringing dunes and encroaching linear sand dunes. Arid climatic conditions and high evaporation rates have resulted in the concentration mineral salts in the sediment of Lake Mackay. The topography of Lake Mackay and immediate surrounds is subdued and flat. Bed elevations at the lake range from approximately 360 mAHD in the east to 364 mAHD in the west. The northern extent of the Proposal area is characterised by extensive sand plains, salt lakes, clay pans and ridges and hills of the Stansmore Highlands. The dominant feature of the Stansmore Highlands are the residual sandstone ridges of the Stansmore Range, which rise up to 80 m above the surrounding sandplains (Blake and Yeates 1976). The western edge of the Stansmore highland reaches an elevation of 510 m above sea level at its highest peak. The main hill features of the highlands are mesas, buttes and cuestas which are less than 3 0m high and rise to the west (Blake and Yeates 1976). Lake Mackay is characterised by more than 270 islands with highly variable areas and elevations, ranging from less than 100 ha to over 2,000 ha and from 1 m high to more than 13.5 m. The larger islands have the greatest topographical relief. The largest islands occur in the centre and eastern portion of the lake, becoming progressively smaller and less common along the western gradient. Calcrete deposits and/or outcropping occurs to varying degrees throughout the islands, although is more prevalent on the larger landforms. These larger islands also support extensive linear east-west trending sand dunes throughout their interior, which are consistent with the lake margins (Agrimin Ltd 2018). The Islands are characterised into six broad categories: Landform island, Large island, Intermediate island (elevated dunes), Intermediate island (low dunes), Small islands (alluvial); and Small Islands (gypsiferous). Five small islands (~2% of all playa islands) in the central part of the lake were relatively unique in the landscape. These islands are composed of gypsiferous sediment and provide outcropping and crevices which is a microhabitat relatively limited in the region, particularly in the vicinity of Lake Mackay.

	Although Lake Mackay has geology and morphology that is locally important in supporting the sub-regions environmental values, Lake Mackay comprises 7.6% of the extent of salt lakes by area in WA and is not unique or provide restricted habitat for fauna or is distinctive or plays an exclusive role in maintaining existing ecological and physical processes. Furthermore, the landform does not support endemic or highly restricted plants or animals. Geology Nine geological units have been mapped within the Proposal area. The 'Cenozoic regolith 76542' unit is the most widespread of the geological units making up over 90% of the Proposal area and being the most dominant geological units of all Development Envelopes (Figure 3-9). This unit broadly represents surficial or regolith units; poorly consolidated alluvial, colluvial, aeolian, lacustrine; and residual deposits. The geology of Lake Mackay is characterised by lake bed sediments, typically comprising a thin halite crust <5mm on the surface. Across much of the lake surface, the halite crust is underlain by variably decomposed organic material, which can be up to several cm thick and typically occurs at surface (where halite is not present) or within ~5 cm of surface. The remaining lake bed sediments includes a gypsum sand horizon in the upper palaeochannel unit, sandy and silty clay with embedded layers of gypsum, halite and calcite in the middle palaeochannel unit; and sands and gravels with minor silts and clays in the lower palaeochannel unit. As noted above, Lake Mackay is not considered rare in its geological formation and is one of numerous internal lake systems of its type at a national, regional or local level. Land Systems Land systems in the rangelands and arid interior of WA have been mapped by the DPIRD, and provide a comprehensive description of biophysical resources within the area (Tille 2006).The Proposal area intersects 10 Land Systems with none of the Land Systems restricted to the Proposal area. 83.41% of the Proposal area lies within the V12 Land System described as 'Plains studded with salt pans, seasonal lakes, calcrete platforms (lunkar) and fringing dunes'. The On-LDE is predominantly within this land system (Figure 3-8). The other dominant Land Systems within the Proposal area include the My98 and AB56 mapped units. These are the predominant mapped land systems in the NIDE and SIDE respectively.
Potential Impacts	Proposal activities have the potential to impact ecological values of Lake Mackay including long-term altering of the landform, disruption, or loss of ecological and hydrological function of Lake Mackay and potential impact to the values of Lake Mackay, islands, and clay pans. Damage / loss of Landforms • Disturbance of up to 15,000 ha within a 217,261 ha On-LDE for the construction of extraction trenches, and construction of evaporation ponds, access roads and infrastructure corridors, and salt pile storage has the potential to lead to long term alteration of Lake Mackay. The on-lake disturbance will be limited to less than 5% of the total lake's surface therefore minimising the potential impact. With the application of mitigation measures, it is not expected that Lake Mackay will be significantly impacted by Proposal activities. Disruption of ecological/hydrological function of Lake Mackay • Medium to long term alteration of the surface hydrology of Lake Mackay as a result of the construction of up to 2,000 km of infiltration trenches, construction and operation of evaporation ponds, access roads, infrastructure corridors. This may affect aquatic biota emergence and persistence and post-flood use by migratory waterbirds. The On-LDE was not found to support a highly diverse aquatic biota community, with the ranges of two species of scientific interest known to extend beyond the Proposal area. Hydraulic modelling results show that the overall hydrological regime and surface water response of Lake Mackay to precipitation is expected to be similar during Proposal development relative to the baseline condition, with temporarily increased lake levels resulting from individual storm events. Additionally, with the application of mitigation measures the risks of significant impacts to the ecological and hydrological function of Lake Mackay are considered minimal. • Changes in hydraulic connectivity from abstracting 100 GL/per annum of brine causing drawdown in groundwater levels. Potentially impacting water quality, adversely impacting aquatic biota habitat, reduced viability, and abundance of resting stages. Samphire communities surrounding the On-LDE are not considered to be groundwater-dependent vegetation and are unlikely to be impacted through groundwater abstraction. The potential environmental impacts of the Proposal can be managed effectively, and Proposal development is considered unlikely to result in long term (or significant) impacts to hydrological regimes and quality of surface water and groundwater of Lake Mackay. Loss of ecological value of Landforms • Storage of Salt Piles may lead to surface water runoff containing elevated concentrations of salts, which may pose an ecotoxicity risk to aquatic biota and riparian vegetation of the Lake Mackay. • Potential contaminant (i.e. hydrocarbons, chemicals) from leaks and spills, and seepage into sediment and groundwater, posing an ecotoxicity risk to aquatic biota and riparian vegetation of Lake Mackay.
Mitigation	Avoid • Less than 5% of the On-LDE (15,000 ha) will be subject to disturbance, with heritage exclusion in the WA portion of the lake (9.5%, 32,261 ha) and avoidance of island formation (5.9%, 20,119 ha) and the NT section of the lake. • The location and layout of the On-LDE infrastructure has been designed to minimise impacts to the Lake Islands and the lake fringe riparian zone, including avoidance buffers ranging from 100 m to 500 m Minimise • Staged development of trenches via BMUs over a 17-year period, engineering design (1 km spacing trench pattern) and strategic crossover drainage measures will not restrict natural surface water flows and flooding in natural depressions of the lake. Manage • Comply with CHMP. Monitor • Annual ecological monitoring program to progress the understanding the ecological values of the lake and peripheral wetlands within a regional context. • Routine monitoring of groundwater drawdown and mounding impacts to the Lake Islands. • Opportunistic monitoring of surface water extent, depth, quality, and aquatic biota during flood conditions. Rehabilitate • Trench network and associated bunding will be breached on completion of LoM to allow natural flow paths to return to the lake. • Southern evaporation pond embankment will be breached at closure to allow periodic pulsed flows and natural dissipation of salt to the lake.

Predicted Outcomes	Lake Mackay does not provide a unique or significant foundation for a particular ecosystems or habitat critical to the survival for significant species which will be significantly impacted. In considering the EPA's objectives for Landform, the relatively small disturbance area associated with impacts to Lake Mackay (when compared to regional lake surface) are not considered significant enough to impact the environmental values of the lake due to the following rationale: Variety and Rarity • The landform is not a unique or important example of a salt lake system in the local, regional and national setting. Salt lakes are well represented over the local, regional or national scale and does not differ from other examples at these scales. The landform is not rare, being one of numerous salt lake systems at a national, regional or local level. Integrity • Although the landform is intact, largely complete or whole and in good condition, it is one of numerous salt lakes in the surrounding environment of similar condition that provide ecological functions similar to Lake Mackay Ecological Importance • Considering the extent of salt lakes in the region, Lake Mackay does not provide an exclusive role in maintaining existing ecological and physical processes. Scientific Values • Lake Mackay does not provide evidence of past ecological processes or is an important geomorphological or geological site. The landform is of recognised scientific interest as a reference site or an example of where important natural processes are operating. Social Importance • Numerous cultural studies and investigations have been carried out across Lake Mackay and areas of elevated significance have been identified and excluded from the Development Envelope. The exclusion areas have been delineated in consultation with relevant TO groups, ensuring the areas the support heritage values are protected. *Given the above, and the management and mitigation measures proposed, Agrimin is of the view that this Proposal can be manage**d to meet the EPA's objecti**ve for Landforms*

11.2 Terrestrial Environmental Quality

Table 11-2: Terrestrial Environmental Quality

EPA Objectives	*To maintain the quality of land and soils so that environmental values are protected* (EPA 2016e).
EPA Policy and Guidance	Key EPA Guidance • Environmental Protection Authority. (EPA 2016e). Environmental Factor Guideline – Terrestrial Environmental Quality. • Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA. • Environmental Protection Authority. (EPA 2021a). Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual Requirements under the *Environmental Protection Act 1986*. Relevant Acts • *Contaminated Sites Act 2003.* • *Environmental Protection Act (EP Act).* • *Mines Safety and Inspection Act 1994* Key Regulatory Technical Guidance and Policies • Department of Environmental Regulation. (DER 2014a). Assessment and Management of Contaminated Sites: Contaminated Sites Guidelines. • Department of Environmental Regulation. (DER 2015a). Acid Sulphate Soils Guideline Series – Identification and Investigation of Acid Sulphate Soils and Acidic Landscapes. • Department of Environmental Regulation. (DER 2015b). Treatment and Management of Soil and Water in Acid Sulphate Soils Landscape. • Department of Mines and Petroleum. (DMP 2016). Draft Guidance Materials Characterisation Baseline Data Requirements of Mining Proposals. • Australian Radiation Protection and Nuclear Safety Agency (Australian Radiation Protection and Nuclear Safety Agency 2021) • Application of Policies and Guidance • Environmental Factor Guideline – Terrestrial Environmental Quality was considered and identified the information required for conducting an EIA of this factor. For the purpose of EIA, the EPA defines Terrestrial Environmental Quality as 'the chemical, physical, biological, and aesthetic characteristics of soil (EPA 2016e).
Receiving Environment	Land Systems and Soils Land systems in the rangelands and arid interior of WA have been mapped by the DPIRD and provide a comprehensive description of biophysical resources within the area (Tille 2006). The Development Envelopes intersect 10 land systems and lies predominantly within the SV12 land system of plains studded with salt pans, seasonal lakes, calcrete (kunkar) platforms and fringing dunes (Figure 3-8). The On-LDE is predominantly within this land system. Chief soils within the SV12 mapped soil landscape unit as detailed in the Digital Atlas of Australian Soils (Bureau of Rural Sciences 2009) include shallow loam and saline clays, with shallow calcareous loamy soils on calcrete and shallow gravelly sands on the dunes. The other dominant soil landscapes within the Proposal area include the My98 and AB56 mapped units. These are the predominant mapped soil units in the NIDE and SIDE, respectively. Described as: • My98 – neutral red earths and red earthy sands on valley plains, with shallow stony and gravelly sands and sandy loams on the hilltops and shallow gravelly sands on the dunes. • AB56 – red earthy sand on the broad interdune plains and red siliceous sands on the dunes. Soils Landscape Regions and Zones The Proposal area occurs in the Sandy Desert and Lander-Barkly Plains soil landscape regions of WA. The soils of these regions are described as: <u>Sandy Desert Region</u>: sandy soils, with red sandy earths common on sandplains and red deep sands on the dunes. Shallow gravels with deep sandy gravels on lateritic plains and tablelands. Calcareous loamy earths occur on calcrete plains while Salt lake soils are also present (Tille 2006). <u>Lander-Barkly Plains Region</u>: sandplain soils are predominantly red sandy earths, with red deep sands on the dunes. Red loamy earths are also present on sandplains and inter-dune flats. Red sandy earths and Loamy earths are found on the tablelands, along with some shallow gravels. Salt lake soils and Calcareous loamy earths are associated with the salt lakes (Tille 2006). Six soil landscape zones have been mapped within the Proposal area including the Wiso Sandplain Zone, Stansmore Dunefield and Ranges Zone, Redvers Dunefield Zone, Stansmore Zone, Tanami Sandplain Zone, and the Great Sandy Desert Zone (Tille 2006). The Wiso Sandplain Zone is the most dominant soil landscape zone within the Proposal area, with approximately 84% of the Proposal area within this landscape zone, prominently within the On-LDE. Soils are described as "Red sandy earths with some red deep sands, salt lake soils and red loamy earths." (Tille 2006). Approximately 9.01% of the Proposal area is within the Stansmore Dunefield and Ranges Zone, and 5.21% of the Proposal area is within the Redvers Dunefield Zone. The remaining Proposal area is within the: Stansmore Zone, Tanami Sandplain Zone, and the Great Sandy Desert Zone. Soils within these zones are described as follows: • <u>Stansmore Dunefield and Ranges Zone and Stansmore Zone</u> - red sandy earths and red deep sands with red loamy earths and some calcareous loamy earths. • <u>Redvers Dunefield Zone</u> - red sandy earths with red deep sands and some red loamy earths and shallow gravels. • <u>Tanami Sandplain Zone</u> - red deep sands with stony soils and some red sandy earths and loamy earths. • <u>Great Sandy Desert Zone</u> - red deep sands and red sandy earths with some red loamy earths and shallow gravels (Tille 2006).

Soil Landscape Zones with Proposal area

All soil landscape zones are common and widespread throughout the region and no limited to the Proposal area (Figure 11-1).

Soil Landscape Zone	Soil Landscape Zone Total Area (ha)	Proposal area		Indicative Footprint	
		ha	% of Zone	ha	% of Zone
Great Sandy Desert	23,625,000	2,312	0.01	73	0.0003
Redvers Dunefield Zone	535,000	13,724	2.57	241	0.0449
Stansmore Dunefield and Range Zone	3,775,000	23,749	0.63	701	0.0186
Stansmore Zone	1,335,000	1,448	0.11	41	0.0031
Tanami Sandplain Zone	1,402,500	150	0.01	3	0.0002
Wiso Sandplain Zone	1,670,000	222,156	13.30	13,700	0.8204

Environmental Values

Lake sediment contains the propagules of aquatic biota, and peripheral soils contain the seed bank for flora and vegetation.

Acid Sulphate Soils and Metals

The Australian National Acid Sulfate Soil Risk Map (online map) (ASRIS 2020) indicates that:

- Lake Mackay sediment have a high probability/low confidence of the presence of potential ASS;
- the soils within the Off-LDE and SIDE have a high probability/very low confidence of the presence of ASS; and
- the soils within the NIDE have a high probability/very low confidence of the presence of ASS in some parts and extremely low probability/very low confidence of ASS

Lake Mackay is a hypersaline lake; ASS has the potential to develop in hypersaline lakes where the degradation of organic material and abundant sulphate in groundwater becomes reduced in anoxic environments to form sulphide minerals, ranging from acidic monosulphide muds (organic layer, black in colour) to pyrite (360 Environmental 2018b). A preliminary ASS investigation was undertaken (Appendix L) to provide preliminary characterisation of the acid generating potential and neutralising capacity of some near surface sediment on Lake Mackay that will be disturbed by the Proposal. Sediment samples were opportunistically collected during the trenching program from 14 trenches and one pilot pond to a maximum depth of 10 mbgs.

Based on soil field pH results (obtained from 119 samples), there were no pH_F values indicative of actual ASS and there were no pH_{FOX} values indicative of PASS from any of the soil samples tested. Findings of the laboratory results indicated there were no occurrences of AASS and two occurrences of PASS with two black organic layer samples collected from the southern edge of Lake Mackay (360 Environmental 2018b). The two samples that indicated PASS slightly exceeded assessment criteria for chromium reducible sulphur. Black organic sediment layers were encountered from 0-0.05 mbgs at most trench locations, often overlain by a surficial salt crust or a thin layer of light brown sand. The remaining nine organic layer samples (black in colour) collected from the central sections of the lake recorded pH changes below the criteria, and no other criteria was exceeded. Overall the black organic layers lithology in the central sections of the lake is determined to be non-ASS (360 Environmental 2018b). All remaining lithologies encountered are considered to have a low risk of acid generation due to the absence of sulphides and the inherently elevated ANC (360 Environmental 2018b).

Heavy metals analysis was undertaken for the sediment samples during the Preliminary ASS Investigation, results indicated that concentrations of all heavy metals tested for all lithology types were below the relevant EILs (Urban Residential / Public Open Space) (Government of Australia 2013). High concentrations of aluminium (Al) and iron (Fe) were detected in on-lake soil/sediment within the sandy clay red/brown, clay-red/brown and clay green lithology types (from 0.05 mbgs onwards). There is potential for Al and Fe to mobilise into the groundwater from these units under acidic conditions; however, the risk is considered low (360 Environmental 2018b).

Uranium and Thorium in soils/sediment

Sediment samples, two waste salts and one potash product sample were analysed for uranium (U) and thorium (Th) as part of the Preliminary ASS Investigation. Additionally, U and Th analyses were previously undertaken for on-lake and off-lake samples under the direction of Toro Energy / Rum Jungle Resources Limited while exploring for Uranium at Lake MacKay. Off-lake samples were not collected from within any of the land-based Development Envelopes (NIDE, Off-LDE, SIDE); however, the findings are representative of a broader regional setting. A review of all laboratory results was undertaken 360 Environmental (2018b) and the findings are presented in Appendix L (360 Environmental 2018d).

All uranium and thorium concentrations in the on-lake soil/sediment, waste salt (halite and epsomite), potash products and intermediate waste salt (kainite) were below the relevant assessment criteria (both terrestrial ecology parkland and industrial for protection of human health and the environment). All on-lake soil/sediment, the potash product, waste salt (halite and epsomite) and intermediate waste salt (kainite) sample results were significantly below the Exemption Levels for nuclide specific activity concentrations, suggesting that on-lake sediment/soil samples are not defined as 'radioactive' in a regulatory context (360 Environmental 2018b). Heavy metal concentrations (aluminium, arsenic, barium, beryllium, cadmium, total chromium, cobalt, copper, iron, lead, mercury, molybdenum, nickel, selenium, strontium, and zinc) in the on-lake soil/sediment, waste salt, potash products and intermediate waste salt were also reported below the adopted EILs and human health investigation levels (HILs – industrial/commercial) (360 Environmental 2018b).

The majority of the uranium and thorium concentrations for off-lake samples were below both the parkland human health and terrestrial ecology criteria. No off-lake samples for uranium exceeded the industrial criteria. Only the insoluble forms of thorium extracted under acid digest exceeded the assessment criteria. A comparison of the thorium concentrations using three analytical methods indicates that the majority of the thorium is in an insoluble form and, therefore, poses a lower risk to human health and the receiving ecological environment under natural conditions. Only 0.66% of thorium concentrations for off-lake samples exceeded the industrial assessment criteria using the A/MS method and no samples exceeded the criteria using the other methods indicating that thorium concentrations pose a low risk to human health for industrial use. No thorium concentrations for off-lake samples exceeded the terrestrial ecology protection – parkland.

The uranium and thorium off lake soil results were also converted to radionuclides and compared to the Exemption Levels (Australian Radiation Protection and Nuclear Safety Agency 2021). All of the off-lake soil specific activity concentrations for each nuclide in the U-238 and U-234 series were below the Exemption Levels, all the thorium concentrations (converted to radionuclides) in the undigested (analytical methods B/MS and TL8/MS) off-lake samples This suggests that off-lake soil in their natural state are not defined as 'radioactive' in a regulatory context (360 Environmental 2018b). The thorium concentrations of the off-lake samples using the A/MS analytical method were converted to specific activity concentrations for each nuclide in the Th-232 series. Based on the conversions, only 4.9 % of the specific activity concentrations exceeded the Exemption Levels. These samples were located at least 20 km to the south east of the proposed SOP processing plant and will not be disturbed by Proposal activities. The concentrations represent natural background levels (360 Environmental 2018b).

There are no potential radiation impacts from the Proposal will be presented from exposure to uranium and thorium within the on-lake soil/sediment and SOP product as laboratory analysis confirmed concentration detected in the samples analysed were below the relevant assessment criteria for protection of human health and the environment.

	Sediment Quality An assessment of surficial sediment quality at Lake Mackay and peripheral wetlands by (Stantec 2021a) (Appendix J) indicate neutral to moderately alkaline pH (6.6 to 8.1) (Hazelton and Murphy 2007). Sodium and chloride are the dominant ions contributing to elevated salinities in the sediment of Lake Mackay and peripheral w etlands, ranging from 74,800 mg/kg to 302,000 mg/kg. There was a high degree of salinity variability, within and between Lake Mackay and peripheral wetlands, likely a result of localised geology influencing sediment composition (Chakrapani 2002), (Gorham 1961) and naturally occurring salt crust, up to 3cm thick in the north-east portion of the lake. Concentrations of total nitrogen (TN) and total phosphorus (TP) have been variable in the sediment of Lake Mackay and the peripheral wetlands. Total nitrogen ranged from 80 mg/kg to 1,380 mg/kg, and total phosphorus ranging from 42 mg/kg to 223 mg/kg (Stantec 2021a) (Appendix J). Higher nutrient levels recorded in peripheral wetlands, compared to Lake Mackay may reflect local riparian vegetation inputs having a stronger influence on nutrient dynamics (Williams *et al.* 1990). The data also indicated that Lake Mackay and peripheral wetland soils and sediment are not geochemically enriched in heavy metals and/or metalloids. All metals and metalloids in sediment were below the ANZG DGVs (Water Quality Australia 2018) for sediment quality. In addition, cadmium and mercury levels in sediment were below respective limit of reporting at all sit es (Appendix J). Salt Piles The evaporation ponds are anticipated to accumulate approximately 6 Mt of waste salt per year of operation, totalling 240 Mt of salt over the 20-year LoM. At closure, it is anticipated salt piles will reach a nominal height of 20 m and occupy an area of approximately 900 ha in the western portion of Lake Mackay. As detailed above, n o reactive wastes are expected to be generated during Proposal, the waste salts include halite (NaCl), thenardite ($Na^{2}SO_4$) and epsomite ($MgSO_4 \cdot 7H_2O$). A salt balance model was developed in order to qualitatively assess potential impacts of runoff and/or outflow from the evaporation ponds and salt piles onto the lake surface and overall salt load for the system. Relative to the natural inflows resulting from rainfall events, the brine from the waste salt ponds is substantially more saline; however, relative to the existing natural salt content of the lake, the proposed additional salt load is not significant. The proposed addition of salts over a temporary period is not expected to alter the salt balance of Lake Mackay significantly. However, residual salt loads may remain in the lake over time in localised areas behind bunds until mobilised by infrequent flood events. Contaminated Sites The DWER Contaminated Sites Database records information on sites classified as: contaminated – remediation required, contaminated – restricted use and remediate for restricted use. No contaminated sites appear in proximity to the Proposal on the publicly available contained sites data from DWER.
Potential Impacts	Potential impacts to Terrestrial Environmental Quality from construction and operation of the Proposal include: • Erosion and scouring, reducing soil quality - topsoil stripping and earthwork activities including clearing of up to 1,500 ha of native vegetation for establishment of infrastructure and disturbance of the Lake Mackay sediment for construction of up to 2,000 km of extraction trenches has the potential to alter the structure of the soils and sediment leading to increase erosion. This can affect native vegetation seed banks and lead to genera loss of soil health. Similarly, erosion and scouring may also occur following heavy rainfall events, where concentrated water flows from disturbed areas and hardstand areas. This risk of substantial erosion is considered minimal given that there will be minimal disturbance of surface soils for construction of the plant and other infrastructure within the Off-LDE and SIDE. With the application of mitigation measures detailed within this table. The risks of substantial serious and erosio n and scouring are considered minimal. • Increase salinity of soils – from dust suppression activities using brackish to saline water, from pipeline leaks or failures from borefield and process water transfer pipelines, from potential improper design of Evaporation Ponds and Salt Piles resulting in seepage of brine or overtopping /embankment failure during extreme weather events. Impacts of increased soil salinities arising from Proposal activities would be localised and easily remediated. Additionally, mitigation measures that will be applied will reduce the likelihood that such impacts will occur, therefore impacts are expected to be low. • Soil / sediment contamination / degradation of soil quality – from leaks and spills during SOP Processing Plant operations. from leaks and spills during transport, storage and dispensing of hydrocarbon fuels and from the release of waste products for Landfill operations and Waste Water Treatment Plant) (WWTP) operations. The Proposal will require the use of hydrocarbon such as diesel, oils, AvGas and other reagents and chemicals. Inappropriate management of these has the potential to result in spills and leaks which may result in soil/sediment contamination. Th e risks of substantial contamination arising from spillage and loss of containment of fuels, reagents and chemicals is considered low with the application of mitigation measures. Waste generated for the Proposal is consistent with typical construction and mining operations. The risk of contamination to soil / sediment as a result of seepage from landfill and/or the WWTP is low. • Soil / sediment acidification – from disturbance/excavation of PASS identified on the On-LDE, resulting in the oxidation of sulphides and the generation of acidity leading to soil/sediment and potential groundwater contamination. Potential for disturbance of PASS during on-lake disturbance is not considered likely to cause a significant acidification of soil /sediment as only a discreet location of PASS was detected and all remaining lithologies encountered are considered to have a low risk of acid generation du e to the absence of sulphides and the inherently elevated ANC. With the application of mitigation measures, impacts relating to acidification of soil in other Development Envelopes are considered low. Potential indirect impacts to Terrestrial Environmental Quality from construction and operation of the Proposal include • Loss of soil due to impacts on periphery flora and vegetation - from changes in hydraulic connectivity from abstraction of up to 100 GL of brine per annum, causing groundwater drawdown and reduced sediment/soil stability and moisture. This is not considered to pose a significant risk to the soil structure and quality, groundwater drawdown impacts are likely to be localised within the vicinity of the trenches. • Insufficient growth medium for rehabilitation - from damage or loss of topsoil during stripping and stockpiling. With mitigation measures and closure planning prior to Proposal commencement, the risk is considered low.
Mitigation	Avoid • Less than 5% of the On-LDE and less than 2% of the Off-LDE will be subject to disturbance. • Trenches and evaporation ponds will be located on the open playa of the lake, avoiding vegetation clearing and soil disturban ce, and salinisation of the terrestrial environment, where possible. • Flood prone areas will be avoided with the design and location of the haul road and Off-LDE infrastructure. Minimise • Where possible existing cleared areas will be utilised to minimise vegetation clearing and disturbance of so ils. • Vegetation clearing, and disturbance will also be minimised for the Proposal, with the use of the existing track from the Kiwirrkurra Community as another access road during construction and operation. • Topsoil stripping will be undertaken in stages in a controlled manner and during daylight hours. • Plant areas have been modelled on levelled and battered pads that will be built up above the natural surface using borrowed fill and minimising excavation and cut required. • Vehicle movement will be confined to defined roads and tracks which will be properly formed and compacted with appropriate drainage.

	• A staged trenching design will be investigated to minimise impacts to the lake sediment. • Buffer zone will be established and maintained between on-lake infrastructure and the riparian zone. • The location and layout of the On-LDE infrastructure has been designed to minimise impacts to the Lake Islands and the lake fringe riparian zone, including avoidance buffers ranging from 100 m to 500 m. • Suitable engineering and drainage built into designs to maintain surface water movement patterns and prevent erosion and sedimentation where possible. • Residual salt crust to assist in retention of sediment/soil moisture limiting sediment/soil mobilisation. • Pipelines to be installed in earthen bunded culverts to prevent spills from discharging into the surrounding environment. • Liners on the upstream face of all Evaporation Pond embankments to prevent structural failure. • Refuelling facilities will be constructed with concrete lined pads to contain any drips and spills. The pads will drain to a sump to allow removal of collected material. Manage • Comply with CEMP and FVEMP. • Develop a Ground Disturbance Permit System and Procedure • Develop a Topsoil Stripping and Storage Procedure. • Development of an ASSMP in accordance with DWER guidelines prior to disturbance to manage any identified AASS / PASS. • Where required, additional ASS Investigations will be conducted to identify PASS/ASS in problematic substrates and neutralising material kept on site to respond to acid generating materials encountered during construction. • Development and implementation of sediment analysis and assessment of aquatic biota propagules as part of the ecological monitoring program for the lake and peripheral habitat as required. • Develop a HSMP and Procedure • Develop a Refuelling Procedures of on-lake vehicles, plant and equipment • Develop an Emergency Response Plan and Spill Response Plan • Develop a Controlled Waste Management Procedure • Bioremediation facility for the treatment of contaminated fill, soils, or sediment • Management of sites as per the *Contaminated Site Act 2003* • Develop a Contaminated Sites Register • Develop an Incident Reporting Procedure • Offshoot drains used within the haul road design for management of surface water flows. • Evaporation pond design to allow sufficient freeboard during operation to prevent overtopping during extreme weather events. • Site drainage works designed, constructed, and monitored to prevent scouring associated with concentrated surface flows. • WWTP and irrigation infrastructure to be operated and maintained in accordance with O&M Manual. • Landfill, bioremediation facility and WWTP to be managed in accordance with any EP Act Part V licences. Monitor • Topsoil stockpiles will be monitored for erosion and mitigation measures implemented as required to prevent erosion. • Pre and post wet season erosion and deposition observations. • Routine monitoring of groundwater drawdown / groundwater levels. Rehabilitate • The MCP will detail closure objectives for all disturbance areas, where possible all domains will be rehabilitated to maximise ecological value and minimise expose areas that may generate wind borne dust. • Areas will be progressively rehabilitated as they become available in accordance with the closure plan. • If required, contaminated site rehabilitation in accordance with closure criteria.
Predicted Outcomes	With the implementation of the mitigation measures all direct and indirect impacts can be managed so that adverse impacts to Terrestrial Environmental Quality can be minimised and there are negligible residual impact because of the Proposal. The lake and peripheral habitat are well-distributed, with biological diversity and ecological integrity to be maintained where possible. As such, it meets the objective for this factor such that the environmental values associated with the quality of land and soils are maintained. *Given the above, and the management and mitigation measures proposed, Agrimin is of the view that this Proposal can be manage**d to meet the EPA's objective for** Terrestrial Environmental Quality.*

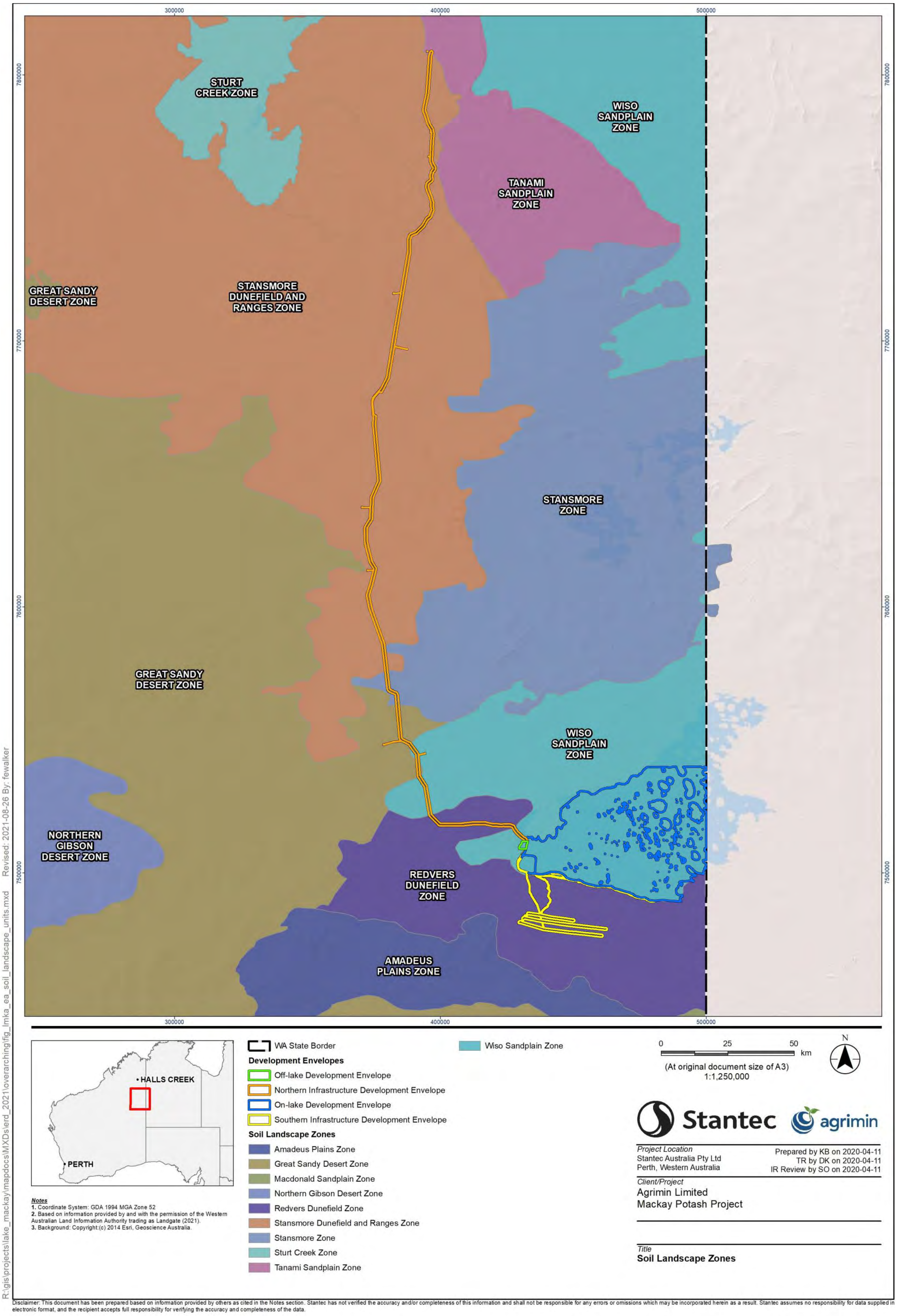


Figure 11-1: Soil landscape zones

11.3 Air Quality

Table 11-3: Air Quality

EPA Objectives	*To maintain air quality and minimise emissions so that environmental values are protected* (EPA 2016a).
EPA Policy and Guidance	Key EPA Guidance • Environmental Protection Authority. (EPA 2016a). Environmental Factor Guideline – Air Quality. • Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA. • Environmental Protection Authority. (EPA 2021a). Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual Requirements under the *Environmental Protection Act 1986*. Relevant Acts and Regulations • *Environmental Protection Act* (EP Act). Key Technical Guidance and Policies • Government of Australia. (Government of Australia 2013). National Environment Protection (Ambient Air Quality) Measure (NEPM). • World Health Organisation. (World Health Organization 2021). Air Quality Guidelines and Criteria. • Application of Policies and Guidance • Environmental Factor Guideline – Air Quality was considered, and details contained within this table identifies the information required for conducting an EIA of this factor.
Receiving Environment	Sensitive Receptors The Proposal is located within the Great Sandy Desert of Central Australia, with no immediate land users. The nearest communities include the Kiwirrkurra Community, located approximately 60 km to the southwest of the Proposal and Balgo located approximately 2.6 km west of the northern edge of the NIDE. There are two, small Aboriginal communities located approximately 45 km from the NIDE, the Bililuna and Mulan communities. The nearest public road is the Tanami Road to the north, which is currently an unsealed road that meets the northern tip of the NIDE. Local land uses are predominantly conservation and natural environment for traditional Indigenous uses, however, two pastoral stations, the Billiluna Station and the Lake Gregory Station lie within 6 km of the Proposal area. Environmental values of the receiving environment that may be impacted may include amenity, natural, cultural and heritage values. Climate and Wind Distribution Walungurru Airport (Kintore) is the closest active weather station to the On-LDE, Off-LDE and SIDE, located approximately 80 km southeast of Lake Mackay's southeast extremity and approximately 136 km from the Off-LDE on the western edge of the lake. Wind data from the Walungurru Airport weather station from 2018 indicates the 9am wind direction is predominantly from the east-northeast; the wind direction was between northeast and southeast for 77% of the 9am data points recorded during the year. The 3pm wind direction is highly variable, with northerly and easterly wind directions being recorded for 10% of the 3pm data points (Stantec 2020). Wind rose from the Giles weather station (013017) in Ngaanyatjarra-Giles, located approximately 274 km to the south of the Proposal area, shows prevailing easterly to south easterly winds present in the general area (9am annual) and the 3pm annual shows winds prevailing from the north and east, south-east (Figure 3-7) (BoM 2021d). Background Ambient Air Quality There are no DWER air quality monitoring stations and no publicly available data on background air quality in proximity to the Proposal. Background dust concentrations are most likely to be influenced by natural sources such as bushfires or wind erosion from the regional area. There has been no meteorological or air quality monitoring undertaken at the Proposal. Background levels of other pollutants in the Lake Mackay airshed are not likely to be of any significance given the nearest industry to the Proposal include Newmont's Tanami Gold Operations in the Northern Territory, located 300 km north-east of the Proposal area and Cummins Range Rare Earth Mine, with a separation distance over 380 km to the north of the Proposal (from the On-LDE).
Potential Impacts	Reduced ambient air quality from dust emissions Construction and fugitive operational dust emissions or airborne particulates from Proposal activities have the potential to lead to deterioration of air quality. Activities that can lead to generation of dust include: • <u>Vegetation clearing and earthwork</u>s – Clearing of 1,500 ha of native vegetation and earthwork activities for construction of the Proposal will expose bare topsoil to wind erosion generating localised dust emissions. There are no existing land uses or residential dwellings in the vicinity of the Proposal that are likely to be affected by temporary localised dust emissions. The nearest sensitive receptor is Balgo, located 2.6 km west of the northern edge of the NIDE. • <u>Processing Plant operations and SOP Loadout</u> – Potential dust emissions and discharge of SOP particulate emissions from processing and loadout activities may reduce localised ambient air quality. There are no existing land uses or residential dwellings in the vicinity of the Proposal that are likely to be affected by this. The nearest sensitive receptor to the Processing area is the Kiwirrkurra Community located approximately 60 km to the southwest of the Proposal area. • <u>Product haulage</u> - Product haulage along the haul road within the NIDE may also generate dust emissions from unsealed road surfaces, presenting a potential impact to the nearest local community, Balgo. The distance to Balgo is approximately 2.6 km west of the northern edge of the NIDE, therefore potential impact of reduced ambient air quality is expected to be minimal given the separation distance. • <u>Erosion of the Evaporation Ponds and Salt Pile surface</u> - Air quality deterioration may also arise from dust deposition associated with erosion of the evaporation pond surfaces, embankments and Salt Piles. This is not likely to present a significant impact to sensitive receptors given the separation distance to land users. Reduced ambient air quality from pollutant emissions Construction and fugitive operational pollutant emissions from Proposal activities have the potential to lead to deterioration of air quality. Activities that can lead to generation of pollutants include: • <u>Vehicle and machinery movement</u> - combustion of diesel for the operation of vehicles, haul trucks, stationary equipment and machinery for construction and operation of the Proposal will result in generation of particulate matter and gaseous compounds such as oxides of carbon and nitrogen, SO_2, and other volatile organic compounds (VOCs) (DMP 2013) from the combustion process

	• ERT Training exercises – fire training exercises may lead to short term, localised impacts to the Lake Mackay airshed from release of carbon dioxide, carbon monoxide, methane and other GHG emissions. There are no existing land uses or residential dwellings in the vicinity of the Proposal that are likely to be significantly impacted given the nearest sensitive receptor to the Processing area is the Kiwirrkurra Community located approximately 60 km to the southwest of the Proposal area; and the air emissions from fire training exercise are not considered to represent a significant source of emissions. • Power Generation - generation of electricity from the LNG fired power plant for power generation will result in the generation of GHG emissions. GHG emissions are further discussed and the impacts are assessed in Table 11-4. Decreased health of vegetation from dust emissions Deposition of airborne particulate matter can lead to indirect impacts surrounding flora and vegetation and consequently potential fauna habitat. Dust may interfere with physiological processes of flora and vegetation. Reduction to flora and vegetation health can result in in degradation of fauna habitat and fragmentation of foraging areas. This is not considered to pose a significant risk to the flora species and fauna habitats identified in the Proposal area.
Mitigation	Avoid • 30% of the haul road will be constructed on the existing cleared track reducing total clearing • Haul road will be sealed in the early stages of the Proposal, limiting dust emissions that would otherwise be likely from an unsealed haul road • Dust collection system will be installed in the dry component of the Processing Plant designed to meet exposure standards of the *Mines Safety and Inspection Regulation 1995*. • Runway strip will be sealed to avoid dust emissions from aircraft taking off and landing. Minimise • Where possible existing cleared areas will be utilised to minimise vegetation clearing. • Vegetation clearing, and disturbance will also be minimised for the Proposal, with the use of the existing track from the Kiwirrkurra Community as another access road during construction and operation. • Vegetation clearing will be staged where possible and construction will be staged where possible to reduce the open areas exposed to wind erosion. • Daily wind conditions will be taking into consideration when clearing activities are proposed. • Use of dust suppression (water carts) during clearing and other activities as conditions require to minimise dust (dry and windy conditions). • Clearing for the haulage corridor pavement width has been reduced from 7.5 m to 6.5 m, reducing the exposed area able to generate dust emissions. • Initially a two-coat spray seal will be applied to the haul road and Agrimin is further investigating options of permanently sealing the haul road, thus minimising dust emissions. • Vehicle movement will be confined to defined roads and tracks which will be properly formed and compacted with appropriate drainage. • Access roads will be subject to speed restrictions to minimise generation of dust. • Water supply pipelines will be placed within existing and planned access road corridors wherever possible to minimise land clearing. • All construction and maintenance equipment/vehicles to be operated and maintained in accordance with Operating and Maintenance manuals and manufacturers' specifications to minimise exhaust emissions. • Engagement of Traditional Owners for understanding local fire regimes and fire management practices • Dedicated ERT fire training area to consider distances to nearest receptors. Manage • Comply with CEMP. • Comply with FVEMP. • Develop a Ground Disturbance Permit System and Procedure to ensure vegetation clearing is minimised and controlled. • Implement the Balgo Community Dust Management Plan • Prevailing winds and local daily fire warnings to be considered prior to Emergency Response Team (ERT) fire training exercises. Monitor • Visual monitoring for dust / particulate matter will be undertaken during clearing and construction activities as required • Regular inspections of fire suppression systems in accordance with relevant AS/NZ Standards. • Maintain a community complaints records and implement a complaints resolution procedure. Rehabilitate The closure plan will detail closure objectives for all disturbance areas, where possible all domains will be rehabilitated to maximise ecological value and minimise expose areas that may generate wind borne dust.
Predicted Outcomes	Agrimin is aware of Balgo being located approximately 2.6 km west of the northern section of the NIDE. Agrimin's view has been that the temporary, localised and short construction timeframes within each Haul Road segment, and sufficient distances from the communities and outstation, provides adequate justification to consider the impacts from dust emissions to be negligible. To inform their impact predictions further, Agrimin has undertaken a site risk assessment for fugitive dust emissions in accordance with the Department of Environment and Conservation (2011) document, *A guideline for managing the impacts of dust and associated contaminates from land development sites, contaminated sites remediation and other related activities.* The assessment of dust emissions and management approaches detailed in these guidelines are applicable to the dust management requirements of the Proposal as it involves earth works, bulk handling, trucking and stockpiling of materials. In accordance with applying the risk assessment specified in the guidelines, a low site classification score has indicated that there is negligible risk to impacting Balgo. In accordance with guidelines the requirement for dust management provisions, including monitoring and modelling are not considered warranted. However, to ensure the risks are avoided and minimised

[redacted]	effectively, Agrimin propose implementing specific management measures for fugitive dust emissions while constructing segments of the Haul Road that traverse in proximity to Balgo. As the construction of the Haul Road moves north towards Balgo, the site manager will undertake the following key measures, which are further detailed below: • Inform the Community that construction is due to commence and the timeframes for completion • Provide key contact details to the Community and maintain a complaint register • Implement dust management measures as detailed in the CEMP The additional management measures have been informed through the application of the risk assessment detailed in the Department of Environment and Conservation (2011) guidelines - *A guideline for managing the impacts of dust and associated contaminates from land development sites, contaminated sites remediation and other related activities*. The current unsealed road between Balgo and the Kiwirrkurra community is likely to generate dust from vehicles regularly utilising the road. Construction of the haul road for the Proposal is likely to lead to a positive outcome for the community and reduce overall dust emissions once it is operational. *Based on the above and the mitigation measures taken to minimise impacts to air quality, the Proposal is not expected to result in significant detrimental effect to air quality, therefore the environments factors of Air Quality can be met.*

11.4 Greenhouse Gas Emissions

Table 11-4: Greenhouse Gas Emissions

EPA Objectives	*To reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change (EPA 2020a).*
EPA Policy and Guidance	Key EPA Guidance • Environmental Protection Authority. (EPA 2020a). Environmental Factor Guideline – Greenhouse Gas Emissions. • Environmental Protection Authority. (EPA 2021d). Statement of environmental principles, factors, objectives and aims of EIA. • Environmental Protection Authority. (EPA 2021a). Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual Requirements under the *Environmental Protection Act 1986*. Relevant Acts and Regulations • Environmental Protection Act 1986 (EP Act) • National Greenhouse and Energy Reporting Act 2007 (NGER Act) (Cwlth) Key Technical Guidance and Policies • Greenhouse and Energy Reporting (Measurement) Determination 2008 (Cwlth). • National Greenhouse and Energy Reporting (Safeguard Mechanism) (Department of Industry Science and Energy Resources 2020b) (Cwlth). • United Nations Framework Convention on Climate Change (UNFCCC) Reporting Guidelines on Annual Inventories (Department of Industry Science and Energy Resources 2020a). • Application of Policies and Guidance • Environmental Factor Guideline – Greenhouse Gas Emissions was considered and this table and the Greenhouse Gas Assessment Memo included as Appendix L identifies the information required for conducting an EIA of this factor, including estimations of Scope 1, Scope 2 and Scope 3 GHG emissions over the LoM, breakdown of GHG emissions by source and projected emissions intensity for the Proposal and benchmarking against comparable projects.
Receiving Environment	Existing GHG's in the atmosphere that are affected directly by anthropogenic sources include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone, synthetic gases. Water vapour is also considered a GHG although is not directly influenced by humans. These gases absorb and re-radiate heat emitted for the earth surface. Vegetated areas assist in absorbing carbon in the atmosphere helping to reduce the levels of GHG's, also known as a carbon sink. The Commonwealth National Greenhouse and Energy Reporting (NGER) Scheme operates under the NGER Act and provides a framework for national greenhouse gas and energy reporting requirements. The GHG emissions that are reported under the NGER Scheme include .CO_2., .CH_4, N_2O, sulphur hexafluoride (SF_6) and specific kinds of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). CO_2-e emissions, is a standard unit for measuring carbon footprint, used to express the impact of each GHG in terms of the amount of CO_2 that would create the same degree of global warming potential. Australia's total GHG emissions were 537.4 million tonnes (Mt) of CO_2-e emissions in 2018 (Department of Industry Science and Energy Resources 2020a), with WA's GHG emissions for 2018 contributing to 91.5 Mt (Department of Industry Science and Energy Resources 2020a). Scope 1 and Scope 2 GHG emissions, reductions, removals, offsets, energy consumption and production are required to be reported under the NGER Act. The Scopes are defined as: Scope 1: GHG emissions are the emissions released to the atmosphere as a direct result of an activity, or a series of activities at a facility level. These may include: • Emissions from gas consumption from power station and SOP Processing plant; and • Emissions from diesel consumption from vehicles, mobile equipment, trench pumps, bore pumps). Scope 2: Indirect emissions form the generation of purchased electricity from a utility provider. Scope 3: Scope 3 emissions are indirect GHG emissions other than Scope 2 emissions that are produced through a wider contribution, from sources that are not owned or controlled by Agrimin and are outside of Agrimin's operational control. Scope 3 emissions include emissions from the construction phase of the Proposal and upstream emissions associated with transportation of fuel and supplies and emissions associated with air transport to site. Scope 3 emissions also include emissions are not required to be reported under the NGER Scheme.
Potential Impacts	Proposal activities have the potential to increase air pollution contributing increased GHG emissions. There is also potential to reduce air quality, causing impacts to sensitive social receptors. This is further discussed in the 'Other Environmental Factor – Air Quality' Table 11-3. Given the distance to the nearest receptors and remote location of the Proposal air emissions from the Proposal are not considered to pose a significant impact to air quality, human health, or amenity. Contribution to GHG Emissions An estimate of GHG emission projections for the Proposal was undertaken by Stantec and Space Design (Appendix M). A total of 73,923 tCO_2-e emissions/yr are expected to be generated from Proposal activities during Scope 1, from year 2 to year 20 (the LoM). The peak emissions will occur during year 1 of the Proposal (95,401 tCO_2-e emissions) prior to renewable sources coming online and from initial vegetation clearing required. Comparison of this to the 91.5 Mt CO_2-e emissions for GHG emissions for 2018 (Department of Industry Science and Energy Resources 2020b), indicates less than that the Proposal will contribute less than 0.2 % of the WA emissions levels (based on 2018 emissions). Scope 1 emissions will be generated via the following: • Combustion of fossil fuels to generate electricity - Generation of electricity from the LNG-fired power plant for power generation and operation of the processing plant. Total electrical power demand for the Proposal is 139,504 MWH/yr. During the first year of production, the LNG power plant will supply 102,641 MWh (73.6%) of electrical power. It is noted that the power plants will operate under Build-Own-Operate contracts with Agrimin having no operational control; however. as per EPA GHG guidelines (EPA 2020a) GHG emissions from this source have still been included within Scope 1 as they are emissions released to the atmosphere as a direct result of an activity, or a series of activities at a facility level. Approximately 50,712 tCO_2-e emissions and 29,233 tCO_2-e emissions/yr will occur during Year 1 and for the rest of the LoM, respectively. • Combustion of fossil fuels to generate heat and electricity - The processing plant, the boiler and dryer are expected to use approximately 7,639 kL/yr of LNG, accounting for 9,959 tCO_2-e emissions/yr. • Combustion of fossil fuels (diesel combustion) - The use of diesel fuel in mobile and stationary fleet will require approximately, 5,911kL of diesel fuel accounting to 183 tCO_2-e emissions/yr, and 67.2 kL of diesel fuel is expected to be required for light vehicles, accounting to 183 tCO_2-e emissions/yr. • Product haulage to Wyndham Port will be undertaken by triple road trains with 122 tonnes capacity requiring 6,813 kL of diesel, these emissions account to 18,531 tCO_2-e emissions/yr.

	• Further detail estimates for the Scope 1 Emissions are provided in the Greenhouse Gas Assessment Memo (Appendix M)). As Agrimin will produce their own electricity there will not be any Scope 2 emissions associated with the Proposal. Scope 2 emissions are defined by EPA GHG guidelines (EPA 2020a) as the emissions from the consumption of an energy product. The Proposal will also have an indirect impact from atmospheric Scope 3 GHG emissions that occur due to Proposal activities but from sources not owned or controlled by Agrimin. This will contribute 11,374 tCO_2-e emissions during the construction of the Proposal, 5,931 tCO_2-e emissions in year 1 of operations and 5,302 tCO_2-e emissions from year 2 to year 20. Sources of Scope 3 emissions include: • Clearing of native vegetation (reducing the carbon sink) - Clearing of no more than 1,500 ha of native vegetation for construction of the Proposal, vegetation consists of desert spinifex and spare scrubland. This will result in the loss of approximately 3.69 tonnes of carbon sink per ha/yr. • Combustion of fossil fuels (diesel combustion) - The use of diesel fuel in stationary and mobile equipment, light and heavy vehicles during construction • Combustion of fossil fuels (diesel combustion) - Upstream transport of fuel and supply • Combustion of fossil fuels (AvGas) - Air travel for the LoM (including construction)
Mitigation	Agrimin have focussed on avoidance and minimisation of potential impacts of GHG through favouring sustainable design during o ptions analysis. Avoid • Incorporation of a hybrid power station, relying on natural gas fired power generation coupled with a solar Photo voltaic (PV) system to provide the preferential alternative source of power. The solar PV system will have the capacity to generate 14 MW that can yield 62.5 MWh per day. At its completion the solar PV system will supply 26.4% of the power requirements for the Proposal. • Incorporate 5x 4.5 MW wind turbines for future sources of power, with a 13.5 MW generation capacity. At its completion the wind turbines will provide 31.2% of the Proposal power supply • In total it is expected that 84% of the power supply will be from renewable energy generation. • The gas-fired power station provides the co-benefit of heating the water required in the processing plant, reducing the overall power demand of the Proposal, and has driven the use of gas over diesel or using 100% renewable power generation. Minimise • Agrimin and (haulage partner) New Haul have selected a triple road train configuration rather than standard quad road train for pr oduct haulage, which will reduce fuel consumption by 3-5%, reducing potential GHG emissions. • Incorporation of a 2 MWh BESS from renewable energy to provide instantaneous power for demand spikes or generation shortfalls. • Construction impacts to vegetative carbon sinks will be minimised by reducing the haul road pavement width from 7.5 m to 6.5 m while utilising cleared areas (for example, existing tracks) where possible. • Renewable power generation will be prioritised. • Implement programs to optimise energy efficiencies wherever possible, including considering energy efficient measures with bu ilding design, including heat conservation principles and insulation to minimise heating and cooling requirements. Manage • Management of GHG emissions will be in accordance with relevant legislation, State and Commonwealth strategies relating to GHG emissions. • Vehicles, the processing plant and power generating equipment will be maintained in accordance with operating manuals to minimise emissions where possi ble. • Implement a procurement policy that required sub-contractors to use energy efficient equipment and vehicles; • Comply with FVEMP. • Develop a Ground Disturbance Permit System and Procedure to ensure vegetation clearing is minimised and controlled. • Agrimin will investigate options for participation in the Emissions Reduction Fund (ERF). Monitor • Review equipment performance and efficiency to identify opportunities for improvement and strategies to reduce Scope 1 emissions over the LoM. • Annual review of energy consumption and emissions to identify areas where further emission reductions are possible. • Annual reporting of GHG emissions in line with the NGER Act.
Predicted Outcomes	Considering the mitigation options proposed including the use of renewables, there will still be some residual GHG emissions from the Proposal. At its peak, the Proposal will contribute 95,401 tCO_2-e emissions/yr. Comparison of the Proposal emissions to the 91.5 Mt CO_2-e emissions for GHG emissions for 2018 (Department of Industry Science and Energy Resources 2020b), indicates that the Proposal contributes less than 0.2% of the WA GHG emission levels. Therefore, the residual impact from the Proposal is assumed to be negligible. *Based on predicted GHG emissions for the construction and operation of the Proposal and the measures taken to minimise impacts to GHG emissions, Agrimin consider GHG impacts arising from the Proposal are not significant.*

12. Matters of National Environmental Significance

12.1 Proposal Background

The Proposal area is remote and extensive (263,675 ha) and therefore four Development Envelopes have been defined (Figure 1-2). The following terms are used ERD:

- Study Area – refers to the boundary within which all investigations and field surveys were undertaken.
- Proposal area - The combined area in which the four Development Envelopes are contained, define d below.
- Development Envelopes – the boundary within which the elements of the Proposal are situated. The Development Envelopes occur entirely within the Study Area and comprise four components that make up the Proposal. The Proposal includes disturbance of up to 15,000 ha of the lake's surface and clearing of approximately 1,500 ha of native vegetation. The proposed extent of the physical and operational elements includes four Development Envelopes (Figure 1-2):
  - On-lake Development Envelope (On-LDE): On-lake development of trenches, extraction of up to 100 GL/a of brine, and solar evaporation and harvesting ponds for potash salts, including ground disturbance of approximately 15,000 ha contained within the 217,261 ha On-LDE.
  - Off-lake Development Envelope (Off-LDE): Off-lake development of a processing plant and associated site infrastructure, including access roads, accommodation camp, airstrip and solar farm, including clearing of approximately 200 ha of native vegetation within the 688 ha Off-LDE.
  - Southern Infrastructure Development Envelope (SIDE): Development of borefield, water pipeline and access tracks for abstracting up to 3.5 GL/a of processing water and off-lake access to Lake Mackay, including clearing of approximately 300 ha of native vegetation within the 11,799 ha SIDE.
  - Northern Infrastructure Development Envelope (NIDE): Haul road for trucking potash production to Wyndham Port, including clearing of approximately 1,000 ha of native vegetation within the 33,928 ha NIDE.
- Indicative Footprint – The proposed Indicative Footprint occurs entirely within the Proposal area and refers to the area that is proposed to be directly disturbed by the Proposal (e.g. clearing of native vegetation). The layout of the Indicative Footprint may be subject to change; however, total disturbance will not exceed the maximum extent of disturbance for each Development Envelope as presented in the ERD. Proponent-led avoidance and minimisation measures have been implemented where possible to reduce and minimise potential impacts on areas of high ecological or heritage value through the detailed design of the Indicative Footprint.

12.2 Controlled Action

The Proposal was determined to be a 'Controlled Action' by a Delegate of the Commonwealth Minister for the Environment under the EPBC Act on 5 August 2019 as it will, or is likely to have, a significant impact on the following MNES:

- listed threatened species and communities (section 18 and 18A of the EPBC Act).

These listed threatened species have the potential to comprise the:

- Night Parrot (*Pezoporus occidentalis*) – Endangered;
- Princess Parrot (*Polvtelis alexandrae*) – Vulnerable;
- Australian Painted Snipe (*Rostratula australis*) – Endangered
- Greater Bilby (*Macrotis lagotis*) – Vulnerable;
- Great Desert Skink (*Liopholis kintorei*) – Vulnerable;
- Grey Falcon (*Falco hypoleucos*) – Vulnerable; and
- Dwarf Desert Spike-rush (*Eleocharis papillosa*) – Vulnerable.

The Proposal was determined to be assessed by accredited assessment under the Bilateral Agreement between the Commonwealth and WA governments.

The Proposal will not impact on a world heritage property or national heritage place and Lake Mackay is not listed as a Ramsar wetland. SOP product, materials handled during SOP production or generated as by-products of SOP production by the Proposal are not radioactive and the proposed activities do not constitute a Nuclear Action.

12.3 Relevant Policy and Guidance

The following Policy and Guidelines have been considered for the assessment:

- Matters of National Environmental Significance: Significant impact guidelines 1.1 – Environment Protection and Biodiversity Conservation Act 1999 (DotE 2013);
- Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DotEE 2017);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Water Quality Australia 2018);
- Night Parrot (*Pexoporus occidentalis*) Interim Recovery Plan for Western Australia 1996 to 1998 (CALM 1996a);
- A Recovery Plan for the Great Desert Skink (*Egernia kintorei*) 2001-2011 (McAlpin 2001);
- Draft National Recovery Plan for the Australian Painted Snipe *Rostratula australis* (DotEE 2019a); and
- Recovery Plan for the Greater Bilby (Macrotis lagotis) DRAFT (DotEE 2019c).

A summary of technical studies and description of factors for the relevant MNES is provided in the following sections:

- Section 5.3: Flora and Vegetation; and
- Section 7: Terrestrial Fauna.

An understanding of environmental values of the Proposal related to the EPBC Act was determined through a review of:

- the Protected Matters Search Tool (100 km buffer of northern coordinates (52K) 404735mE, 7801704mN and southern coordinates (52K) 390089mE, 7548559mN undertaken on 02/04/2019);
- previous environmental assessments including flora and fauna surveys and groundwater investigations; and
- known and available scientific information on relevant EPBC Act-listed species regarding their habitat needs and requirements.

12.4 Threatened Species

Threatened fauna desktop assessments were undertaken, which included the protected matter search tool, for threatened flora and fauna to identify species with potential to occur and be potentially impacted by the Proposal. Based on the fauna desktop assessment, 16 threatened fauna have been previously recorded within 100 km of the Proposal. These comprised, 10 mammals, five birds and one reptile. An additional seven mammals have historically been recorded within 150 km of the Proposal however these species are now classified under the EPBC Act as extinct.

An assessment of likelihood of occurrence was undertaken for the 16 fauna species, informed by survey work and the results of the desktop study (Appendix G.1). Based on this assessment, six threatened fauna were confirmed to occur and none were considered likely to occur. The remaining species were either considered possible (one species), unlikely (three species) or as no longer occurring in the Great Sandy Desert or Tanami bioregions (seven species).

For each of the six threatened fauna confirmed from the Study Area, a summary of key threats, records in the Study Area, habitat requirements and ecology are presented in Table 12-1. In addition to the species identified by the Commonwealth as MNES for the Proposal, one additional threatened species was recorded during field surveys, the Grey Falcon (*Falco hypoleucos*)(Vu) (Table 12-1). The Grey Falcon became listed as threatened under the EPBC Act on the 9th of July 2020. Fauna that are listed under the EPBC Act but are considered not present, unlikely, or possible to occur in the Proposal area are not considered further in this section.

In total there were six threatened fauna species recorded within or in close proximity to the Proposal area, comprising:

- Night Parrot;
- Princess Parrot;
- Australian Painted Snipe;
- Greater Bilby;
- Great Desert Skink and
- Grey Falcon.

Significant impact criteria for threatened species requires an assessment of whether the records represent an 'important population' of a species and whether the habitat in the Study Area represents 'critical habitat to the survival of a species'. An 'important population' of a species is defined by DotE (2013) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

For the species listed above, habitat critical to the survival of a species or ecological community is defined by DotE (2013) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long-term evolutionary development; and/or
- for the reintroduction of populations or recovery of the species or ecological community.

Each of these species were assessed against these criteria within Appendix G.1 and against the significant impact criteria within Section 12.4.1 to Section 12.4.6. The areas of each habitat listed as being of importance to these species with respect to the Study Area, Proposal area and Indicative Footprint are detailed within Section 7 (Terrestrial Fauna).

The threatened flora desktop assessment identified one threatened flora; Dwarf Desert Spike-rush (Vu) that has been previously recorded within 100 km of the Proposal. This species was subsequently assessed as possible to occur based on the proximity of records and the presence of suitable habitats. Details informing the assessment of likelihood for the Dwarf Desert Spike-rush are provided within Appendix F and summarised in Section 6.4.3. As the Commonwealth determined that the Proposal is likely to have a significant impact on the species, an assessment against the MNES criteria has been provided within Section 12.4.7.

Likelihood of impact is classified as known, likely, possible or unlikely.

Table 12-1: Summary of Listed Threatened Species

Common name (*Scientific name*)	Conservation status EPBC Act	Threatening processes and reason for listing	Consolidated records in the Study Area and surrounds (Appendix G.1)	Primary habitat(s) based survey records and known ecology
Mammals				
Greater Bilby (*Macrotis lagotis*)	Vu	Threatening processes: • Predation by introduced predators (Feral Cats and Foxes and to a lesser extent by Dingos/Wild Dogs); • Altered fire regimes; and • Habitat degradation (Woinarski et *al*. 2014).	Confirmed The species was recorded at 130 locations (77 burrows) within the Study Area, all within the NIDE, including active burrows, tracks, scats and diggings (Appendix G.1). The species was recorded at 165 locations in the surrounding region (150km), of which 66 occur near the Study Area (within 25km). Of these, 56 were recorded in the last 10 years by the Kiwirrkurra and Ngururrpa Indigenous groups and Desert Support Services (Desert Support Services 2018; Paltridge 2012;2015).	Ecology: The Greater Bilby is solitary and shelter in deep burrows. They have large, shifting home ranges that change in response to food resources. Greater Bilby burrow use is relatively dynamic, with individuals maintaining several burrows at once and abandoning, re-using or excavating new burrows continually. Primary habitat (foraging and breeding): • Gravel spinifex plain (92 locations); and • Spinifex sandplain (33 locations). Secondary habitat (foraging and breeding): • Claypan and claypan mosaics (3 locations); • Dunefield (1 location); and • Dune (1 location). Gravel spinifex plain is likely to be an important foraging habitat for the species due to the presence of *Acacia hilliana* which is a host species for root larvae known to be an important food resource for the Greater Bilby.
Birds				
Night Parrot (*Pezoporus occidentalis*)	En	Threatening processes: Little is known about the species; however, key threats (not an exclusive list) in the vicinity of the Study Area are likely to include; • predation by introduced and feral cats and potentially foxes (DBCA 2017c; DotE 2016; DPaW 2017b; NESP 2019) – the species appears to be highly vulnerable to cat predation; • Altered fire regimes (DBCA 2017c; DotE 2016; DPaW 2017b; NESP 2019) – the species appears to prefer long unburnt triodia hummocks for roosting/breeding; and • The loss or degradation of habitat (DBCA 2017c; DPaW 2017b) – roosting/breeding sites are of primary importance, but foraging resources, particularly in proximity to roost sites are also important.	Confirmed The species was recorded foraging from two locations 25 km apart via four acoustic units (two at each location) within the NIDE (Appendix G.1). The foraging calls were detected during long-term deployments after Phase 2 of the Stantec 2020 Survey, which occurred after rainfall. No calls were recorded at these same locations during the Phase 1 or during Phase 2 survey. Targeted Night Parrot survey work was subsequently undertaken at the two locations over four stages of survey work to better understand how the species was utilising the area (Stantec 2020b). Analysis of the calls indicates that across the surveys, on average there were between two and five individuals in the north and between two and three individuals in the south. The records were associated with large, seasonally inundated broad drainage basins, which support seeding vegetation and old growth spinifex. The records within the Study Area were as follows: • Northern location: gravel spinifex plain in association with claypans and claypan mosaic habitat • Southern location: claypans and claypan mosaic habitat near spinifex sandplain habitat. Suitable habitat for roosting has been detected within the Study Area in the form of old growth spinifex. These areas are visible on aerial imagery both within and outside the Study Area, particularly in association with the drainage basins containing a claypan mosaic habitats. Additionally, based on regional modelling, it is estimated that an additional 46,199 ha occurs in the surrounding region.	Ecology: The Night Parrot is a small green, highly cryptic parrot. They are nocturnal, primarily ground-feeding and inhabit remote arid and semi-arid Australia. The species roosts in clumps of dense vegetation, primarily long un-burnt *Triodia* hummocks. The species is likely to feed on seeding grasses, forbs, herbs and succulents, particularly in low-lying areas that are seasonally inundated promoting diverse, seeding ephemerals. Primary habitat (foraging and potential for roosting): • Claypans and claypan mosaic habitat (foraging calls); and • Saline flats and depressions are also likely to be primary habitat based on regional records (Murphy *et al.* 2017). The foraging calls recorded in gravel spinifex plain habitat was in close proximity to claypan and claypan mosaic habitat. The gravel spinifex plain is likely to have low potential to support foraging habitat from the species when not in association with claypan and claypan mosaic. Specifically, locations of low-lying ephemeral drainage areas containing old-growth spinifex appear to be important habitat within the Study Area. Secondary habitat (foraging and/or potential roosting): • Lake margin complex; • Drainage line; and • Ridge slope.
Princess Parrot (*Polytelis alexandrae*)	Vu	Threatening processes: • Habitat degradation and food reduction caused by altered fire regimes, livestock and introduced herbivores; • Competition with other native parrots which may have extended their range into the arid zone after water became more freely available in grazing country; and • Poaching and disease have also been listed as potential threats (TSSC 2018).	Confirmed The species was recorded from the NIDE from a sighting of ~12-30 individuals near the western edge of Lake Mackay in 2012 (Paltridge 2012) (Appendix G.1). The species has been recorded at 30 locations in the surrounding region (150 km from the Proposal area) mainly within the last 10 years, none of which occur near the Study Area (25 km).	Ecology: The species is rare and highly nomadic. They nest in tree hollows and have been recorded to forage on flowers, seeds and other plant material on the ground and in the foliage. Primary habitat (foraging, potentially breeding): • Dunefield (1 location). Some areas of the Dunefield habitat supported isolated patches of *Allocasuarina decaisneana* or *Corymbia* which may provide hollows suitable for nesting. Secondary habitat (foraging, potentially breeding);

Common name (*Scientific name*)	Conservation status EPBC Act	Threatening processes and reason for listing	Consolidated records in the Study Area and surrounds (Appendix G.1)	Primary habitat(s) based survey records and known ecology
				• Claypan and claypan mosaic (where trees are present); and • Spinifex sandplain (where trees are present). These secondary habitats rarely also supported isolated patches of trees large enough to support hollows suitable for breeding. Such trees were rare and isolated in the landscape
Grey Falcon (*Falco hypoleucos*)	Vu	Threatening processes: • Predation by cats, increased temperatures in arid and semi-arid Australia (climate change), small population size, grazing by exotic herbivores, nest shortage (TSSC 2020); • land clearing, over grazing and drought which are known to reduce suitable habitat, population persistence and breeding success (Garnett *et al.* 2011; Olsen and Olsen 1986); and • Their extremely low population, (estimated at less than 1000) potentially effecting genetic viability of the population (Schoenjahn *et al.* 2020).	Confirmed Three Grey Falcons (2 adults, 1 juvenile) from one location were recorded in the Study Area from the northern end of the NIDE (Appendix G.1). The species was recorded at 17 locations in the surrounding region (150 km), of which five are near the Study Area (25 km) during 2001 – 2016 (Birdlife Australia 2020; Paltridge 2015).	Ecology: Considered rare, the Grey Falcon inhabits lightly treed inland plains, gibber deserts, sand ridges, and timbered watercourses over much of inland arid Australia. Primary habitat (foraging and potential breeding where tall trees or communication towers are present): • Spinifex sandplain (1 location); and • Gravel spinifex plain.
Birds – Waterbirds and migratory shorebirds				
Australian Painted Snipe (*Rostratula benghalensis*)	En	Threatening Processes: • Loss and alteration of wetland habitat, primarily via draining of wetlands and the diversion of water to agriculture and reservoirs; • Predation by feral predators, including cats and foxes; • Drought; • Trampling of wetland vegetation by livestock (particularly in the arid zone); • Frequent and altered fire regimes; and • Weed encroachment (DAWE 2020h; DotEE 2019a).	Confirmed The species was recorded once in the Study Area on the eastern edge of Lake Mackay in 2017 (360 Environmental 2017b) (Appendix G.1). The species was recorded at three locations in the surrounding region (150 km from the Proposal area) from 1995 – 2002, none of which occur in close proximity to the Study Area (25 km) (Birdlife Australia 2020).	Ecology: Painted Snipes inhabit well vegetated shallows and margins of terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Following rainfall events, the following habitats within the Study Area may provide suitable foraging and breeding habitat for the species; Primary habitat (breeding and foraging): • Saline flats and depressions (1 location); and • Claypans and claypan mosaic. Secondary habitat (breeding and foraging): • Salt lake playa; and • Lake margin.
Reptiles				
Great Desert Skink (*Liopholis kintorei*)	Vu	Threatening processes: • Altered fire regimes; • Predation by feral cats and introduced foxes (McAlpin 2001; Pavey 2006); • Predation by native predators (dingo and birds of prey); • Development; and • habitat destruction by introduced rabbits (McAlpin 2001; Pavey 2006)	Confirmed The species has been recorded from three areas within the Study Area: • Yagga Yagga population which overlaps with the NIDE: 64 active burrows recorded approximately 22 km south of Yagga Yagga. After the population was better defined through additional survey work, the NIDE was realigned so that all active burrows associated with the population were avoided with a buffer of 300 m. • Murrawa population: two locations recorded in 2000. Subsequent targeted survey work has established that this population is no longer present. • Lake Mackay population: one location 10 km south of Lake Mackay from 2018. Subsequent targeted survey work has established that this population is no longer present. Additionally, the species has been recorded at 138 locations in the surrounding region (150 km). Almost all are in a 30 km stretch of the Kiwirrkurra road ~20 km southeast of the Kiwirrkurra community (DBCA 2020).	Ecology: The species has undergone a widespread decline, with many historical populations no longer existing. The species tends to occupy sandplains and swales with hummock grasses and scattered shrubs. The species lives communally in multi-generational family groups, with up to 10 individuals occupying a burrow system, defecating at a shared latrine and maintaining the burrow. Individuals are relatively sedentary, only moving up to 150 m from the burrow while foraging; however, may move up to 10 km to colonise new areas (DAWE 2020i). During the breeding season, males will mate with multiple females at multiple nearby burrows (DAWE 2020i). Primary habitat within the Study Area (foraging and breeding): • Spinifex sandplain (all three populations were recorded in spinifex sandplain).

12.4.1 Night Parrot (*Pezoporus occidentalis*) (En)

The Night Parrot is a small green, highly cryptic parrot that is endemic to Australia. They are nocturnal and inhabit remote arid and semi-arid Australia. Broad habitat requirements for the Night Parrots include treeless or unburnt spinifex plains often scattered with chenopods (Pyke and Ehrlich 2014) and areas of old-growth spinifex for roosting and nesting, together with foraging habitats that are likely to include various native grasses and herbs and may or may not contain shrubs or low trees (DPaW 2017b). Night parrots have been known to fly up to 40 km or more in a night during foraging expeditions, so foraging habitat is not necessarily within or adjacent to roosting areas (DPaW 2017b). Night Parrots were confirmed within the Proposal during Phase 2 of the Stantec (2020) Survey.

The species was recorded foraging in the Study Area at two locations approximately 25 km apart. The foraging calls were detected during long-term deployments after Phase 2 of the Stantec 2020 Survey, which occurred after rainfall. No calls were recorded at these same locations during the Phase 1 or during Phase 2 survey.

Targeted Night Parrot survey work was subsequently undertaken at the two locations over four stages of survey work to better understand how the species was utilising the area (Stantec 2020b). During the targeted surveys, a total of 89 recording units were deployed and a total of 604 nights of recordings were analysed. Calls were recorded on 38 units in the north and 20 units in the south. Analysis of the calls indicates that across the surveys, on average there were between two and five individuals in the north and between two and three individuals in the south. Including both the baseline and targeted surveys, Night Parrot calls have been recorded both inside the Proposal area (north: three locations, south: four locations) and outside (north: 35 locations, south 16 locations) the Proposal area. Of the total of 58 locations, only two were from within the Indicative Footprint (Figure 12-1).

The majority of the calls at each location were best attributed to foraging or nightly movement within the landscape. However, the timing of calls detected at 19 units are suggestive of one or more nearby roost sites within approximately 1 km of each of these recording units. No units within the Proposal area in the north and two units within the proposed haulage corridor in the south recorded calls which indicate roost sites are within 1 km of the units i.e. two of the 19 locations. None of these recording units were within the Indicative Footprint. The exact locations of these roosts were not able to be determined from recording units and on-ground listening surveys and searching would be required to find the roost locations. Individual Night Parrots are known to use several different roosts within their range (N. Jacket pers. comms.). Little is known about the fidelity of Night Parrots to their roost locations, but they may move and use different roosts in response to seasonal inundation, proximity to food resources, or proximity to nesting sites.

Subsequent to the discovery of the Night Parrot populations by Stantec in March 2020, Ngururrpa rangers discovered a further three locations within the vicinity of the proposed haulage corridor during the first half of 2021. All of these additional locations are from outside the proposed corridor (Figure 12-2). At the time of this report, the original populations discovered by Stantec represented the 6th and 7th known populations in WA (Nigel Jacket pers comms) while the additional populations discovered by the Ngururrpa rangers are likely to represent the 11th, 12th and 13th populations in WA (Nigel Jacket, pers. comm.).

Based on the locations of records and known ecology, within the Study Area, primary habitats for the Night Parrot have been identified as claypans and claypan mosaic, and saline flats and depressions (Appendix G.1). Specifically, these habitats have been identified as important due to the presence of old growth spinifex (potential roost habitat) in association with ephemeral grasses and herbs (foraging habitat). Subsequent fine scale desktop mapping has estimated that a total of 11,522 ha of old growth spinifex occurs within the Study Area (Appendix G.1).

Regional modelling of prospective Night Parrot habitat was undertaken within a 10 km buffer of the Proposal Appendix G.1. In total, the regional modelling identified 46,199 ha of additional habitat within 10 km of the Proposal which is likely to be suitable for Night Parrots. This regional modelling was further substantiated by the discovery of the three additional Night Parrot locations by Ngururrpa rangers which likely occur within the modelled areas (coordinates were not provided) (Figure 12-1).

Suitable habitat for roosting has been detected within the Study Area in the form of old growth spinifex, and it is considered that Night Parrot habitat is well represented in the local and regional contexts, based on the modelling and subsequent records.

The Commonwealth's *Conservation Advice Pezoporus occidentalis night parrot* (DotE 2016) and *Night Parrot (Pezoporus occidentalis) Interim Recovery Plan for Western Australia* (CALM 1996b) have been considered in the assessment of the Proposal against significant impact criteria (Table 12-2). In particular, proposed threats to the species have been presented within Table 12-1 (Threatening Processes) and this information has in turn been used to assess whether any potential impacts from the Proposal could increase any of these existing threats to the species.

Table 12-2: Significant impact criteria for the Night Parrot (En)

<table>
<tr><th>Significant Impact Criteria</th><th>Likelihood of Impact</th><th>Justification</th></tr>
<tr><td>Will the action lead to a long-term decrease in the size of a population?</td><td>Unlikely</td><td>The Proposal is unlikely to lead to a long-term decrease in the size of the population.
Potential threats to the species from the Proposal that could lead to a decrease in the size of the population include:
• Loss of individuals or roost sites during clearing
• Loss of individuals through road strike
• Loss of individuals through increased predation
• Loss of individuals through altered fire regimes
Given the rarity of the species, clearing is unlikely to result in the direct loss of any individuals. However, given the small population size of the species, the loss of any individuals would be considered a significant impact.
Proposed mitigation measures during clearing include limiting clearing (where possible) of potential roost habitat, particularly old growth spinifex. Based on fine scale desktop mapping, it is estimated that a total of 11,522 ha of old growth spinifex occurs within the Study Area, of which 646.62 ha (5.61%) occurs within the Proposal area and 23.55 ha (0.20 %) occurs within the Indicative Footprint. Additionally, the potential for direct loss of individuals through clearing will be mitigated through the following measures as detailed in the CEMP:
• Within the two areas where Night Parrots have been detected, pre-clearance listening surveys will be undertaken to determine if any roost sites occur within or in the vicinity of the Indicative Footprint. In the unlikely event that a Night Parrot roost is detected within the Indicative Footprint, staff will use non-invasive methods similar to those already accepted and used for other species (e.g. Greater Bilby) (DBCA 2018) to encourage the bird/s to leave the area prior to clearing. Field staff will wait for the bird to leave the roost in the evening (confirmed by visual inspection of roost) before disturbing or removing the roost hummock to discourage the bird from returning. As Night Parrots are likely to use several roosts within their range, and extensive similar roosting habitat is present adjacent to the clearing footprint, it is anticipated that this will not have any long-term negative effects on the bird. Staff will continue to monitor the area to ensure the bird has abandoned the roost site. These potential dispersal methods will be discussed and refined in consultation with DBCA. If a nest is detected during pre-clearance listening surveys, these methods will not apply and the nest area will be avoided entirely until any chicks have fledged.
• Although Night Parrots have not been detected elsewhere within the Study Area, there is potential for the species to occur due to the presence of suitable habitat. Potential foraging and roost habitat in the form of old growth has been identified and delineated though desktop mapping. Pre-clearance Night Parrot recording surveys will be undertaken in these areas where they occur within the Indicative Footprint. If any calls indicate a roost site may occur in the area, then pre-clearance listening surveys will be undertaken to identify the location of the roost as above.
Where clearing is required within the drainage features, infrastructure will be constructed to maintain surface hydrology and therefore ecosystem function along the drainage features that extend up to 5 km either side of the NIDE.
Road strike during haulage was identified as a potential impact to the species. To mitigate this potential impact haulage operations will be restricted to daylight hours. Additionally, road access will be restricted to operational traffic and local aboriginal communities.</td></tr>
</table>

Significant Impact Criteria	Likelihood of Impact	Justification
		Feral predation and altered fire regimes are listed as key threats to the species and have potential to be increased as a result of the Proposal. To mitigate any potential increase in these threats to the species, the Proposal will implement a Fire Management Procedure, and Feral Predator Control Program. Based on the proposed mitigation measures, the Proposal is unlikely to lead to a long-term decrease in the size of the population.
Will the action reduce the area of occupancy of the species?	Unlikely	The Proposal is unlikely to have a significant impact on the area of occupancy of the species. Primary habitats for the species in the Study Area have been identified as claypans and claypan mosaic, and saline flats and depressions. The Night Parrot has been recorded at two locations within the NIDE. Both locations occur within broad drainage features which are traversed by the NIDE in association with claypan and claypan mosaic habitat. These drainage features are likely to be productive foraging areas after rainfall as they support diverse, seeding ephemeral grasses and herbs. Mitigation measures will focus on maintaining surface hydrology (i.e. ecosystem function within the drainage features that both extend approximately 5 km either side of the NIDE). Additionally, haulage will be limited to daytime hours so that the operations of trucks does not deter the species from travelling through the area. Given that clearing for the Proposal will be on average 24 m (of which 30% follows an existing cleared track) within the NIDE and that the broader habitat will be maintained, the Proposal is unlikely to have a significant impact on the area of occupancy of the species.
Will the action fragment an existing population into two or more populations?	Unlikely	The Proposal is unlikely to fragment an existing population into two or more populations. Night Parrots were recorded in the Study Area from two locations 25 km apart. Based on the call types detected and call timing in relation to one another, between two and five individuals are estimated to occur in the north and between two and three individuals are estimated to occur in the south. While clearing of primary habitat will occur within the Proposal area, it is unlikely to cause the fragmentation of either population into two or more populations. The proposed clearing corridor for the haul road will be up to 24 m, with a final running surface of 6.5 m wide. 30% of the haul road will be constructed on an existing-cleared track. This distance is unlikely to create a physical barrier to the species. Given that the haul road is unlikely to create a barrier to the species, the Proposal is unlikely to fragment an existing population into two or more populations.
Will the action adversely affect habitat critical to the survival of a species?	Unlikely	The Proposal is unlikely to adversely affect habitat critical to the survival of the species. Critical habitat for the Night Parrot comprises roosting habitat. Suitable habitat for roosting has been detected within the Study Area and within the Indicative Footprint, in the form of old growth spinifex. These areas are visible on aerial imagery both within and outside the Study Area, particularly in association with the drainage basins containing a claypan and claypan mosaic habitat. Regional modelling of prospective Night Parrot habitat was undertaken within a 10 km buffer of the Proposal (Appendix G.1). In total, the regional modelling identified 46,199 ha of additional habitat within 10 km of the Proposal which is likely to be suitable for Night Parrots. This regional modelling was further substantiated by the discovery of three additional Night Parrot locations by Ngururrpa rangers which likely occur within the modelled areas (coordinates were not provided) (Figure 12-1). Based on the modelling and the subsequent records, Night Parrot habitat is considered well represented in the local and regional contexts.

Significant Impact Criteria	Likelihood of Impact	Justification
		Based on fine scale desktop mapping, it is estimated that a total of 11,522 ha of old growth spinifex occurs within the Study Area, of which 646.62 ha (5.61%) occurs within the Proposal area and only 23.55 ha (0.20 %) occurs within the Indicative Footprint. Although clearing for the Proposal will result in the loss of old growth spinifex, the Indicative Footprint will comprise only a small proportion of the extent in the Study Area and within the wider landscape (0.20 %). Given that clearing will affect only a small proportion of the extent of old growth spinifex, the Proposal is unlikely to adversely affect habitat critical to the survival of the species.
Will the action disrupt the breeding cycle of a population?	Unlikely	The Proposal is unlikely to have a significant impact on the breeding cycle of the population. Suitable habitat for roosting and therefore nesting has been detected within the Study Area and within the Indicative Footprint, in the form of old growth spinifex. Based on fine scale desktop mapping, it is estimated that a total of 11,522 ha of old growth spinifex occurs within the Study Area, of which 646.62 ha (5.61%) occurs within the Proposal area and 23.55 ha (0.20 %) occurs within the Indicative Footprint (Appendix G.1). Given the rarity of the species, clearing is very unlikely to result in the direct loss of any individuals, roost sites or breeding sites. However, any loss of individuals including fledglings in nests would be considered to have a significant consequence given the small population size of the species. Consequently, mitigation measures during clearing will involve the following: • Within the two areas where Night Parrots have been detected, pre-clearance listening surveys will be undertaken to determine if any roost sites occur within or in the vicinity of the Indicative Footprint. In the unlikely event that a Night Parrot roost is detected within the Indicative Footprint, staff will use non-invasive methods similar to those already accepted and used for other species (e.g. Greater Bilby) (DBCA 2018) to encourage the bird/s to leave the area prior to clearing. Field staff will wait for the bird to leave the roost in the evening (confirmed by visual inspection of roost) before disturbing or removing the roost hummock to discourage the bird from returning. As Night Parrots are likely to use several roosts within their range, and extensive similar roosting habitat is present adjacent to the clearing footprint, it is anticipated that this will not have any long-term negative effects on the bird. Staff will continue to monitor the area to ensure the bird has abandoned the roost site. These potential dispersal methods will be discussed and refined in consultation with DBCA. If a nest is detected during pre-clearance listening surveys, these methods will not apply and the nest area will be avoided entirely until any chicks have fledged. • Although Night Parrots have not been detected elsewhere within the Study Area, there is potential for the species to occur due to the presence of suitable habitat. Potential foraging and roost habitat in the form of old growth has been identified and delineated though desktop mapping (Appendix G.1). Pre-clearance Night Parrot recording surveys will be undertaken in these areas where they occur within the Indicative Footprint. If any calls indicate a roost site may occur in the area, then pre-clearance listening surveys will be undertaken to identify the location of the roost as above. Given that mitigation measures are likely to reduce the potential to impact any breeding sites, the Proposal is unlikely to have a significant impact on the breeding cycle of the population.
Will the action modify, destroy, remove, isolate or decrease the availability or	Unlikely	The Proposal is unlikely to modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline. Broad fauna habitats have been described and delineated for the Study Area as a whole (Section 7). Based on the locations of records and known ecology, within the Study Area, primary habitats for the Night Parrot have been

Significant Impact Criteria	Likelihood of Impact	Justification
quality of habitat to the extent that the species is likely to decline?		identified as claypans and claypan mosaic, and saline flats and depressions. With respect to the Proposal, these habitats occur in the following proportions: • Claypans and claypan mosaic habitat: A total of 15,961 ha occurs within the Study Area, of which 1,457 ha (9.13%) occurs within the Proposal area and 42.22 ha (0.26%) occurs within the Indicative Footprint. • Saline flats and depressions habitat: A total of 8,069 ha occurs within the Study Area, of which 151 ha (1.87 %) occurs within the Proposal area and 3.44 ha (0.04 %) occurs within the Indicative Footprint. In addition to the broadscale habitat mapping, fine scale desktop mapping of old growth spinifex has been undertaken for the Study Area. In total, it is estimated that 11,522 ha of old growth spinifex occurs within the Study Area, of which 646.62 ha (5.61%) occurs within the Proposal area and 23.55 ha (0.20 %) occurs within the Indicative Footprint (Appendix G.1). To place these potential impacts in a regional context, regional modelling of prospective Night Parrot habitat was undertaken within a 10 km buffer of the Proposal (Appendix G.1). In total, the regional modelling identified 46,199 ha of additional habitat within 10 km of the Proposal which is likely to be suitable for Night Parrots. This regional modelling was further substantiated by the discovery of three additional Night Parrot locations by Ngururrpa rangers which likely occur within the modelled areas (indicative locations provided) (Figure 12-1). Based on the modelling and the subsequent records, Night Parrot habitat is considered well represented in the local and regional contexts. Although the Proposal will clear areas of primary habitat; the extent of these habitats within the Indicative Footprint comprise a very small proportion of the extent within the Study Area and wider surrounds. Where clearing is required within the broad drainage features that comprise Night Parrot habitat, infrastructure will be constructed to maintain surface hydrology and therefore ecosystem function along the drainage features that extend up to 5 km either side of the NIDE. Clearing for the Proposal's haul road will be on average 24 m in a 30 m corridor within the NIDE (30% of which is an existing cleared track), ensuring broader habitat will be maintained. As a result, the Proposal is unlikely to modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Will the action result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?	Unlikely	The Proposal is unlikely to result in an increase invasive species that are harmful to the Night Parrot becoming established in the Night Parrots habitat. The Proposal has the potential to result in an increase of predators in the area due to ease of access along established roads, scavenging opportunities relating to increased human activity (e.g. food waste, landfills, etc) and increased roadkill along the haul road. Predation by feral animals is listed as a key threatening process for the Night Parrot. The spread of weeds (e.g. Buffel Grass) via machinery, mobile equipment, and vehicles on the haul road has the potential to alter composition and structure of native vegetation communities resulting in reduced suitability for native fauna. Weeds has the potential to increase fuel loads, and the associated frequency and intensity of fire. These potential impacts will be mitigated via the following: • Implement a feral predator control program to manage any potential increase in the prevalence of feral predators as a result of the Proposal. • Management of potential feral predator foraging resources (i.e. site landfill). • Implement a weed management procedure.

Significant Impact Criteria	Likelihood of Impact	Justification
		Invasive species already occur within the Study Area, however, based on the proposed mitigation measures, the Proposal is unlikely to result in an increase invasive species that are harmful to the Night Parrot becoming established in the Night Parrots habitat.
Will the action introduce disease that may cause the species to decline?	Unlikely	The Proposal is unlikely to introduce disease that may cause the species to decline. The Proposal is unlikely to introduce disease (Psittacine Beak and Feather disease) into the Proposal area or surrounding regions. The Proposal is unlikely to introduce disease that may cause the species to decline.
Will the action interfere with the recovery of the species?	Unlikely	The Proposal is unlikely to interfere with the recovery of the species. The extensive surveys undertaken by the Proponent, in partnership with traditional owners, has defined a further population of this highly cryptic species. This has increased the known occurrence of the species and its habitat requirements and may assist with recovery efforts for the species. Little is known about the species; however, key threats (not an exclusive list) in the vicinity of the Proposal are likely to include; • Predation by introduced and Feral Cats and potentially Foxes (DBCA 2017c; DotE 2016; DPaW 2017b; NESP 2019) – the species appears to be highly vulnerable to Cat predation; • Altered fire regimes (DBCA 2017c; DotE 2016; DPaW 2017b; NESP 2019) – the species appears to prefer long unburnt *Triodia* hummocks for roosting/breeding; and • The loss or degradation of habitat (DBCA 2017c; DPaW 2017b) – roosting/breeding sites are of primary importance, but foraging resources, particularly in proximity to roost sites are also important. Where there exists potential for the Proposal to increase impacts associated with these threats, they will be mitigated via the following: • Feral Predator Control Program; • Fire Management Procedure; and • limiting clearing to the Indicative Footprint and maintain ecosystem function within the broad drainage features. Given that potential impacts from the Proposal can be effectively mitigated, the Proposal is unlikely to interfere with the recovery of the species.
Residual impact	Although there is not expected to be significant residual impact to the Night Parrot, there is potential for significant residual impact to critical and supporting habitat of the species. Agrimin are committed to supporting the conservation of this species, and survey work and analysis have substantially contributed to understanding of the ecology of this species. However, it is acknowledged that there are remaining knowledge gaps, which may better inform conservation management of the Night Parrot across its range. As a result, Agrimin have committed to two voluntary indirect offsets that have potential for meaningful conservation outcomes for this species, while concurrently supporting Indigenous groups on the associated IPAs. These voluntary indirect offsets are discussed within Section 13.4.1.	

Redacted

Figure 12-1: Night Parrot records and modelled prospective habitat with respect to the Indicative Footprint, Proposal area and Study Area (redacted from public version of ERD).

Redacted

Figure 12-2: Regional Night Parrot records and modelled of prospective habitat with respect to the Indicative Footprint, Proposal area and Study area (redacted from public version of ERD).

12.4.2 Princess Parrot (*Polytelis alexandrae*) (Vu)

The Princess Parrot is confined to arid regions of WA, the Northern Territory, and South Australia (TSSC 2018). The core distribution of the species is in the Great Sandy Desert, but can also be found in the Gibson, Tanami, and Great Victoria Deserts, where the species inhabits sand dune country with scattered trees and a covering of shrubs and spinifex. Princess Parrots are considered an irregular visitor to most sites in its range and movements are largely unknown (DAWE 2020k). They nest in tree hollows and have been recorded foraging on flowers, seeds and other plant material, both on the ground and in the foliage, including those from *Acacia*, *Grevillea*, *Leptosema*, *Hakea*, *Eremophila*, *Ptilotus* species and grass species (*Digitaria ammophila, Eragrostis eriopoda*) (Pavey *et al.* 2014). They can also inhabit stands of mulga, *Casuarina*, desert-oaks, desert poplars and hakeas and be found in areas containing parakeelia and other succulents around salt lakes (Menkhorst *et al.* 2017; Pizzey and Knight 2007).

Princess Parrots were recorded twice within the Study Area, comprising a 2012 sighting of 12-30 Princess Parrots near the western edge of Lake Mackay (Paltridge 2012) and a 2021 sighting of 11 Princess Parrots flying over an island on the Lake Mackay playa during an inundation event (Appendix G.1). The species was recorded at 30 locations in the surrounding region (150 km), none of which occur near the Study Area (25 km). Of these, the most recent records were ~100 km to the south or southwest of the Study Area. Based on the locations of records and known ecology primary habitat for the Princess Parrot within the Study Area was identified as dunefield habitat (Appendix G.1).

The Commonwealth's *Conservation Advice for Polytelis alexandrae (Princess Parrot)* (TSSC 2018) has been considered in the assessment of the Proposal against significant impact criteria for MNES (Table 12-3) and presented in Figure 12-3 (DotE 2013). In particular, threats to the species (Table 12-1: Threatening Processes) has in turn been used to assess whether any potential impacts from the Proposal could increase any of these existing threats to the species.

Table 12-3: Significant impact criteria for the Princess Parrot (Vu)

Significant Impact Criteria	Likelihood of Impact	Justification
Will the action lead to a long-term decrease in the size of an important population of a species?	Unlikely	The Proposal is unlikely to lead to a long-term decrease in the size of the population. Given the lack of records in the Study Area or in the local surrounds, the Proposal is unlikely to lead to a long-term decrease in the size of the population.
Will the action reduce the area of occupancy of an important population?	Unlikely	The Proposal is unlikely to reduce the area of occupancy of an important population. Given the lack of records in the Study Area or in the local surrounds, it is unlikely that the Study Area contains an important population of the species. Primary habitat for the species has been identified as dunefield habitat. With respect to the Proposal, these habitats occur in the following proportions: • Dunefield habitat: A total of 41,418 ha occurs within the Study Area, of which 5,432 ha (13.11 %) occurs within the Proposal area and 281.82 ha (0.68 %) occurs within the Indicative Footprint. Given that the area is unlikely to support an important population and given that clearing for the Proposal comprises only 0.68% of the extent of primary habitat for the species, the Proposal is unlikely to reduce the area of occupancy of an important population.
Will the action fragment an existing important population into two or more populations?	Unlikely	The Proposal is unlikely to fragment an existing population into two or more populations. Given the lack of records in the Study Area or in the local surrounds, it is unlikely that the Study Area contains an important population of the species. Additionally, the Proposal is unlikely to create any barriers to dispersal for the species. The Proposal is unlikely to fragment an existing population into two or more populations.
Will the action adversely affect habitat critical to the survival of a species?	Unlikely	The Proposal is unlikely to adversely affect habitat critical to the survival of the species. While the species was recorded from two locations in the Study Area, there are no other local records and the species is highly nomadic, relying on resources widespread in the central arid regions. As such it is unlikely that the Study Area contains critical habitat for the survival of the species. The primary habitat for the species within the Study Area has been defined as dunefield habitat. Within the Study Area, 5,432 ha (13.11%) of the dunefield habitat occurs within the Proposal area, of which, 281.82 ha (0.68 %) occurs within the Indicative Footprint. Given that clearing will affect only a small proportion of primary habitat, the Proposal is unlikely to adversely affect habitat critical to the survival of the species.
Will the action disrupt the breeding cycle of an important population?	Unlikely	The Proposal is unlikely to disrupt the breeding cycle of an important population. Given the lack of records in the Study Area or in the local surrounds, it is unlikely that the Study Area contains an important population of the species. The Proposal is unlikely to disrupt the breeding cycle of an important population.
Will the action modify, destroy, remove or isolate or decrease the	Unlikely	The Proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Significant Impact Criteria	Likelihood of Impact	Justification
availability or quality of habitat to the extent that the species is likely to decline?		Given the species was only recorded from two locations in the Study Area and that there are no other local records, it is unlikely that the Study Area contains critical habitat for the survival of the species. The primary habitat for the species within the Study Area is dunefield. A total of 41,418 ha occurs within the Study Area, of which 5,432 ha (13.11 %) occurs within the Proposal area and 281.82 ha (0.68 %) occurs within the Indicative Footprint. Given that the species is represented two records and that primary habitat is extensive outside the Indicative Footprint, the Proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	Unlikely	The Proposal is unlikely to result in invasive species that are harmful to the Princess Parrot becoming established in the Princess Parrots habitat. Predation by feral animals is not listed as a key threatening process for the Princess Parrot. However, the Proposal has the potential to result in an increase of predators in the area due to ease of access along established roads, scavenging opportunities relating to increased human activity (e.g. food waste, landfills, etc) and increased roadkill along the haul road. The spread of weeds (e.g. Buffel Grass) via machinery, mobile equipment, and vehicles on the haul road has the potential to alter composition and structure of native vegetation communities resulting in reduced suitability for native fauna. Weeds have the potential to increase fuel loads, and the associated frequency and intensity of fire. Habitat degradation and food reduction caused by altered fire regimes is listed as a key threatening process for the species. These potential impacts will be mitigated via the following: • Implement a feral predator control program manage any potential increase in the prevalence of feral predators as a result of the Proposal. • Management of potential feral predator foraging resources (i.e. site landfill). • Implement a weed management procedure to limit the spread of existing weed species and the establishment of new weeds as a result of the Proposal • Eradicate weed infestations detected during inspections. Based on the proposed mitigation measures, the Proposal is unlikely to result in invasive species that are harmful to the Princess Parrot becoming established in the Princess Parrots habitat.
Will the action introduce disease that may cause the species to decline?	Unlikely	The Proposal is unlikely to introduce disease that may cause the species to decline. The Proposal is unlikely to introduce disease (e.g. Psittacine Beak and Feather disease) into the Proposal area or surrounding regions. The Proposal is unlikely to introduce disease that may cause the species to decline.
Will the action interfere substantially with the recovery of the species?	Unlikely	The Proposal is unlikely to interfere with the recovery of the species. Despite the presence of the species, the Proposal area does not contain an important population of the species or provide habitat critical to the survival of the species. Development of the Proposal is therefore unlikely to interfere with the recovery of the species.
Residual impact	No significant residual impact to the Princess Parrot (*Polytelis alexandrae*).	

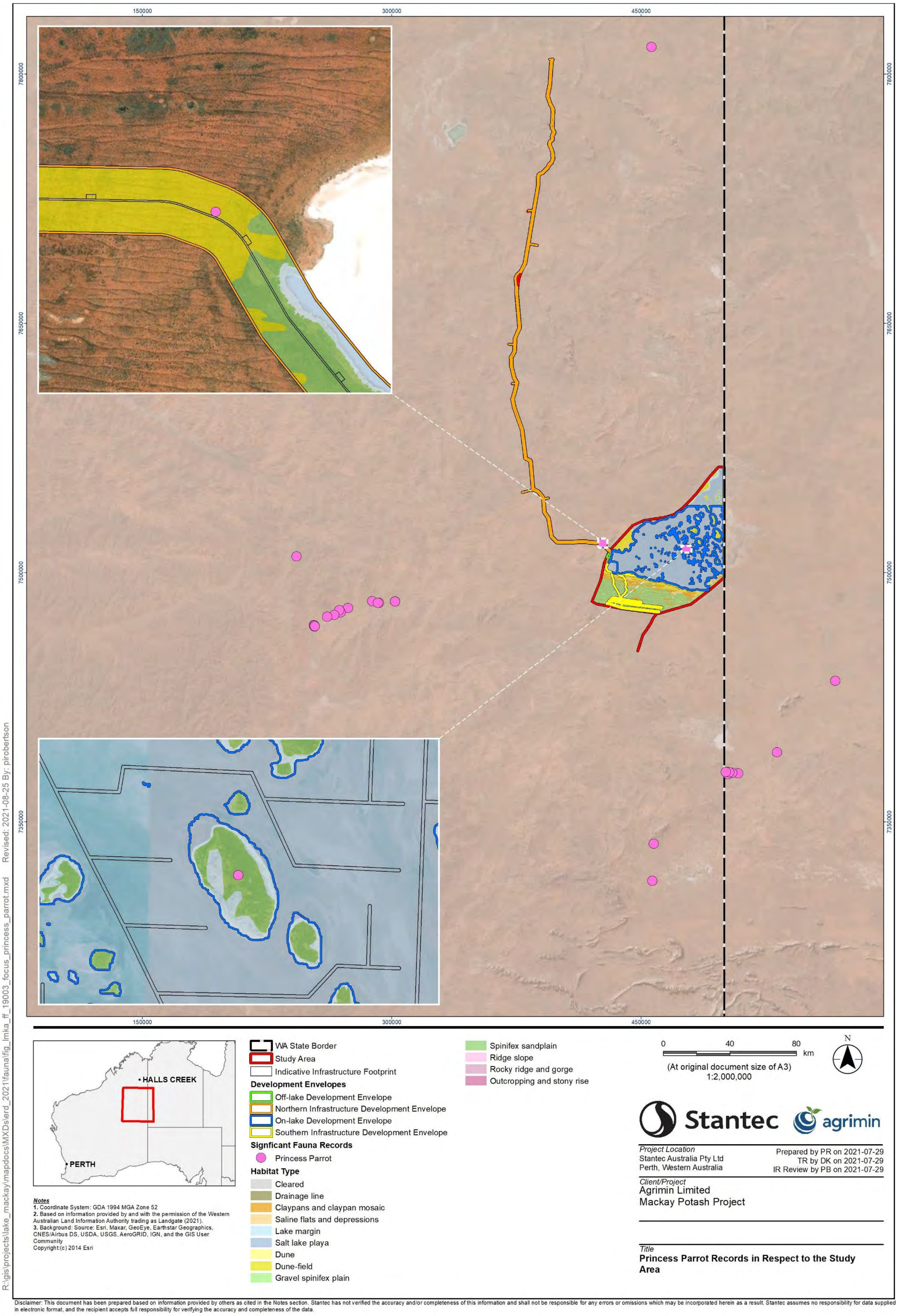


Figure 12-3: Princess Parrot records with respect to the Study Area and the Proposal.

12.4.3 Australian Painted Snipe (*Rostratula benghalensis*) (En)

The Australian Painted Snipe has been recorded at wetlands in all states of Australia (Barrett *et al.* 2003; Blakers *et al.* 1984). Painted Snipes inhabit well vegetated shallows and margins of terrestrial freshwater (occasionally brackish) wetlands, lakes, swamps claypans, dams, wet pastures, marshy areas, and open timbered areas (Pizzey and Knight 2007). This species is mainly active at dawn and dusk, preferring to sit quietly under cover of grass, reeds, or other dense cover during the day and becoming more active at dawn, dusk, and night. They generally remain in dense cover when feeding, although may forage over nearby mudflats and other open areas such as ploughed land or grassland (Marchant & Higgins 1993 in (DAWE 2020h). They eat vegetation, seeds, insects, worms and molluscs, crustaceans, and other invertebrates (DAWE 2020h). The species has a historical distribution through most of continent including some desert regions, but the Murray-Darling Basin appears to be a stronghold (DotEE 2019a). The species is poorly understood; however, individual estimates ranges from a few hundred to 5,000 breeding adults (DAWE 2020h).

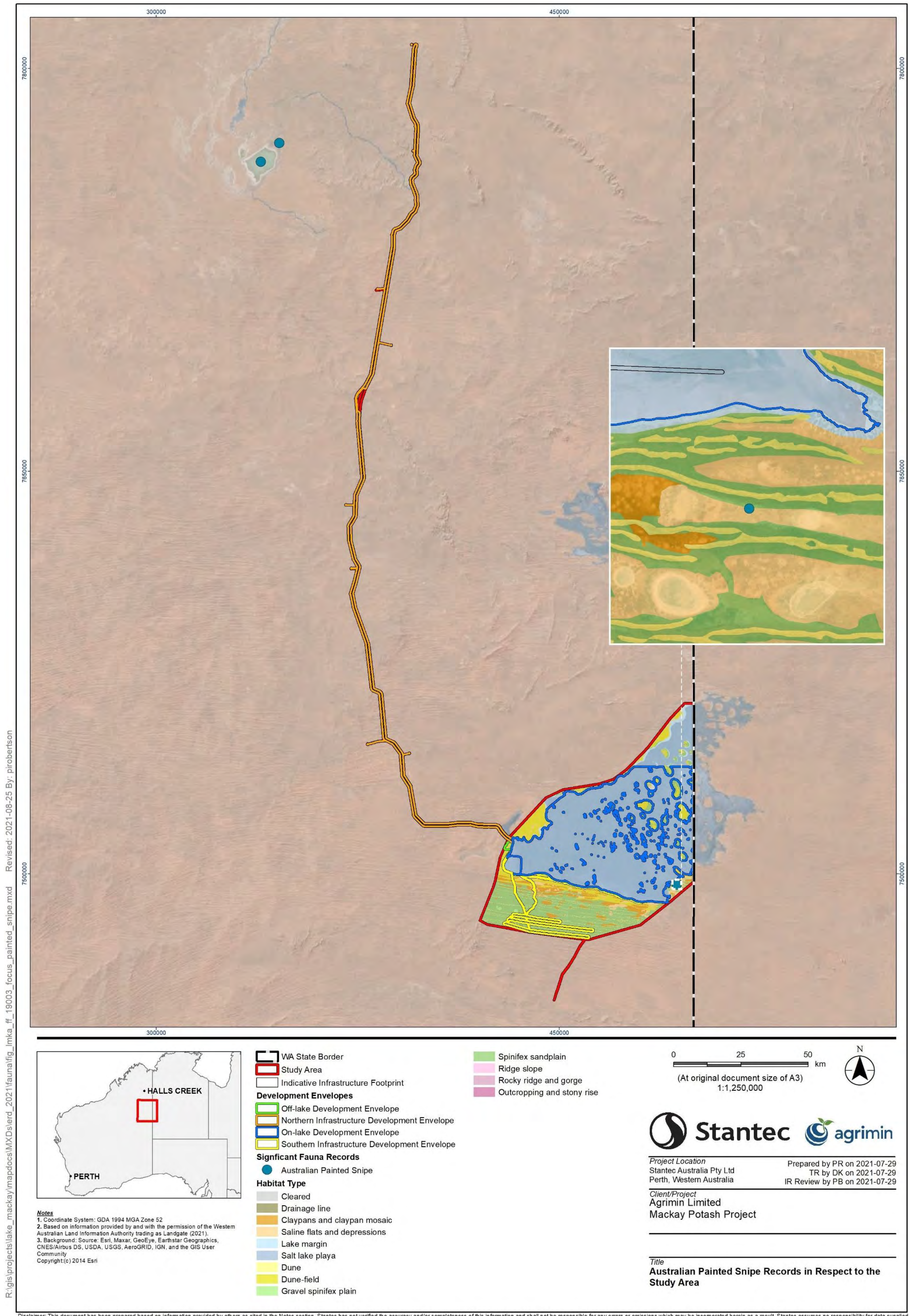
The species was recorded once in the Proposal area in 2017 following an extreme rainfall event and at two locations from nearby Lake Gregory in 1995 and 2000 (360 Environmental 2017b; DAWE 2020g). The species was recorded in saline flats and depressions habitat in the Proposal area. This habitat is consistent with the species known preferred habitats for well vegetated shallows and margins of terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps claypans and dams for roosting and foraging (Pizzey and Knight 2007). The Proposal area also encompasses claypans and claypan mosaics which would be primary foraging and breeding habitat for the species following rain.

The Commonwealth's *Approved Conservation Advice for Rostratula australis (Australian painted snipe)* (TSSC 2013) and the *Draft National Recovery Plan for the Australian Painted Snipe Rostratula australis* (DotEE 2019a) have been considered in the assessment of the Proposal against significant impact criteria for MNES is provided in Table 12-4 and presented in Figure 12-4 (DotE 2013). In particular, threats to the species (Table 12-1: Threatening Processes) and habitat critical to the survival of the species has been used in the assessment.

Table 12-4: Significant impact criteria for the Australian Painted Snipe

Significant Impact Criteria	Likelihood of Impact	Justification
Will the action lead to a long-term decrease in the size of a population?	Unlikely	The Proposal is unlikely lead to a long-term decrease in the size of a population. Although the previous water bird surveys (360 Environmental 2017b; Duguid *et al.* 2005), may have missed peak activity of some waterbird species, given only a single individual was recorded from the Study Area and given the low number of records in the region, it is unlikely that the Proposal area supports an important population. Consequently, the development of the Proposal is unlikely lead to a long-term decrease in the size of a population.
Will the action reduce the area of occupancy of the species?	Unlikely	The Proposal is unlikely reduce the area of occupancy of the species. Given that only a single individual was recorded from the Study Area and given the low number of records in the region, the Proposal is unlikely reduce the area of occupancy of the species.
Will the action fragment an existing population into two or more populations?	Unlikely	The Proposal is unlikely to result in the fragmentation of existing populations. Given that only a single individual was recorded from the Study Area and given the low number of records in the region, the Proposal is unlikely to result in the fragmentation of existing populations.
Will the action adversely affect habitat critical to the survival of a species?	Unlikely	The Proposal is unlikely adversely affect habitat critical to the survival of the species. Although the Study Area may contain suitable foraging habitat, breeding, and roosting habitat, the Study Area is unlikely to be necessary for the long-term maintenance of the species, maintain genetic diversity/evolutionary development or for the reintroduction of a population. Consequently, the Proposal is unlikely adversely affect habitat critical to the survival of the species.
Will the action disrupt the breeding cycle of a population?	Unlikely	The Proposal is unlikely disrupt the breeding cycle of the population. Although the previous water bird surveys (360 Environmental 2017b; Duguid *et al.* 2005), may have missed peak activity of some species, given only a single individual was recorded from the Proposal area and the low number of records in the region, the Proposal is unlikely disrupt the breeding cycle of the population.
Will the action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Unlikely	The Proposal is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. The Proposal area may contain suitable foraging habitat, breeding, and roosting habitat. Primary habitat for the species within the Study Area has been defined as claypans and claypan mosaic and saline flats and depressions. With respect to the Proposal, these habitats occur in the following proportions: • Claypans and claypan mosaic habitat: A total of 15,960 ha occurs within the Study Area, of which 1,457 ha (9.13%) occurs within the Proposal area and 42.22 ha (0.26%) occurs within the Indicative Footprint. • Saline flats and depressions habitat: A total of 8,069 ha occurs within the Study Area, of which 151.24 ha (1.87 %) occurs within the Proposal area and 3.44 ha (0.04 %) occurs within the Indicative Footprint. Given the small proportions of these habitat that occur within the Indicative Footprint, the Proposal is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Significant Impact Criteria	Likelihood of Impact	Justification
Will the action result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?	Unlikely	The Proposal is unlikely to have a significant impact the species based on this criterion. Key threatening processes for the species includes: • Predation by feral predators, including cats and foxes; • Frequent and altered fire regimes; and • Weed encroachment. The Proposal has the potential to result in an increase of predators and the spread of weeds (e.g Buffel grass). Any spread of weeds may in turn have the potential to increase fuel loads, and the associated frequency and intensity of fire. These potential impacts will be mitigated via the following: • Implement a feral predator control program manage any potential increase in the prevalence of feral predators as a result of the Proposal. • Management of potential feral predator foraging resources (i.e. site landfill). • Implement a weed management procedure to limit the spread of existing weed species and the establishment of new weeds as a result of the Proposal Based on the proposed mitigation measures, the Proposal is unlikely to have a significant impact the species based on this criterion.
Will the action introduce disease that may cause the species to decline?	Unlikely	The Proposal is unlikely to have a significant impact the species based on this criterion. The Proposal is unlikely to introduce disease into the area. As such, the Proposal is unlikely to have a significant impact the species based on this criterion.
Will the action interfere with the recovery of the species?	Unlikely	The Proposal is unlikely to interfere with the recovery of the species. Despite the presence of the species, the Study Area does not provide habitat critical to the survival of the species and is therefore unlikely to interfere with the species recovery. The Proposal is unlikely to interfere with the recovery of the species.
Residual impact	No significant residual impact to the Australian Painted Snipe (*Rostratula benghalensis*).	



Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

Figure 12-4: Australian Painted Snipe records with respect to the Study Area and the Proposal.

12.4.4 Greater Bilby (*Macrotis lagotis*) (Vu)

The Greater Bilby formerly occurred over 70% of arid and semi-arid mainland Australia and is currently patchily distributed from the Tanami Desert in the Northern Territory to Broome and Warburton in WA. The Greater Bilby is omnivorous, using their strong forelimbs to dig for insects, larvae, seeds, bulbs, fruit and fungi (van Dyck and Strahan 2008). The Greater Bilby occupies a range of habitats including desert sandplains and dunefields with *Acacia* shrubland and spinifex hummock grasslands. They also occupy clay and stony areas in south-western Queensland (Menkhorst and Knight 2011; van Dyck *et al.* 2013; van Dyck and Strahan 2008). The Greater Bilby is solitary and shelter in deep burrows. They have large, shifting home ranges that change in response to food resources (van Dyck and Strahan 2008). Greater Bilby burrow use is relatively dynamic, with individuals maintaining several burrows at once and abandoning, re-using or excavating new burrows continually.

The Greater Bilby was recorded at 130 locations (77 burrows) in the Study Area via tracks, digs, burrows, scats and camera trap photos (Appendix G.1). Additionally, the species was recorded at 165 locations in the surrounding region (150 km), of which 66 occur near the Study Area (within 25 km). Based on the locations of records and known ecology, within the Study Area, primary habitat for the Greater Bilby was identified as gravel spinifex plain (92 locations) and spinifex sandplain (33 locations).

Due to the species high mobility, dynamic burrow use and the relatively high density of the species within and immediately surrounding the Study Area, alteration to the Indicative Footprint is unlikely to reduce potential impacts to the species as a result of clearing.

The Commonwealth's *Conservation Advice Macrotis lagotis Greater Bilby* (TSSC 2016b), *National Recovery Plan for the Greater Bilby Macrotis lagotis* (Pavey 2006) and the *Draft Recovery Plan for the Greater Bilby (Macrotis lagotis)* (DotEE 2019c) have been taken into consideration in the assessment of the Proposal against significant impact criteria for MNES is provided in Table 12-5 and presented in Figure 12-5 (DotE 2013). In particular, threats to the species (Table 12-1: Threatening Processes), assessments of 'important populations' and 'habitat critical to the survival of the species' has been used in the assessment.

Table 12-5: Significant impact criteria for the Greater Bilby

Significant Impact Criteria	Likelihood of Impact	Justification
Will the action lead to a long-term decrease in the size of an important population of a species?	Unlikely	The Proposal is unlikely to lead to a long-term decrease in the size of the population. The concept of 'important populations' is not relevant to the conservation of the Greater Bilby (DotEE 2019c). According to the 2019 Draft Recovery Plan, the Greater Bilby is considered a single population even though fragmentation and isolation has occurred across the species range (DotEE 2019c). However, given the prevalence of records in the Study Area (and adjacent to the Study Area) in recent years, the Study Area is considered to support an important component of the overarching population. The direct loss of individuals has the potential to occur if individuals are present in burrows during clearing. Based on survey work, 77 burrows have been recorded in the NIDE, of which eight burrows (10 %) occur within the Indicative Footprint. Additional Greater Bilby burrows are likely to occur within suitable habitat within the NIDE and potentially within the SIDE. The potential loss of individuals will be mitigated through the following: • Conduct pre-clearance survey (four weeks prior to clearing) within the Indicative Footprint. • Where clearing of burrows is unavoidable, mitigate impacts by relocating individuals to alternative suitable habitat following measures aligned with *Box 2. Guidelines for relocation of bilbies prior to vegetation clearing* within DBCA (2018): ○ Initially encourage burrow abandonment by disturbing entrance and monitoring (e.g. burrow sweeps and motion cameras) to confirm individual has left. Close burrow once abandoned. ○ If burrow not abandoned, trap individual at entrance and relocate before collapsing burrow, in the presence of suitably qualified fauna experts. • Implement feral control program to mitigate predation pressure prior to relocation program to increase success of program Road strike during haulage was identified as a potential impact to the species. To mitigate this potential impact haulage operations will be restricted to daylight hours. Additionally, road access will be restricted to operational traffic and local aboriginal communities. Feral predation and altered fire regimes are listed as key threats to the species and have potential to be increased as a result of the Proposal. To mitigate any potential increase in these threats to the species, the Proposal will implement a Fire Management Procedure, and Feral Predator Control Program. Based on the proposed mitigation measures, the Proposal is unlikely to lead to a long-term decrease in the size of the population.
Will the action reduce the area of occupancy of an important population?	Unlikely	The Proposal is unlikely to have a significant impact on the area of occupancy of the population. The concept of 'important populations' is not relevant to the conservation of the Greater Bilby as the species is considered a single population (DotEE 2019c). However, given the prevalence of records in the Study Area (and adjacent to the Study Area) in recent years, the Study Area is considered to support an important component of the overarching population. The area of occupancy within the Study Area aligns with the habitats described and delineated as primary habitats within Appendix G.1.

Significant Impact Criteria	Likelihood of Impact	Justification
		Primary habitats for the species in the Study Area have been identified as gravel spinifex plain (92 locations) and spinifex sandplain (33 locations). With respect to the Proposal, these habitats occur in the following proportions: • Gravel spinifex plain: A total of 9,646 ha occurs within the Study Area, of which 8,614 ha (89.30%) occurs within the Proposal area and 248.12 ha (2.57 %) occurs within the Indicative Footprint. • Spinifex sandplain: A total of 103,435 ha occurs within the Study Area, of which 28,189 ha (27.25%) occurs within the Proposal area and 754.20 ha (0.73 %) occurs within the Indicative Footprint. Proposed management measures include, where possible, implementing strict clearing mitigation, avoiding clearing wherever possible, minimising disturbance to primary habitats, particularly gravel spinifex plain, aligning the haul road with existing tracks wherever possible to minimise clearing and avoiding impacts to the broader Proposal area, and rehabilitating disturbed habitats. Given that clearing for the Proposal will result in the loss of only a small proportion of primary habitat (2.57% and 0.73%), and that these habitats are well represented within the wider landscape, the Proposal is unlikely to have a significant impact on the area of occupancy of the species.
Will the action fragment an existing important population into two or more populations?	Unlikely	The Proposal is unlikely to fragment the existing population into two or more populations. The Greater Bilby largely now occurs as small groups of the former near continuous distribution (DotEE 2019c). All 130 Greater Bilby records from within the Study Area occur within the 346 km NIDE. The construction of the haul road (24 m wide, 30% of which is on an existing cleared track) will pass through this population. Although clearing and construction of the haul road is unlikely to act as a physical barrier, impacts during operation has the potential to result in the exclusion of the Greater Bilby near the haul road. Potential operational impacts could include direct mortality of individuals from vehicle strikes as well as deter the Greater Bilby from the vicinity of the haul road via noise, vibration, dust, and light exposure. These potential impacts will be mitigated by the following measures: • Implement speed limits for all traffic at dawn/dusk and night time in habitats and areas of importance to significant species. • Restricting haulage operations to daylight hours. Closing the haul road to public access, with the exception of local communities. Based on the proposed mitigation measures, the Proposal is unlikely to fragment the existing population into two or more populations.
Will the action adversely affect habitat critical to the survival of a species?	Unlikely	The Proposal is unlikely to adversely affect habitat critical to the survival of the species. Habitat critical to the survival of the Greater Bilby may be more usefully defined at a bioregional scale, with any area where the species is known or likely to occur assessed as 'critical to the survival of the species' (DotEE 2019c). With respect to the Study Area, the areas of importance to the species aligns with the habitats described and delineated as primary habitats within Appendix G.1. With respect to the Proposal, these habitats occur in the following proportions: • Gravel spinifex plain: A total of 9,646 ha occurs within the Study Area, of which 8, 614 ha (89.30%) occurs within the Proposal area and 248.12 ha (2.57 %) occurs within the Indicative Footprint. • Spinifex sandplain: A total of 103,435 ha occurs within the Study Area, of which 28,189 ha (27.%) occurs within the Proposal area and 754.20 ha (0.73 %) occurs within the Indicative Footprint.

Significant Impact Criteria	Likelihood of Impact	Justification
		Proposed management measures include, where possible, minimising disturbance to primary habitats, particularly gravel spinifex plain, limiting disturbance to the Indicative Footprint, aligning the haul road with existing tracks wherever possible to minimise clearing and avoiding impacts to the broader Proposal area, and rehabilitating disturbed habitats. Although clearing for the Proposal will result in the loss of primary habitat, the Indicative Footprint will comprise only a small proportion of the extent in the Study Area and within the wider landscape. Given that clearing will affect a small proportion of the extent of primary habitats, the Proposal is unlikely to adversely affect habitat critical to the survival of the species.
Will the action disrupt the breeding cycle of an important population?	Unlikely	The Proposal is unlikely to disrupt the breeding cycle of the Greater Bilby population. The operation of the haul road has the potential to result in road strike of adults in search of mates or dispersing young. Additional secondary impacts could include altered fauna behaviour through noise, vibration, dust, and light exposure has the potential to result in reduced breeding potential in proximity to the haul road. These potential impacts will be mitigated by the following measures: • Implement speed limits for all traffic at dawn/dusk and night time in habitats and areas of importance to significant species. • Restricting haulage operations to daylight hours. Closing the haul road to public access, with the exception of local communities. Based on the proposed mitigation measures above, the Proposal is unlikely to disrupt the breeding cycle of the Greater Bilby population.
Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Unlikely	The Proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. The Study Area contains gravel spinifex plain and spinifex sandplain habitats which have been identified as important for foraging, breeding and dispersal. Although the Proposal will result in the loss of Greater Bilby habitat, the extent of these habitats within the Indicative Footprint comprise only a small proportion of the overall extent within the Study Area: gravel spinifex plain 248.12 ha (2.57%) and spinifex sandplain 754.20 ha (0.73%). Additionally, the removal of these habitats will mostly be limited to 24 m wide area within for the proposed haul road within the NIDE where clearing will be distributed over the 350 km length of the proposed haulage corridor. 30% of this haulage corridor is on an existing cleared track. In addition to the extent in the Study Area, these habitats are likely to be well distributed in the surrounding region. Given that primary habitat is extensive outside the Indicative Footprint, the Proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	Unlikely	The Proposal is unlikely to result in invasive species that are harmful to the Greater Bilby becoming established in Greater Bilby habitat. Predation by feral animals is listed as a key threatening process for the Greater Bilby. The Proposal has the potential to result in an increase of predators in the area due to ease of access along established roads, scavenging opportunities relating to increased human activity (e.g. food waste, landfills, etc) and increased roadkill along the haul road. The spread of weeds (e.g. Buffel Grass) via machinery, mobile equipment, and vehicles on the haul road has the potential to alter composition and structure of native vegetation communities resulting in reduced suitability for native fauna. Weeds have the potential to increase fuel loads, and the associated frequency and intensity of fire. Mitigation will primarily include:

Significant Impact Criteria	Likelihood of Impact	Justification
		• Implement a feral predator control program to manage any potential increase in the prevalence of feral predators as a result of the Proposal. • Management of potential feral predator foraging resources (i.e. site landfill). • Implement a weed management procedure to limit the spread of existing weed species and the establishment of new weeds as a result of the Proposal Based on the proposed mitigation measures, the Proposal is unlikely to result in invasive species that are harmful to the Greater Bilby becoming established in Greater Bilby habitat.
Will the action introduce disease that may cause the species to decline?	Unlikely	The Proposal is unlikely to introduce disease that may cause the species to decline. Introduced disease is not a key threatening process for the Greater Bilby. The Proposal is unlikely to introduce disease that may cause the species to decline.
Will the action interfere substantially with the recovery of the species?	Unlikely	The Proposal is unlikely to substantially interfere with the recovery of the species. The 2019 Draft Recovery Plan for the Greater Bilby identifies land clearance for the development of roads, fences, dams, mines and associated camps, pipelines and other industrial structures, agriculture, and settlements may interfere with the recovery of the species through habitat loss, increased risk of road kill, increased barriers to dispersal and gene flow, and increased predator densities resulting from changes in food and water resources (DotEE 2019c). Where there exists potential for the Proposal to increase these impacts, they will be mitigated via the following: • Implement a feral predator control program manage any potential increase in the prevalence of feral predators as a result of the Proposal. • Implement a Fire Management Procedure to limit any potential increase in unplanned fires as a result of the Proposal. • Restricting haulage operations to daylight hours. Closing the haul road to public access, with the exception of local communities. • Implement speed limits for all traffic, particularly at dawn/dusk and night time in habitats and areas of importance to significant species. Clearing for the Proposal will result in the loss of only a small proportion of primary habitat (2.57% and 0.73%), and that these habitats are well represented within the wider landscape. Additionally, mitigation will involve limiting clearing to the Indicative Footprint and avoiding primary habitats where possible. Given that the majority of potential impacts from the Proposal can be effectively mitigated, the Proposal is unlikely to substantially interfere with the recovery of the species.
Residual impact	Although there is not expected to be significant residual impact to the Greater Bilby, there is potential for significant residual impact to critical and supporting habitat of the species. Agrimin are committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).	

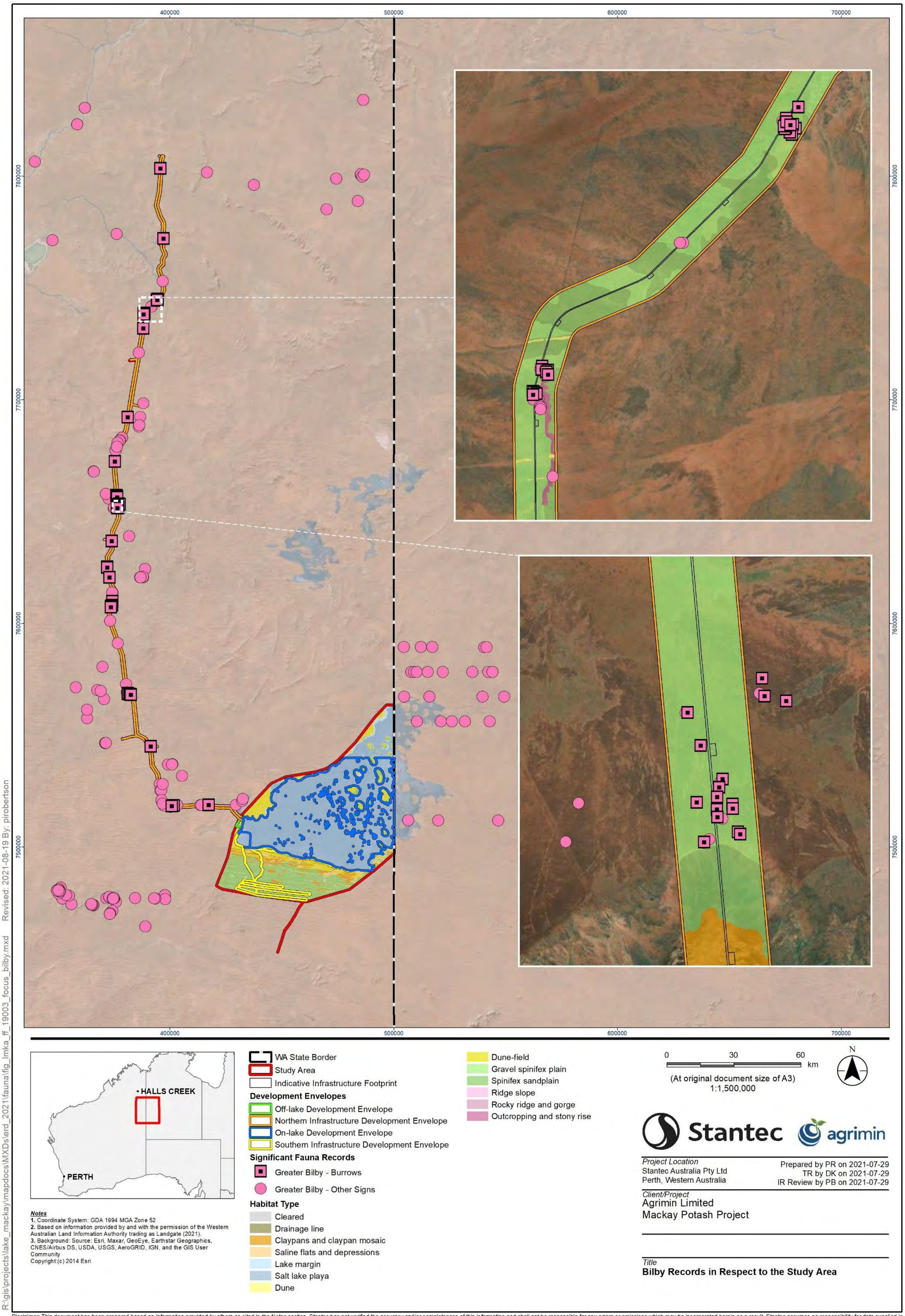


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Figure 12-5: Greater Bilby records with respect to the Study Area and the Proposal.

12.4.5 Great Desert Skink (*Liopholis kintorei*) (Vu)

The Great Desert Skink has undergone a widespread decline, with many historical populations no longer occurring. The species tends to occupy sandplains and swales with hummock grasses and scattered shrubs. The species lives communally in multi-generational family groups, with up to 10 individuals occupying a burrow system, using a shared latrine and maintaining the burrow. The species is long lived, potentially up to 20 years. Individuals are relatively sedentary, only moving up to 150 m from the burrow while foraging; however, may move up to 10 km to colonise new areas (DAWE 2020i). During the breeding season, males will mate with multiple females at multiple nearby burrows (DAWE 2020i).

Knowledge of the species current fine-scale distribution is unclear due to the remote and inaccessible nature of sites. However eight key populations occur in the following areas (TSSC 2016a), with population estimates listed where available (McAlpin 2001):

WA (n=~3,000, may exceed):

- Kiwirrkurra Indigenous Protected Area (managed by Central Desert Native Title Services) (n=<500);
- Karlamilyi National Park (managed by the Kanyirninpa Jukurrpa);
- Ngaanyatjarra Indigenous Protected Area (managed by Ngaanyatjarra Council);

Northern Territory (Tanami Desert n=<2,250):

- North-western Tanami Desert (Sangsters bore – Rabbit Flat region);
- Southern Tanami Indigenous Protected Area;
- Uluru-Kata Tjuta National Park (jointly managed by its traditional owners Anangu and Parks Australia) and adjoining Yulara freehold land (managed by the Indigenous Land Corporation) (n=~800);
- Newhaven Wildlife Sanctuary (managed by the Australian Wildlife Conservancy); and

South Australia (n=<50):

- Watarru on Anangu Pitjantjatjara Yankunytjatjara Lands.

In the Study Area, the primary habitat for the species is Spinifex Sandplain. The processes threatening the species are altered fire regimes, predation by cats and foxes (McAlpin 2001; Pavey 2006), predation by native predators (dingo and birds of prey), development and habitat destruction by introduced rabbits (McAlpin 2001; Pavey 2006).

The Great Desert Skink has been recorded from three areas within the Study Area:

- Yagga Yagga population which overlaps with the NIDE: 64 active burrows recorded approximately 22 km south of Yagga Yagga. After the population was better defined through additional targeted survey work, the NIDE was realigned so that all active burrows associated with the population were avoided with a buffer of 300 m.
- Murrawa population within the NIDE: two locations recorded in 2000. Subsequent targeted survey work has established that this population is no longer present.
- Lake Mackay population within the Study Area but outside the Proposal area: one location 10 km south of Lake Mackay from 2018. Subsequent targeted survey work has established that this population is no longer present.

Additionally, the species has been recorded at 138 locations in the surrounding region (150 km). Almost all are in a 30 km stretch of the Kiwirrkurra road ~20 km southeast of the Kiwirrkurra community (the Kiwirrkurra population)(DBCA 2020).

Assessment of the Proposal against significant impact criteria for MNES is provided in Table 12-6 and presented in Figure 12-6 (DotE 2013), which have taken into consideration the Commonwealth's *Recovery Plan for the Great Desert Skink (Egernia kintorei) 2001-2011*.

The Commonwealth's *Conservation Advice Liopholis kintorei great desert skink* (TSSC 2016a) and *A Recovery Plan for the Great Desert Skink (Egernia kintorei) 2001-2011* (McAlpin 2001) has been taken into consideration in the assessment of the Proposal against significant impact criteria for MNES is provided in Table 12-6 and presented in Figure 12-6 (DotE 2013). In particular, threats to the species (Table 12-1: Threatening Processes), occurrence of key populations and 'habitat critical to the survival of the species' has been used in the assessment.

Table 12-6: Significant impact criteria for the Great Desert Skink

Significant Impact Criteria	Likelihood of Impact	Justification
Will the action lead to a long-term decrease in the size of an important population of a species?	Unlikely	The Proposal is unlikely to result in a long-term decrease in the size of an important population of the species. Based on survey work, 64 active burrows have been recorded as forming the Yagga Yagga population. Given the size of the population and that the population is likely to be more extensive than currently recorded, the population is likely to be an important population for the species. The species is largely sedentary, only forages within 150 m of the burrow, and females have high fidelity with burrows for their lifespan (estimated to be up to 20 years). During the breeding season in spring and summer, males will mate with multiple females at nearby burrow systems. During this time, males are at greater risk of road strike and feral predation and this in turn may have a large impact on the breeding success of numerous burrow systems (DAWE 2020i). Potential impacts to this population have been mitigated by realigning the NIDE to avoid all active burrows associated with the population with a buffer of 300 m. Additionally, through the implementation of additional mitigation measures, the significance of impacts to the species can be further reduced. The loss of individuals will be mitigated through the following: • Implementing strict clearing mitigation that limit disturbance to the Indicative Footprint and avoid impacts to the broader Proposal area. • Conduct pre-clearance survey (four weeks prior to clearing) within the Indicative Footprint within primary habitat. There exists the potential for populations to occur elsewhere in the Proposal area, however no additional populations have been discovered despite extensive survey work and reconnaissance of historic records has found these populations are no longer present. • Restricting haulage operations to daylight hours. Closing the haul road to public access, with the exception of local communities. • Implement speed limits for all traffic at dawn/dusk and night time in habitats and areas of importance to significant species, specifically in the vicinity of the population. • Implement a feral predator control program to manage any potential increase in the prevalence of feral predators as a result of the Proposal. With the proposed mitigation measures, the Proposal is unlikely to result in a long-term decrease in the size of an important population of the species.
Will the action reduce the area of occupancy of an important population?	Unlikely	The Proposal is unlikely to reduce the area of occupancy of an important population of the species. Given the sedentary nature of the species, its long-life span and ecology, impacts to the 'area of occupancy' of an important population' will be the same as impacts to the 'size of an important population'. Through realigning the NIDE to avoid all active burrows associated with the Yagga Yagga population with a buffer of 300 m, the Proposal is unlikely to reduce the area of occupancy of an important population of the species.
Will the action fragment an existing important population into two or more populations?	Unlikely	The Proposal is unlikely result in the fragmentation of the population into two populations. Through realigning the NIDE to go around the core population, the proposed haul road minimises fragmentation of the population. Based on survey work, the population occurs primarily to the east of the revised NIDE with only two records found to occur to the west of the revised alignment of the NIDE. Furthermore, clearing and construction of the haul road is unlikely to act as a physical barrier to the species. Although road strike is unlikely to result in the loss of foraging individuals (within 150 m of burrows), there is the potential to impact upon males in search of females during the

Significant Impact Criteria	Likelihood of Impact	Justification
		breeding season and of dispersing juveniles. To further minimise potential impacts associated with road strike that could contribute to population fragmentation, haulage operations will be restricted to daylight hours. Through realigning the NIDE to go around the Yagga Yagga population and restricting haulage to daylight hours to reduce barriers to dispersal, the Proposal is unlikely result in the fragmentation of the population into two populations.
Will the action adversely affect habitat critical to the survival of a species?	Unlikely	The Proposal is unlikely to adversely affect habitat critical to the survival of the species. Great Desert Skinks occupy a variety of habitat types within the western deserts region (McAlpin 2001). While sandplain vegetated by spinifex (*Triodia* spp.) and scattered shrubs seems to be the habitat type most widely used (McAlpin 2001), the reason why some sandplains are occupied while others are not is unknown (McAlpin 2001). With respect to the Study Area, the primary habitat for the Great Desert Skink is the Spinifex sandplain habitat. With respect to the Study Area, the primary habitat for the Great Desert Skink is the Spinifex sandplain habitat. However, it is not understood why the Yagga Yagga population only occurs in a small proportion of this otherwise extensive habitat. A total of 103,435 ha of spinifex sandplain occurs within the Study Area, of which 28,189 ha (27.25%) occurs within the Proposal area and 754.20 ha (0.73 %) occurs within the Indicative Footprint. Proposed mitigation measures include, where possible, minimising disturbance spinifex sandplain, limiting disturbance to the Indicative Footprint and avoiding impacts to the broader Proposal area. Although clearing for the Proposal will result in the loss of some primary habitat, the Indicative Footprint will comprise a small proportion of the extent in the Study Area and within the wider landscape. Given that clearing will affect a small proportion of the extent of primary habitat, the Proposal is unlikely to adversely affect habitat critical to the survival of the species.
Will the action disrupt the breeding cycle of an important population?	Unlikely	Proposal is unlikely to disrupt the breeding cycle of an important population. During the breeding season, males will go in search of females and may visit multiple burrows within a population. To minimise impacts to the breeding cycle, the NIDE has been realigned to go around the core population. Based on survey work, the population occurs primarily to the east of the revised NIDE with only two active borrows found to occur to the west of the revised alignment of the NIDE. Clearing and construction of the haul road is unlikely to act as a physical barrier to the species. Although road strike is unlikely to result in the loss of foraging individuals (within 150 m of burrows), there is the potential to impact upon males in search of females during the breeding season and of dispersing juveniles. To minimise potential impacts associated with road strike that could disrupt the breeding cycle, haulage operations will be restricted to daylight hours. Through realigning the NIDE to go around the Yagga Yagga population and restricting haulage to daylight hours to reduce barriers to breeding males or dispersing juveniles, the Proposal is unlikely to disrupt the breeding cycle of an important population.
Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Unlikely	The Proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Primary habitat for the Great Desert Skink within the Study Area has been defined as spinifex sandplain. A total of 103,435 ha of spinifex sandplain occurs within the Study Area, of which 28,189 ha (27.25%) occurs within the Proposal area and 754.20 ha (0.73%) occurs within the Indicative Footprint. Given that the extent of spinifex sandplain habitat within the Indicative Footprint represents 0.73% (754.20 ha) of the known extent in the Study Area, the Proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Significant Impact Criteria	Likelihood of Impact	Justification
Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	Unlikely	Proposal is unlikely to increase the prevalence of feral predators or other invasive species within Great Desert Skink habitat. Predation by feral animals is listed as a key threatening process for the Great Desert Skink. Evidence of feral cats have been recorded at the Yagga Yagga population where tracks have indicated they are stalking Great Desert Skinks at the entrance to their burrows. The Proposal has the potential to result in an increase of predators in the area due to ease of access along established roads, scavenging opportunities relating to increased human activity (e.g. food waste, landfills, etc) and increased roadkill along the haul road. The spread of weeds (e.g. Buffel Grass) via machinery, mobile equipment, and vehicles on the haul road has the potential to alter composition and structure of native vegetation communities resulting in reduced suitability for native fauna. Weeds have the potential to increase fuel loads, and the associated frequency and intensity of fire. Altered fire regimes is a key threatening process for the species. Proposed mitigation measures will primarily include: • Implement a feral predator control program manage any potential increase in the prevalence of feral predators as a result of the Proposal. • Management of potential feral predator foraging resources (i.e. site landfill). • Implement a weed management procedure to limit the spread of existing weed species and the establishment of new weeds as a result of the Proposal. The Yagga Yagga population is currently under predation pressure from feral cats. However, based on the proposed mitigation measures, the Proposal is unlikely to increase the prevalence of feral predators or other invasive species within Great Desert Skink habitat.
Will the action introduce disease that may cause the species to decline?	Unlikely	The Proposal is unlikely to introduce disease that may cause the species to decline. Introduced disease is not listed as a threatening process for the Great Desert Skink. The Proposal is unlikely to introduce disease that may cause the species to decline.
Will the action interfere substantially with the recovery of the species?	Unlikely	The Proposal is unlikely to interfere substantially with the recovery of the species. The conservation advice for the Great Desert Skink (TSSC 2016a), identifies fire, predation, habitat degradation from rabbit and camels, and Buffel grass invasion as the main threatening processes for the Great Desert Skink. Proposed mitigation measures align with the conservation objectives of the conservation advice (TSSC 2016a), and include managing any potential increases in these threats as a result of the Proposal, including Fire Management Procedure, Feral Predator Control Program, and a Weed Management Plan. The Yagga Yagga population is likely to be a significant population; however, through realigning the haul road, and through implementing proposed mitigation measures, the Proposal is unlikely to interfere substantially with the recovery of the species.
Residual impact	Although there is not expected to be significant residual impact to the Great Desert Skink, there is potential for significant residual impact to critical and supporting habitat of the species. Agrimin are committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012)	

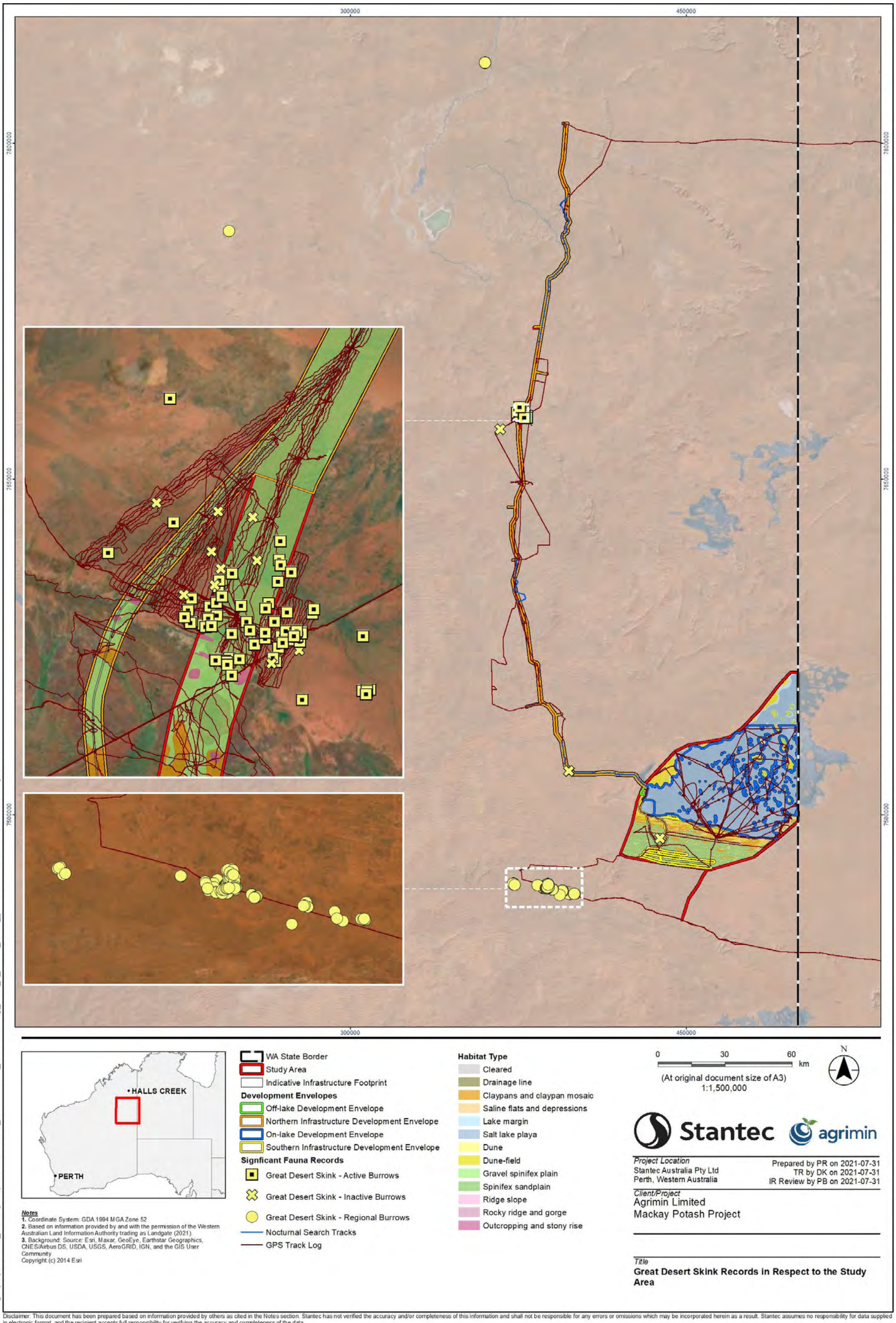

Figure 12-6: Great Desert Skink records with respect to the Study Area and the Proposal.

12.4.6 Grey Falcon (*Falco hypoleucos*) (Vu)

Considered rare, the Grey Falcon inhabits lightly treed inland plains, gibber deserts, sand ridges, and timbered watercourses (Menkhorst *et al.* 2017; Pizzey and Knight 2007) over much of inland arid Australia, including the Murray Darling Basin, Eyre basin, central Australia and WA (Marchant and Higgins 1993). Specifically, the species frequents *Acacia* shrublands with tree-lined water courses (TSSC 2020). They tend to forage near watercourses by ambushing flocks of smaller drinking or ground foraging birds (Menkhorst et al. 2017) but also hunt in treeless areas (TSSC 2020). They have also been recorded foraging on small mammals, reptiles and locusts (Olsen and Olsen 1986).

One opportunistic sighting of three Grey Falcons (a pair of adults with one juvenile) was recorded in the Study Area during Phase 1 of the Stantec 2020 Survey, indicating the species may breed in the area. The species was also recorded at 17 locations in the surrounding region (150 km), of which five occur near the Study Area (25 km). Based on the locations of records and known ecology, within the Study Area, primary habitats for the Grey Falcon have been identified as spinifex sandplain and gravel spinifex plain. Tall trees in the landscape are likely to be important for nesting however no evidence of nesting was recorded during the surveys.

The Commonwealth's *Conservation Advice Falco hypoleucos Grey Falcon* (TSSC 2020) has been taken into consideration in the assessment of the Proposal against significant impact criteria for MNES is provided in Table 12-7 and presented in Figure 12-7 (DotE 2013). In particular, threats to the species (Table 12-1: Threatening Processes) has been used in the assessment.

Table 12-7: Significant impact criteria for the Grey Falcon

Significant Impact Criteria	Likelihood of Impact	Justification
Will the action lead to a long-term decrease in the size of an important population of a species?	Unlikely	The Proposal is unlikely to lead to a long-term decrease in the size of an important population of the species. Given the species was only recorded from one location (three individuals) within the Study Area, and that the species forages widely in the landscape, the Study Area is unlikely to meet the criteria of supporting an important population. Consequently, the Proposal is unlikely to lead to a long-term decrease in the size of an important population of the species.
Will the action reduce the area of occupancy of an important population?	Unlikely	The Proposal is unlikely to reduce the area of occupancy of an important population of the species. Given the species was only recorded from one location (three individuals) within the Study Area, and that the species forages widely in the landscape, the Study Area is unlikely to meet the criteria of supporting an important population. Consequently, the Proposal is unlikely to reduce the area of occupancy of an important population of the species.
Will the action fragment an existing important population into two or more populations?	Unlikely	The Proposal are unlikely to fragment an existing population into two or more populations. The occurrence of the species in the Study Area is unlikely to meet the criteria of supporting an important population. Additionally, given the species forages widely in the landscape, direct and indirect impacts associated with the Proposal are unlikely to fragment an existing population into two or more populations.
Will the action adversely affect habitat critical to the survival of a species?	Unlikely	The Proposal will adversely affect habitat critical to the survival of the species Given the species forages widely and that there was no evidence of nesting in the Study Area, it is unlikely that the Study Area contains critical habitat for the survival of the species (DotE 2013). Given that habitat within the Study Area does not meet the criteria for critical habitat, it is unlikely that the Proposal will adversely affect habitat critical to the survival of the species
Will the action disrupt the breeding cycle of an important population?	Unlikely	The Proposal is unlikely disrupt the breeding cycle of an important population of the species. Given the species was only recorded from one location (three individuals) within the Study Area, and that the species forages widely in the landscape, the Study Area is unlikely to meet the criteria of supporting an important population. Although one individual was a juvenile, there was no evidence of nesting within the Study Area. Consequently, the Proposal is unlikely disrupt the breeding cycle of an important population of the species.
Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Unlikely	The Proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Although habitats within the Study Area do not meet the criteria for critical habitat (DotE 2013), suitable foraging habitat does occur. Primary foraging habitats for the Grey Falcon within the Study Area are gravel spinifex plain and spinifex sandplain. With respect to the Proposal, these habitats occur in the following proportions: • Gravel spinifex plain: A total of 9,646 ha occurs within the Study Area, of which 8,7614 ha (89.30%) occurs within the Proposal area and 248.12 ha (2.57 %) occurs within the Indicative Footprint. • Spinifex sandplain: A total of 103,435 ha occurs within the Study Area, of which 28,198 ha (27.25%) occurs within the Proposal area and 754.20 ha (0.73 %) occurs within the Indicative Footprint.

Significant Impact Criteria	Likelihood of Impact	Justification
		Given the species forages widely and that there was no evidence of nesting in the Study Area, the Proposal is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	Unlikely	The Proposal is unlikely result in invasive species becoming established that are harmful to the Grey Falcon. Key threatening processes for the Grey Falcon include land clearing, over grazing and drought which are known to reduce suitable habitat, population persistence and breeding success (Garnett *et al.* 2011; Olsen and Olsen 1986). The Grey Falcon does not appear to be suspectable to invasive species. Consequently, the Proposal is unlikely result in invasive species becoming established that are harmful to the Grey Falcon.
Will the action introduce disease that may cause the species to decline?	Unlikely	The Proposal is unlikely to introduce disease that may cause the species to decline. Introduced disease is not listed as a threatening process for the Grey Falcon. The Proposal is unlikely to introduce disease that may cause the species to decline.
Will the action interfere substantially with the recovery of the species?	Unlikely	The Proposal is unlikely to interfere substantially with the recovery of the species. As the Study Area does not contain an important population, or critical habitat for the survival of the species. Consequently, the Proposal is unlikely to interfere substantially with the recovery of the species.
Residual impact	No significant residual impact to the Grey Falcon (*Falco hypoleucos*).	

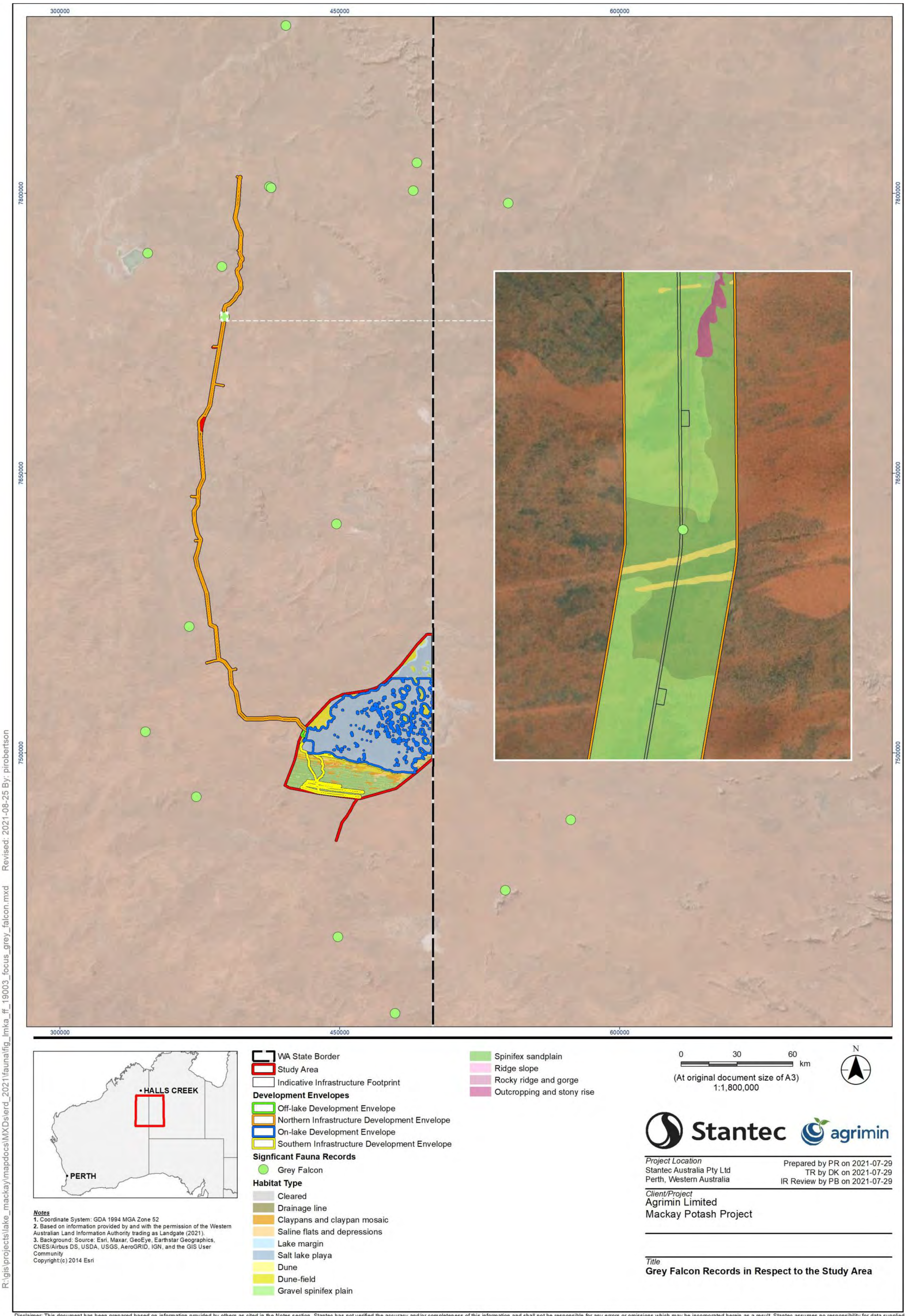

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Figure 12-7: Grey Falcon records with respect to the Study Area and the Proposal.

12.4.7 Dwarf Desert Spike-rush (*Eleocharis papillosa*) (Vu)

The Dwarf Desert Spike-rush is a clonal sedge that is classified as Vulnerable under the EPBC Act, and a Priority 3 species under the BC Act. It has been recorded once from the north-eastern edge of Lake Mackay within the Northern Territory, approximately 36 km east of the Proposal area. This species has not been recorded during any survey within the Study Area or the Proposal area including:

- Stantec (2021c) (Appendix F) Lake Mackay Potash Project: Detailed Flora and Vegetation Survey and Consolidation (two-phase survey and targeted flora survey);
- Stantec (2021a) (Appendix J) Lake Mackay Potash Project: Baseline Aquatic Ecology Study;
- Strategen Environmental (2018b), Lake Mackay Sulphate of Potash Project: Detailed Flora and Vegetation Assessment at Lake Mackay;
- 360 Environmental (2017a), Lake Mackay Sulphate of Potash Project: Detailed Flora and Vegetation Assessment at Lake Mackay;
- ecologia Environment (2017a), Agrimin Mackay Project: Level 1 Fauna and Single Phase Level 2 Flora Assessment;
- Outback Ecology (2012c) Toro Energy Ltd Theseus Project - Level 1 Flora and Vegetation Assessment; and
- BushBlitz (2015) Bush Blitz Kiwirrkurra Indigenous Protected Area Western Australia.

Habitat for the species has been identified as freshwater swamps of low salinity and with fringing vegetation, and the margins of lakes and claypans. Based on the proximity of the previous record and presence of suitable habitat within the Study Area and Proposal area, the species was assessed as Possible to occur (Appendix G.1).

The Species Profile and Threats Database (SPRAT) (DotEE 2019b) for Dwarf Desert Spike-rush indicates a Recovery Plan is not required, and that a Threat Abatement Plan has been identified as not relevant for this species. The SPRAT advises weed species such as **Cynodon dactylon* (Couch Grass) and **Cenchrus ciliaris* (Buffel Grass) pose a threat to Dwarf Desert Spike-rush.

The Australasian Virtual Herbarium database lists 38 locations of Dwarf Desert Spike-rush have been submitted as vouchered specimens to six Australian herbaria. Within WA, vouchered specimens of Dwarf Desert Spike-rush originate from 14 locations within five bioregions and separated by substantial distances (WAH 2021b). The widespread distribution of this species across WA, the Northern Territory and South Australia would indicate Dwarf Desert Spike-rush does not have a restricted range and therefore the Proposal will not pose a significant risk to the species (Figure 12-8).

The Commonwealth's Approved Conservation Advice for *Eleocharis papillosa* (Dwarf Desert Spike-rush) which includes threats to the species, has been taken into consideration in the assessment of the Proposal against significant impact criteria is provided in Table 12-8 and presented in Figure 12-8 (DotE 2013).

Table 12-8: Significant impact criteria for the Dwarf Desert Spike-rush

<table>
<tr><th>Significant Impact Criteria</th><th>Likelihood of Impact</th><th>Justification</th></tr>
<tr><td>Will the action lead to a long-term decrease in the size of an important population of a species?</td><td>Unlikely</td><td>The Proposal is unlikely to lead to a long-term decrease in the size of an important population of the species.
Given the species was not recorded within the Study Area, the Study Area does not meet the criteria of supporting an important population. Consequently, the Proposal is unlikely to lead to a long-term decrease in the size of an important population of the species.</td></tr>
<tr><td>Will the action reduce the area of occupancy of an important population?</td><td>Unlikely</td><td>The Proposal is unlikely to reduce the area of occupancy of an important population of the species.
Given the species was not recorded within the Study Area, the Study Area does not meet the criteria of supporting an important population. Consequently, the Proposal is unlikely to reduce the area of occupancy of an important population of the species.</td></tr>
<tr><td>Will the action fragment an existing important population into two or more populations?</td><td>Unlikely</td><td>The Proposal is unlikely to fragment an existing important population into two or more populations.
Given the species was not recorded within the Study Area, the Study Area does not meet the criteria of supporting an important population. Consequently, the Proposal is unlikely to fragment an existing important population into two or more populations.</td></tr>
<tr><td>Will the action adversely affect habitat critical to the survival of a species?</td><td>Unlikely</td><td>The Proposal is unlikely to adversely affect habitat critical to the survival of the species.
The Proposal area includes habitat that has potential to support the species in the form of the following five vegetation types: SaoFcTsa(Tb), MgTbTsaTs, EvTb(TsaTs), ±SahDrAcAhhFdAvll and AlSaoTbTp. The areas of these vegetation types in the Study Area, Proposal area and Indicative Footprint are presented in the table below.
<table>
<tr><th rowspan="2">Vegetation type</th><th rowspan="2">Extent within the Study Area (ha)</th><th colspan="2">Total Proposal area</th><th colspan="2">Total Indicative Footprint</th></tr>
<tr><th>ha</th><th>%</th><th>ha</th><th>%</th></tr>
<tr><td>SaoFcTsa(Tb)</td><td>5,972.17</td><td>70.51</td><td>1.18</td><td>0.20</td><td><0.01</td></tr>
<tr><td>MgTbTsaTs</td><td>5,833.57</td><td>153.74</td><td>2.64</td><td>5.64</td><td>0.10</td></tr>
<tr><td>EvTb(TsaTs)</td><td>544.14</td><td>28.18</td><td>5.18</td><td>0.84</td><td>0.15</td></tr>
<tr><td>±SahDrAcAhhFdAvll</td><td>382.92</td><td>382.92</td><td>100</td><td>16.80</td><td>4.39</td></tr>
<tr><td>AlSaoTbTp</td><td>208.91</td><td>208.91</td><td>100</td><td>9.25</td><td>4.43</td></tr>
<tr><td>Total</td><td>12,941.71</td><td>844.26</td><td>209.00</td><td>32.73</td><td>9.07</td></tr>
</table>
Percent values are calculated as the as a proportion of the area of that vegetation type within the Study Area.
Given the small proportion of the respective vegetation types proposed to be impacted by the Proposal, the Proposal is unlikely to adversely affect habitat critical to the survival of the species.</td></tr>
</table>

Significant Impact Criteria	Likelihood of Impact	Justification
Will the action disrupt the breeding cycle of an important population?	Unlikely	The Proposal is unlikely to disrupt the breeding cycle of an important population. Given the species was not recorded within the Study Area, the Study Area does not meet the criteria of supporting an important population. Consequently, the Proposal is unlikely to disrupt the breeding cycle of an important population.
Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Unlikely	Proposal is unlikely modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Potential habitat for the species potentially comprises the vegetation types: SaoFcTsa(Tb), MgTbTsaTs, EvTb(TsaTs), ±SahDrAcAhhFdAvll and AlSaoTbTp. Given that the species has not been recorded within the Proposal area and that the proportions of these vegetation types comprise a small proportion of the extent in the Study Area, the Proposal is unlikely modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	Unlikely	The proposal is unlikely to result in invasive species that are harmful, becoming established within Dwarf Desert Spike-rush habitat. The invasion of suitable habitat for the Dwarf Desert Spike-rush by Couch Grass has been listed as a threatening process for the species. Although Cooch Grass has not been recorded within the Study Area, the introduction and spread of weeds has been identified as a potential secondary impact of the Proposal. Mitigation of this potential impact will be primarily achieved through the following: • Implement a weed management procedure to limit the spread of existing weed species and the establishment of new weeds as a result of the Proposal • Eradicate weed infestations detected during inspections. • Implement a weed management procedure to limit the spread of existing weed species and the establishment of new weeds as a result of the Proposal Given that Couch Grass has not been recorded within the Study Area and given that mitigation measures will be implemented, it is unlikely that invasive species will become established in habitat for the Dwarf Desert Spike-rush. Consequently, the proposal is unlikely to result in invasive species that are harmful, becoming established within Dwarf Desert Spike-rush habitat.
Will the action introduce disease that may cause the species to decline?	Unlikely	The Proposal is unlikely to introduce disease that may cause the species to decline. Introduced disease is not listed as a threatening process for the Dwarf Desert Spike-rush. The Proposal is unlikely to introduce disease that may cause the species to decline.
Will the action interfere substantially with the recovery of the species?	Unlikely	The Proposal is unlikely to interfere substantially with the recovery of the species. As the Study Area does not contain an important population, the Proposal is unlikely to interfere substantially with the recovery of the species.
Residual impact	No significant residual impact to the Dwarf Desert Spike-rush (*Eleocharis papillosa*).	

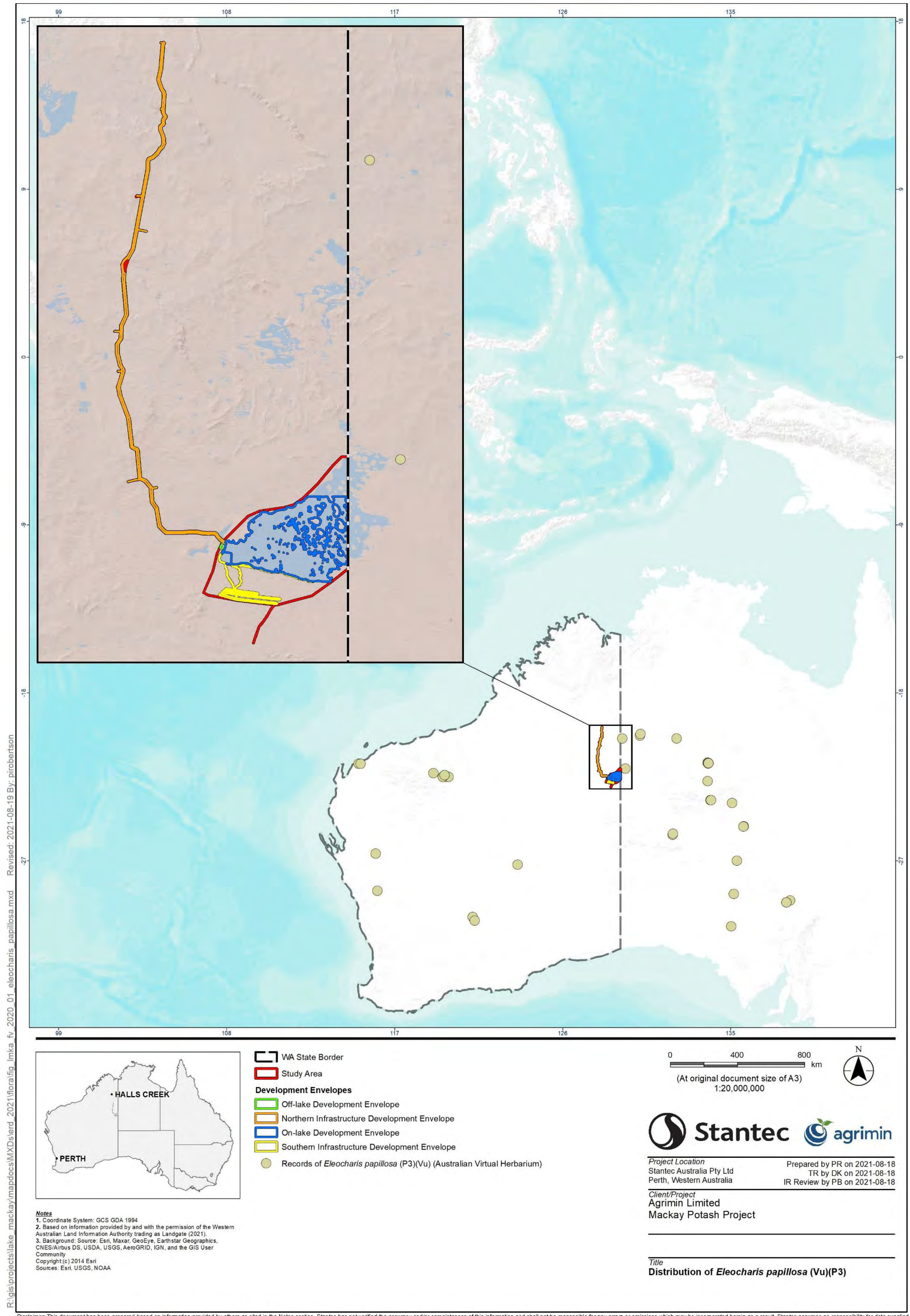

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Figure 12-8: Regional Dwarf Desert Spike-rush records with respect to the Study Area and the Proposal

12.5 Migratory Species and Habitats (Not a Controlling Provision)

Agrimin notes that the EPBC Act's controlling provision for 'List Migratory Species' was not triggered for this Proposal. Agrimin's consideration for migratory species demonstrates its commitment to understanding and protecting the environmental values of the Great Sandy Desert region.

Migratory species under the EPBC Act are birds, mammals or reptiles listed under international agreements. Desktop assessments were undertaken, which included the protected matter search tool, to identify migratory species with potential to occur and be potentially impacted by the Proposal. Based on the desktop assessment, 25 migratory species were recorded within 100 km of the Proposal.

An assessment of likelihood of occurrence was undertaken for the 25 migratory species that was informed by survey work and the results of the desktop study (Appendix G.1). Based on this assessment, nine migratory species were confirmed and four were considered likely to occur. The remaining species were either considered possible (five species), unlikely (five species) or as not occurring in the Great Sandy Desert or Tanami bioregions (two species). A summary of key threats, records in the Study Area, habitat requirements and ecology for each migratory species recorded or likely to occur is presented in Table 12-10 and Table 12-11, respectively. The locations of these records with respect to the Proposal are presented within Figure 12-9.

Aside from the Fork-tailed Swift, the remaining 12 migratory species confirmed (8) or likely (4) to occur were waterbirds that may utilise Lake Mackay and the peripheral wetlands after periods of rainfall. Previous waterbird surveys at Lake Mackay have recorded migratory shorebirds following large inundation events in 2001 and 2016 and during a smaller inundation event in 2021 (Table 7-6, Appendix G.1). See Section 7.4.1.2 for a summary of previous waterbird surveys and inundation events at Lake Mackay.

Table 12-9: Summary of waterbird recorded during waterbird surveys of Lake Mackay.

Waterbird Survey	Waterbird species (confirmed ID)*	Listed species	Waterbird abundance	Inundation duration (> 20 %)
2001 Survey (Duguid *et al.* 2005)	20	3	42,473	398 days
2017 Survey (360 Environmental 2017b)	25	5	3,273	89 days
2021 Survey (Appendix G.1)	12	4	42,194	24 days
Total	34	8	-	-

*Note: * indicates excludes non-waterbird species and waterbird species that could not be confirmed to species level e.g. Tern Whiskered or White-winged.*

Based on the analysis of available historical satellite imagery, Lake Mackay had 58 inundation events (with over 20 % inundation) over the last 33 years of available imagery (Appendix I.21)(Figure 7-11). Typically, the duration of these events lasted less than a month. Of the 58 events, 21 were equivalent or greater in duration to the event observed during the 2021 waterbird survey (24 days) while only two were greater in duration than the event observed during the 2017 waterbird survey (more than 400 mm of rainfall; 89 days duration). These large inundation events (greater than 89 days) were 139 days in 2000 and the event observed during the 2001 waterbird survey estimated to be 398 days in duration. This event in 2000/2001 was the longest inundation event on available records and was nearly 30 times the average inundation duration. Lake levels were predicted to have reached approximately 4 m in the south-east of the lake, initially spilling into the surrounding riparian vegetation zone.

Listed migratory bird species are protected under the EPBC Act and further delineated to recognise migratory shorebirds that are protected under international migratory shorebird agreements. Most migratory shorebirds make an annual return journey of thousands of kilometres between their breeding grounds in the northern hemisphere and their non-breeding grounds in the southern hemisphere (DotE 2015). This migration pattern involving species that return to Australia is termed the East Asian – Australasian flyway. In general, each year, migratory shorebirds arrive in Australia in September and disperse across Australia to feed over summer months before gathering again in flocks to depart on their northern migration in March. Currently there are 37 species of migratory shorebirds that visit Australia (DotE 2015) and their populations were last officially assessed by Hansen *et al.* (2016b).

Based on the previous surveys, Lake Mackay meets the threshold of representing internationally important habitat for migratory shorebirds. Between 3,758 to 10,000 individuals per observation were recorded foraging on the playa in 2021, equating to 4.4% to 11.8% of the flyway population which is well over the 1% threshold for international importance. In 2017 Red-necked Stints on the playa and peripheral wetlands (502 individuals) exceeded the 0.1% of the flyway population considered for national significance (0.1 % threshold = 475 individuals). Additionally, the Oriental Plover is considered likely to trigger the criteria for the habitat at Lake Mackay being nationally important as they were recorded in numbers that are internationally significant at Lake Gregory (265 km from Lake Mackay).

Significant impact criteria for listed migratory species (excluding migratory shorebirds) requires an assessment of whether the habitat is 'important habitat for a migratory species' and whether records represent an 'ecologically significant proportion' of the population. Each of these species were assessed against these criteria within Appendix G.1. The assessment for migratory waterbirds (excluding migratory shorebirds) against the significant impact criteria for listed migratory species according to DotE (2013) are detailed within Table 12-12. This assessment only includes the Gull-billed Tern and the Fork-tailed Swift.

Significant impact criteria for migratory shorebirds requires an assessment of whether the area contains an 'ecologically significant proportion' of the population is presented within Appendix G.1 and is based on population estimates provided within Hansen *et al.* (2016b). The assessment against the significant impact criteria for migratory shorebirds, according to DotEE (2017), is detailed within Table 12-13. This assessment collectively assesses potential impacts to migratory shorebird habitat for all species confirmed or likely to occur. The process acknowledges that Lake Mackay triggers the threshold as being internationally important habitat based on supporting over 1 % of the fly-way population of the Sharp-tailed Sandpiper. The guidelines also acknowledge that ephemeral wetlands such as Lake Mackay may trigger this criteria for assessment even if they only occasionally provide suitable habitat.

The Fork-tailed Swift (Mi) is listed as migratory under the EPBC Act and was confirmed to occur; however, is not assessed against the MNES criteria. This species is likely to fly over the Study Area periodically, but as it is an aerial forager that does not breed in Australia, it is not dependent on habitats within the Study Area. Therefore, the criteria within DotE (2013) are not relevant to this species.

Recorded:

- Red-necked Stint (*Calidris ruficollis*) (Mi: migratory shorebird);
- Sharp-tailed Sandpiper (*Calidris acuminata*) (Mi: migratory shorebird);
- Oriental Plover (*Charadrius veredus*) (Mi: migratory shorebird);
- Common Greenshank (*Tringa nebularia*) (Mi: migratory shorebird);
- Marsh Sandpiper (*Tringa stagnatilis*) (Mi: migratory shorebird);
- Glossy Ibis (*Plegadis falcinellus*) (Mi);
- Gull-billed Tern (*Sterna nilotica*) (Mi);
- White-winged Black Tern (*Sterna leucoptera*) (Mi); and
- Fork-tailed Swift (*Apus pacificus*) (Mi).

Likely to occur:

- Common Sandpiper (*Tringa hypoleucos*) (Mi: migratory shorebird);
- Pectoral Sandpiper (*Calidris melanotos*) (Mi: migratory shorebird);
- Oriental Pratincole (*Glareola maldivarum*) (Mi: migratory shorebird); and
- Wood Sandpiper (*Tringa glareola*) (Mi: migratory shorebird).

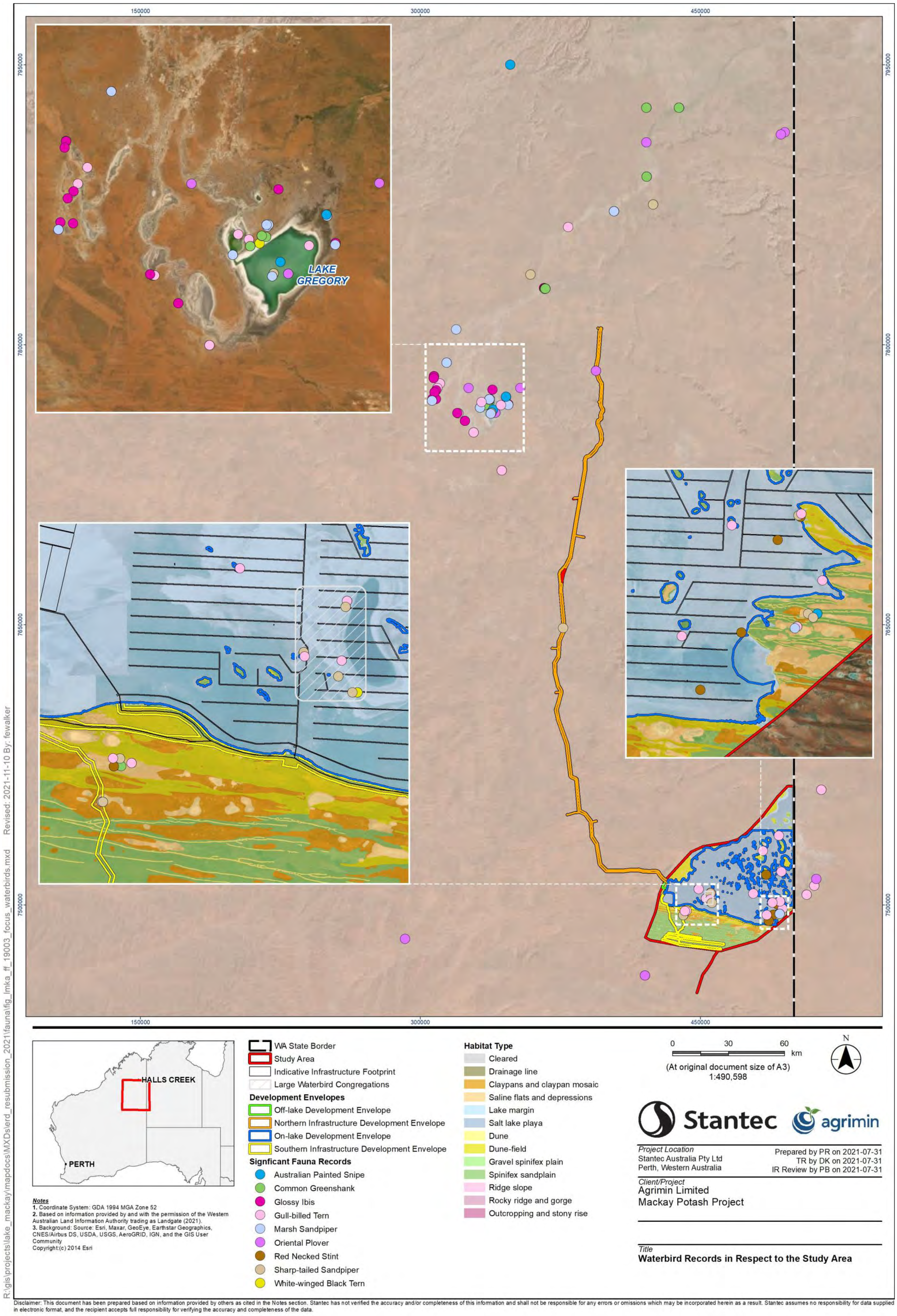

Figure 12-9: Migratory bird records with respect to the Study Area and the Proposal.

Table 12-10: Summary of listed migratory species confirmed from the Study Area

Common name (*Scientific name*)	Conservation status		Threatening processes and reason for listing	Consolidated records in the Study Area	Primary habitat(s) within the Study Area and number of recorded locations.
	EPBC Act	BC Act			
Birds					
Fork-tailed Swift (*Apus pacificus*)	Mi	IA	Threatening processes: • There are no significant threats to the Fork-tailed Swift in Australia; however, potential threats include habitat destruction and predation by feral animals (DAWE 2020a).	Confirmed The species was recorded at one location in the Study Area, flying over Lake Mackay in 2017 (360 Environmental 2018c). The species was recorded at 5 locations in the surrounding region (150 km) during the 1970s – 2010 (Birdlife Australia 2020).	Ecology: The Fork-tailed Swift is an aerial species, foraging in high-flying flocks over a wide range of habitats including islands, open country, coasts, semi-deserts, urban, forests. The species is a non-breeding visitor to Australia, is an exclusive aerial forager and has a large foraging range. Primary habitat (foraging): • The species is aerial and may use all habitats within the Study Area without being dependent on specific types.
Birds - Waterbirds and migratory shorebirds					
Red-necked Stint (*Calidris ruficollis*)	Mi	IA	Threatening processes (within Australia): • Habitat loss from clearing, inundation, draining or infilling of roosting and foraging habitat; • Loss of marine or estuarine vegetation; • Invasion of mudflat by weeds; • Water pollution; • Human disturbance from residential and recreational activities; • Bird strike from wind turbines and aircraft; and • Climate change (DAWE 2020d).	Confirmed The species was recorded at five locations in the Study Area at Lake Mackay and surrounding claypans in 2017, comprising 252 and 250 individuals, respectively (360 Environmental 2017b; Birdlife Australia 2020). The species was recorded at seven locations at, or near, Lake Gregory between 1980 and 2005 (Birdlife Australia 2020).	Ecology: The Red-necked Stint over-winters in Australia during the non-breeding season, where it is distributed along most of the Australian coastline. Following rainfall events, the following habitats in the Study Area may provide suitable foraging habitat for the species; Primary habitats (foraging): • Salt lake playa (4 locations); • Saline flats and depressions (1 location); • Lake margin; and • Claypans and claypan mosaic.
Sharp-tailed Sandpiper (*Calidris acuminata*)	MI	IA	Threatening processes (within Australia): • Habitat loss and degradation, via land clearing, inundation, draining and diversion of water; • Weed encroachment; • Pollution; • Climate change; • Human disturbance; and • Exposure to ASS, all of which reduces the availability of foraging and roosting sites for the species (DAWE 2020c)	Confirmed The species was recorded in the Study Area from nine locations. Most individuals were recorded foraging on the playa in 2021 by Stantec: between 3,758 and 10,000 individuals were recorded per observation, with a survey total of 27,733 however this likely includes large numbers of repeat individuals (Appendix G.1). Additionally, 37 individuals from four locations were recorded in 2017 on Lake Mackay and one location (four individuals) within the proposed haulage corridor during the Stantec Survey (360 Environmental 2017b; Birdlife Australia 2020; DBCA 2020) (Appendix G.1). The species was recorded at 10 locations in the surrounding region (150 km) from the 1970s – 2018, none of which are near the Study Area (25 km). This includes 10,000 individuals recorded at Lake Gregory (Bamford *et al.* 2008) which is considered internationally important (DotEE 2017).	Ecology: The Sharp-tailed Sandpiper spends its non-breeding season in Australia, where most of the population migrates to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Following rainfall events, the following habitats within the Study Area may provide suitable foraging habitat for the species; Primary habitat (foraging): • Saline flats and depressions (5 locations); • Claypan and claypan mosaic (1 location); • Salt lake playa (1 location); and • Lake margin.
Marsh Sandpiper (*Tringa stagnatilis*)	MI	IA	Threatening processes (within Australia): • Habitat loss via land clearing, inundation, infilling or draining reducing the availability of roosting and foraging sites; • habitat degradation via weed encroachment, loss of marine or estuarine vegetation, pollution, and ASS; • residential or recreational human disturbance, and • bird strike from wind turbines and aircraft (DAWE 2020m).	Confirmed The species was recorded in saline flats and depressions habitat in the periphery of Lake Mackay following lake inundation in 2021 (six individuals from one location) (Appendix G.1). Additionally, the species was recorded in recorded in the surrounds (150 km) at 11 locations, none of which occur in close proximity (25 km) to the Study Area. The species was recorded at Lake Gregory and to the north of Lake Gregory between 1986 and 2005 at 10 locations (Birdlife Australia 2020; DBCA 2020), and 65 km to the north of the Study Area on Sturt Creek in 1978 (DBCA 2020).	Ecology: The Marsh Sandpiper migrates to Australia from September to November during their non-breeding season, ranging across the eastern states, Northern Territory, northern WA, and the southern and western coastlines. Habitats include coastal and inland wetlands (e.g. shallow salt, brackish and freshwater wetlands), sewage ponds, mangroves, tidal mudflats, and estuaries (Menkhorst *et al.* 2017; Pizzey and Knight 2007). The Marsh Sandpiper forages on insects, molluscs and crustaceans (Higgins and Davies 1996). The species does not breed in Australia. Primary habitat (foraging): • saline flats and depressions (1 location); • claypan and claypan mosaic; • salt lake playa; and • lake margin.

Common name (*Scientific name*)	Conservation status		Threatening processes and reason for listing	Consolidated records in the Study Area	Primary habitat(s) within the Study Area and number of recorded locations.
	EPBC Act	BC Act			
Oriental Plover (*Charadrius veredus*)	Mi	IA	Threatening processes: There are no threatening processes specific to Oriental Plovers in Australia, but threats may include; • Bird strike; and • Human disturbance (DAWE 2020l).	Confirmed Three individuals were recorded in the Study Area from one location within the proposed haulage corridor. The species was recorded at 13 locations in the surrounding region (150 km) from 1992 – 2010, of which three occur near the Study Area (25 km) (Birdlife Australia 2020; DBCA 2020). Records included 25,707 individuals in 1989 from Lake Gregory (Bamford *et al.* 2008) which is considered internationally important (DotEE 2017).	Ecology: The entire global population of Oriental Plovers is considered to occur in Australia during the non-breeding season. The species occurs at numerous and widespread sites in Australia, especially along the north-western (and to a lesser extent, northern) coast and at many scattered sites inland. Primary habitat (foraging): • Spinifex sandplain (1 location); • Gravel spinifex plain; and • Claypan and claypan mosaic.
Common Greenshank (*Tringa nebularia*)	MI	IA	Threatening processes (within Australia): • Loss and modification of roosting and foraging habitat due to residential, farming, industrial and aquaculture/fishing activities; • Pollution; • Weed encroachment; and • Human disturbance (DAWE 2020l).	Confirmed Four individuals were recorded in the Study Area from one location in 2017 at Lake Mackay (360 Environmental 2017b). The species was recorded at 15 locations in the surrounding region (150 km) from 1977 – 2005, none of which occur near the Study Area (25 km) (DBCA 2020).	Ecology: The Common Greenshank does not breed in Australia but has the widest distribution of any shorebird in the country. Following rainfall events, the following habitats within the Study Area may provide suitable foraging habitat for the species; Primary habitat (foraging): • Saline flats and depressions (1 location); • Claypan and claypan mosaic; • Salt lake playa; and • Lake margin.
Gull-billed Tern (*Sterna nilotica*)	Mi	IA	Threatening processes: There are no threatening processes specific to Gull-billed Terns in Australia, but general threats to seabirds such as terns is largely; • Predation at nesting colonies by introduced and feral predators (Dias et al. 2019).	Confirmed The species was recorded at Lake Mackay; 39 individuals were recorded at Lake Mackay and peripheral wetlands in 2017 (360 Environmental 2017b) and 14 individuals were recorded at the lake in 2001 (Duguid *et al.* 2005). The species was recorded at Lake Gregory from 15 locations between 1977 and 2006, and at Sturt Creek (35-60 km north-east of the Study Area) between 1978 and 2001 at four locations (DBCA 2020).	Ecology: Gull-billed Terns occur on all continents except Antarctica. Habitats include beaches, mudflats, fresh and brackish wetlands and salt lakes, including those far inland, freshwater swamps, grasslands, crops and ploughed fields, throughout much of Australia. Following rainfall events, the following habitats within the Study Area may provide suitable foraging habitat for the species; Primary habitat (foraging and breeding); • Saline flats and depressions (2 location); • Salt lake playa (3 locations); • Lake margin (2 locations); and • Claypan and claypan mosaic.
White-winged Black Tern (*Sterna leucoptera*)	Mi	IA	Threatening processes: • The main threatening process in south-east Queensland where human disturbance (recreational and residential) is affecting their behaviour and displacing them from their habitat. • No other threats are listed for the species throughout the rest of its range (DAWE 2020g).	Confirmed The species was recorded foraging on the inundated lake playa in 2021; 83 individuals were identified in breeding plumage in a flock with a further 608 individuals in non-breeding plumage that were potentially Whiskered Terns or White-winged Black Terns (Appendix G.1). The species was recorded once in the surrounding region (150 km) at Lake Gregory in 1999 (60 km from Study Area) (Birdlife Australia 2020; DBCA 2020).	Ecology: (Menkhorst *et al.* 2017) The White-winged Black Tern occupies large coastal and inland wetlands (both fresh and saline), sewage ponds, estuaries, coastal water, lagoons, grassy swamps and inundated grasslands (Menkhorst *et al.* 2017; Pizzey and Knight 2007). The White-winged Black Tern is an opportunistic forager, feeding mainly on aquatic insects, and less often on terrestrial insects, spiders, small fish, tadpoles, frogs and skinks (DAWE 2020g). They mainly forage over coastal estuaries and freshwater wetlands. The species does not breed in Australia. Primary habitat (foraging): • saline flats and depressions; • claypan and claypan mosaic; • salt lake playa (1 location); and • lake margin.
Glossy Ibis (*Plegadis falcinellus*)	Mi	IA	Threatening processes: • Destruction and degradation of wetland habitat via water diversion, draining and irrigation, clearing, grazing, burning, and/or invasion by exotic plants; • Human disturbance; and • Disease (DAWE 2020j).	Confirmed 110 Glossy Ibis were recorded at Lake Mackay during the survey (360 Environmental 2017b; Duguid *et al.* 2005). While this included the NT portion of the lake (outside the Study Area), their presence on Lake Mackay demonstrates they would use the Study Area. The species was recorded in the surrounding region (150 km) at 27 locations during 1986 – 2007, none of which occur near the Study Area (25 km) (Birdlife Australia 2020; DBCA 2020).	Ecology: The species tends to forage in shallow fresh water but also in estuarine water or grasslands. Following rainfall events, the following habitats in the Study Area may provide suitable foraging and breeding habitat for the species; Primary habitat (foraging, unlikely to breed in the Study Area however known to breed in dense, low vegetation near water): • Saline flats and depressions; • Claypan and claypan mosaic; • Salt lake playa (including the islands) (foraging only); and • Lake margin (foraging only).

Table 12-11: Summary of Listed Migratory Species likely to occur within the Study Area

Common name (*Scientific name*)	Conservation status EPBC Act	BC Act	Threatening processes	Ecology	Likelihood of occurrence: Records in the Study Area and surrounds	Important habitat within the Study Area
Waterbirds and migratory shorebirds						
Common Sandpiper (*Tringa hypoleucos*)	Mi	IA	Threatening processes: • Habitat loss; • The draining of wetlands and the diversion of water to agriculture and reservoirs; • Pollution; • Climate change; and • Human disturbance (DAWE 2020b).	Ecology: Common Sandpipers are commonly associated with shallow aquatic habitats, including wetlands, marshes, sewage ponds, river and creek line flats, tidal flats, grassy edges of wetlands, mudflats, saltmarshes, estuaries, lake margins and other inland water and bore or grassy plains (Johnstone and Storr 1998; Menkhorst *et al.* 2017). The species has a varied diet, often comprising invertebrates, including worms, bivalves, molluscs, crustaceans, and insects (such as termites, beetles, grasshoppers, crickets) and their larvae, arachnids, plants, seeds, algae, fish and frogs.	Likely The species was not recorded in the Study Area, but was recorded once on the eastern edge of Lake Mackay in 2001 in the Northern Territory (NT Fauna Atlas in (ecologia Environment 2017a)). They were recorded at Lake Gregory from two locations in 1998 and 1999, and six were recorded ~80km north at Sturt Creek in the 1970s (DBCA 2020).	Following rainfall events, the following habitats in the Study Area may provide suitable foraging habitat for the species; Primary habitat (foraging): • Saline flats and depressions; • Claypan and claypan mosaic; • Salt lake playa; and • Lake margin.
Pectoral Sandpiper (*Calidris melanotos)*	Mi	IA	Threatening processes: • Habitat loss reducing availability of foraging and roosting sites; • Habitat degradation including loss of vegetation; • Weed encroachment; • Water pollution; • ASS potentially restricting foraging habitat; • Human disturbance; and • Bird strike from wind turbines and aircraft (DAWE 2020f).	Ecology The Pectoral Sandpiper is only occasionally recorded in WA; however, it has been observed at the Nullarbor Plain, Reid, Stoke's Inlet, Grassmere Lake, Warden Lake, Dalyup and Yellilup Swamp, Swan River, Benger Swamp, Guraga Lake, Wittecarra, Harding River, coastal Gascoyne, the Pilbara and the Kimberley (DAWE 2020f). Migratory species are commonly associated with shallow aquatic habitats, including wetlands, marshes, sewage ponds, river and creek line flats, tidal flats, grassy edges of wetlands, mudflats, saltmarshes, estuaries, lake margins and other inland waters and bore or grassy plains (Johnstone and Storr 1998; Menkhorst *et al.* 2017)	Likely The species was not recorded in the Study Area, and the Study Area is outside the species range (Menkhorst *et al.* 2017). However, it was recorded in the region (150km) at two locations, once at Lake Gregory in 2000 and a single individual 45 km to the north-west of the Study Area in 2018 at Sturt Creek (Birdlife Australia 2020).	Following rainfall events, the following habitats in the Study Area may provide suitable foraging habitat for the species: Primary habitat (foraging): • Saline flats and depressions; • Claypan and claypan mosaic; • Salt lake playa; and • Lake margin.
Oriental Pratincole (*Glareola maldivarum*)	Mi	IA	Threatening processes: There are no threatening processes specific to Oriental Pratincole in Australia, but threats may include; • Bird strike from wind turbines and aircraft; • habitat loss due to changes to grazing regimes; and • habitat loss due to development (DAWE 2020e). Outside Australia, habitat destruction and hunting are key threats (DAWE 2020e).	Ecology: The Oriental Pratincole migrate from eastern Asia, foraging on the wing in and above open country in northern Australia. Inhabits open plains, shallow wet and dry edges of open bare wetlands, tidal mudflats, beaches (Menkhorst *et al.* 2017; Pizzey and Knight 2007). They roost in bare areas such as claypans or areas with low vegetation, such as saltmarshes. They usually rest in the heat of the day near the edges of terrestrial wetlands (DAWE 2020e). Within Australia the Oriental Pratincole is widespread in northern areas, especially along the coasts of the Pilbara Region and the Kimberley Division in WA, northern NT, and parts of the Gulf of Carpentaria. It is also widespread but scattered inland (DAWE 2020e).	Likely Although not recorded in the Study Area, the Oriental Pratincole was recorded nearby, within 3 km of the most northerly section of the Study Area in 2001 (Birdlife Australia 2020; DBCA 2020). The species was recorded at three locations to the north of the Study Area on Sturt Creek in the 1970s (DBCA 2020), and 1,000 individuals were recorded near the Tanami minesite in 2002 (Birdlife Australia 2020). The species was recorded in spinifex sandplain habitat adjacent to the Study Area. This habitat is consistent with the species known habitat preferences, which include open plain country and shallow wet and dry edges of open bare wetlands (Menkhorst *et al.* 2017; Pizzey and Knight 2007), suitable for foraging.	Following rainfall events, the following habitats within the Study Area may provide suitable foraging and roosting habitat for the species; Primary habitat (foraging and roosting): • Saline flats and depressions; • Claypan and claypan mosaic; and • Lake margin. Secondary habitat (foraging): • Spinifex sandplain.
Wood Sandpiper (*Tringa glareola*)	Mi	IA	Threatening processes (within Australia): • Habitat loss via land clearing, inundation, infilling or draining reducing the availability of roosting and foraging sites, • Habitat degradation via weed encroachment, • Loss of marine or estuarine vegetation, • Pollution, and ASS, • Residential or recreational human disturbance, and • Bird strike from wind turbines and aircraft (DAWE 2020j).	Ecology: Migrating to Australia in September to April in the non-breeding season, the Wood Sandpiper can be found throughout mainland Australia but is generally more common in northern Australia. The species is uncommon in southern Australia and sparse throughout inland habitat. Their habitat includes muddy margins of freshwater wetlands and tidal mudflats, tidal mangroves, saltmarshes, and sewage ponds (Menkhorst *et al.* 2017; Pizzey and Knight 2007). The species mainly forages on insects and molluscs (Higgins and Davies 1996), but will also eat seeds, algae, worms, crustaceans, arachnids, fish and frogs. The species does not breed in Australia.	Likely The species was not recorded in the Study Area but was recorded in the surrounding region (150 km) at 10 locations, none of which occur in close proximity (25 km) to the Study Area. The species was recorded at and around Lake Gregory from five locations between 1986 and 2005 (Birdlife Australia 2020; DBCA 2020) and at five locations on Sturt Creek to the north between 1977 and 2005 (DBCA 2020).	Following rainfall events, the following habitats in the Study Area may provide suitable foraging habitat for the species; Primary habitat (foraging): • Saline flats and depressions; • Claypan and claypan mosaic; • Salt lake playa; and • Lake margin.

Table 12-12: Significant impact criteria for migratory species (Mi) (excluding migratory shorebirds)

Significant Impact Criteria	Likelihood of Impact	Gull-billed Tern (*Sterna nilotica*) (Mi)	White-winged Black Tern (*Sterna leucoptera*) (Mi)	Glossy Ibis (*Plegadis falcinellus*) (Mi)
Will the action substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Unlikely	Lake Mackay was assessed as possible to support important habitat for the Gull-billed Tern (Appendix G.1). Within the Study Area, important habitat for the Gull-billed Tern comprises: Salt lake playa, Lake margin, Claypans and claypan mosaic, and Saline flats and depressions. With respect to the Proposal, these habitats occur in the following proportions: • Salt lake playa: A total of 243,271 ha occurs within the Study Area, of which 216,341 ha (88.9 %) occurs within the Proposal area and 14,982.2 ha (6.16 %) occurs within the Indicative Footprint. • Lake margin: A total of 14,884 ha occurs within the Study Area, of which 1,379 ha (9.3 %) occurs within the Proposal area and 22.9 ha (0.15 %) occurs within the Indicative Footprint. • Claypan and claypan mosaic: A total of 15,899 ha occurs within the Study Area, of which 1,546 ha (9.7 %) occurs within the Proposal area and 33.0 ha (0.74 %) occurs within the Indicative Footprint. • Saline flats and depressions: A total of 8,069 ha occurs within the Study Area, of which 151 ha (1.9 %) occurs within the Proposal area and 5.6 ha (0.07 %) occurs within the Indicative Footprint. Secondary impacts to surface hydrology could occur through the construction of trenches, ponds, bunds and associated infrastructure. These have the potential to change the areas, depths and duration of flood events. These changes to surface hydrology could affect the productivity of the lake as a whole and may not limited to the Indicative Footprint. Based on modelling, the total inundated area of the lake under the modelled rainfall events effectively remains the same as under baseline conditions, and the water ultimately ponds in the deepest parts of the lake under all scenarios (Section 9). At closure the southern feeder trench will be breached and BMU trenches allowed to naturally infill, a process likely to occur within approximately 10 years (based on field observations of test trenches). Based on drawdown modelling and the trend of recent inundation events, the duration of inundation events (foraging events: greater than 24 days and breeding events: greater than 65 days), are predicted to continue during operations (Table 7-12). Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions (Section 7.6.4). See details for waterbird foraging within Section 7.6.4 and for waterbird breeding within Section 7.6.5. See the section on Inland Waters for greater detail on potential impacts to surface hydrology (lake productivity) and groundwater drawdown (duration of inundation events)(Section 9). Given the small proportion of these habitats within the Indicative Footprint and that during flood conditions surface hydrology and productivity of the lake is unlikely to be substantially affected, the Proposal is unlikely to substantially modify suitable habitat for the species.	Lake Mackay was assessed as possible to support important habitat for the White-winged Black Tern (Appendix G.1). Within the Study Area, important habitat for the White-winged Black Tern comprises: Salt lake playa, Lake margin, Claypans and claypan mosaic, and Saline flats and depressions. With respect to the Proposal, these habitats occur in the following proportions: • Salt lake playa: A total of 243,271 ha occurs within the Study Area, of which 216,333 ha (88.93 %) occurs within the Proposal area and 13,362.12 ha (5.49 %) occurs within the Indicative Footprint. • Lake margin: A total of 14,884.20 ha occurs within the Study Area, of which 1,341.30 ha (9.01 %) occurs within the Proposal area and 22.36 ha (0.15 %) occurs within the Indicative Footprint. • Claypan and claypan mosaic: A total of 15,960 ha occurs within the Study Area, of which 1,457 ha (9.13 %) occurs within the Proposal area and 42.22 ha (0.26 %) occurs within the Indicative Footprint. • Saline flats and depressions: A total of 8,069 ha occurs within the Study Area, of which 151.24 ha (1.87 %) occurs within the Proposal area and 3.44 ha (0.04 %) occurs within the Indicative Footprint. Secondary impacts to surface hydrology could occur through the construction of trenches, ponds, bunds and associated infrastructure. These have the potential to change the areas, depths and duration of flood events. These changes to surface hydrology could affect the productivity of the lake as a whole and may not limited to the Indicative Footprint. Based on modelling, the total inundated area of the lake under the modelled rainfall events effectively remains the same as under baseline conditions, and the water ultimately ponds in the deepest parts of the lake under all scenarios (Section 9). At closure the southern feeder trench will be breached and BMU trenches allowed to naturally infill, a process likely to occur within approximately 10 years (based on field observations of test trenches). Based on drawdown modelling and the trend of recent inundation events, the duration of inundation events (foraging events: greater than 24 days and breeding events: greater than 65 days), are predicted to continue during operations (Table 7-12). Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions (Section 7.6.4). See details for waterbird foraging within Section 7.6.4 and for waterbird breeding within Section 7.6.5. See the section on Inland Waters for greater detail on potential impacts to surface hydrology (lake productivity) and groundwater drawdown (duration of inundation events) (Section 9). Given the small proportion of these habitats within the Indicative Footprint and that during flood conditions surface hydrology and productivity of the lake is unlikely to be substantially affected, the Proposal is unlikely to substantially modify suitable habitat for the species.	Lake Mackay was assessed as unlikely to support important habitat for the Glossy Ibis (Appendix G.1). Consequently, the Proposal is unlikely to substantially modify, destroy or isolate an area of important habitat for the Glossy Ibis.

Significant Impact Criteria	Likelihood of Impact	Gull-billed Tern (*Sterna nilotica*) (Mi)	White-winged Black Tern (*Sterna leucoptera*) (Mi)	Glossy Ibis (*Plegadis falcinellus*) (Mi)
Will the action result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.	Unlikely	Lake Mackay was assessed as possible to support important habitat for the Gull-billed Tern (Appendix G.1). Predation at nesting colonies by introduced and feral predators is listed as a key threatening process for the Gull-billed Tern. However, breeding by the species at Lake Mackay is unlikely to occur as there have been few breeding records north of 25ºS. Additionally, any potential increases in feral predators as a result of the Proposal will be mitigated primarily via the following: • Implement a feral predator control program manage any potential increase in the prevalence of feral predators as a result of the Proposal. • Management of potential feral predator foraging resources (i.e. site landfill). Consequently, the Proposal is unlikely to have a significant impact to the Gull-billed Tern under this category.	Lake Mackay was assessed as possible to support important habitat for the White-winged Black Tern (Appendix G.1). Predation is not listed as a key threatening process for the Gull-billed Tern; however, any potential increases in feral predators as a result of the Proposal will be mitigated primarily via the following: • Implement a feral predator control program manage any potential increase in the prevalence of feral predators as a result of the Proposal. • Management of potential feral predator foraging resources (i.e. site landfill). Consequently, the Proposal is unlikely to have a significant impact to the White-winged Black Tern under this category.	Lake Mackay was assessed as unlikely to support important habitat for the Glossy Ibis (Appendix G.1). Consequently, the Proposal is unlikely to have a significant impact on the Glossy Ibis under this category.
Will the action seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Unlikely	Lake Mackay was assessed as possible to support ecologically significant proportion of the population of the Gull-billed Tern (Appendix G.1). However, this would only occur under suitable conditions. The presence of adults in breeding plumage and juvenile individuals in 2021 and 2017 indicates the species potentially breeds at Lake Mackay; however, these were not in significant abundances (Appendix G.1). Note that 2017 records occurred once the playa productivity was minimal, and as such underestimated Gull-billed Tern breeding and abundance. Based on drawdown modelling and the trend of recent inundation events, the duration of inundation events (foraging events: greater than 24 days and breeding events: greater than 65 days), are predicted to continue during operations (Table 7-12). Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions (Section 7.6.4). See details for waterbird foraging within Section 7.6.4 and for waterbird breeding within Section 7.6.5. See the section on Inland Waters for greater detail on potential impacts to surface hydrology (lake productivity) and groundwater drawdown (duration of inundation events)(Section 9). The main impacts of the Proposal are through disturbance to foraging habitat. Direct and indirect impacts are unlikely to substantially modify foraging habitat for the species. Additionally, to avoid disturbance to breeding waterbirds, no access will be permitted to islands used for breeding by waterbirds. To avoid disturbance to foraging waterbirds, no access will be permitted to inundated portions of Lake Mackay when more than 20 % of the lake is inundated. Similarly, no access will be permitted to inundated claypans or salt pans with the exception of areas that coincide with the Indicative Footprint. Consequently, the Proposal is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species.	Lake Mackay was assessed as possible to support ecologically significant proportion of the population of the White-winged Black Tern (Appendix G.1). However, this would only occur under suitable conditions. The species does not breed within Australia; however, Lake Mackay may serve as a resource for the species prior to migration to breeding grounds (Appendix G.1). Based on drawdown modelling and the trend of recent inundation events, the duration of inundation events (foraging events: greater than 24 days and breeding events: greater than 65 days), are predicted to continue during operations (Table 7-12). Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions (Section 7.6.4). See details for waterbird foraging within Section 7.6.4 and for waterbird breeding within Section 7.6.5. See the section on Inland Waters for greater detail on potential impacts to surface hydrology (lake productivity) and groundwater drawdown (duration of inundation events) (Section 9). The main impacts of the Proposal are through disturbance to foraging habitat. Direct and indirect impacts are unlikely to substantially modify foraging habitat for the species. Consequently, the Proposal is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species.	Lake Mackay was assessed as unlikely to support ecologically significant proportion of the population of the Glossy Ibis (Appendix G.1). Consequently, the Proposal is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species

Note: Likelihood of impact is classified as either known, likely, possible or unlikely.

Table 12-13: Thresholds of significant impacts on migratory shorebirds (Mi) (excluding non-shorebirds)

Ecological Element	Significant Impact Criteria	Likelihood of Impact	Justification
Important habitat	Loss of habitat	Unlikely	The Proposal will disturb habitats identified as being internationally important to migratory shorebirds. Within the Study Area, important habitat for migratory shorebirds comprises: Salt lake playa, Lake margin, Claypans and claypan mosaic, and Saline flats and depressions. With respect to the Proposal, these habitats occur in the following proportions: • Salt lake playa: A total of 243,271 ha occurs within the Study Area, of which 216,333 ha (88.93 %) occurs within the Proposal area and 13,362.12 ha (5.49 %) occurs within the Indicative Footprint. • Lake margin: A total of 14,884.20 ha occurs within the Study Area, of which 1,341.30 ha (9.01 %) occurs within the Proposal area and 22.36 ha (0.15 %) occurs within the Indicative Footprint. • Claypan and claypan mosaic: A total of 15,960 ha occurs within the Study Area, of which 1,457 ha (9.13 %) occurs within the Proposal area and 42.22 ha (0.26 %) occurs within the Indicative Footprint. • Saline flats and depressions: A total of 8,069 ha occurs within the Study Area, of which 151.24 ha (1.87 %) occurs within the Proposal area and 3.44 ha (0.04 %) occurs within the Indicative Footprint. Secondary impacts to surface hydrology could occur through the construction of trenches, ponds, bunds and associated infrastructure. These have the potential to change the areas, depths and duration of flood events. These changes to surface hydrology could affect the productivity of the lake as a whole and may not be limited to the Indicative Footprint. Based on modelling, the total inundated area of the lake under the modelled rainfall events effectively remains the same as under baseline conditions, and the water ultimately ponds in the deepest parts of the lake under all scenarios (Section 9). At closure the southern feeder trench will be breached and BMU trenches allowed to naturally infill, a process likely to occur within approximately 10 years (based on field observations of test trenches). Based on drawdown modelling and the trend of recent inundation events, the duration of inundation events (foraging events: greater than 24 days), are predicted to continue during operations (Table 7-12). Recovery of groundwater levels then occurs over a period of two to five years once pumping ceases, to within 95% of baseline conditions (Section 7.6.4). See details for waterbird foraging within Section 7.6.4. See the section on Inland Waters for greater detail on potential impacts to surface hydrology (lake productivity) and groundwater drawdown (duration of inundation events)(Section 9). In summary, the Indicative Footprint comprises a small proportion of these habitats within the Study Area, and during flood conditions, surface hydrology and productivity of the lake is unlikely to be substantially affected. Consequently, the Proposal is unlikely to have a significant impact where it results in a reduction in the capacity of the habitat to support migratory shorebirds.
	Degradation of habitat leading to a substantial reduction in migratory shorebird numbers	Unlikely	Given that hydrological processes and therefore productivity of the lake are likely to be maintained, the Proposal is unlikely to degrade habitat to a point that it leads to a substantial reduction in migratory shorebird numbers.
	Increased disturbance leading to a substantial reduction in migratory shorebird numbers	Unlikely	Lake Mackay is relatively unimpacted from prior developments. The Proposal is unlikely to increase disturbance to a point that it leads to a substantial reduction in migratory shorebird numbers.
	Direct mortality of birds leading to a substantial reduction in migratory shorebird numbers	Unlikely	The creation of artificial water sources is considered a necessary part of the development of the Proposal. Waterbirds have been known to be attracted to artificial water sources, even when they can adversely impact their health and may lead to death. During flood events, conditions at the lake are likely to attract migratory shorebirds. However, as the lake becomes more saline and food sources decline, it is anticipated that migratory shorebirds will depart the area. Although artificial water sources will be present that could result in reduced health or mortality, it is likely that individuals will avoid these areas as they will be hypersaline and lack food resources. To mitigate potential impacts to migratory shorebirds from artificial waterbodies, a management plan will be established that will involve an iterative approach of mitigation and monitoring. Mitigation options that will be considered will include the implementation of bird deterrents around artificial water sources if required.

Note: Likelihood of impact is classified as either known, likely, possible or unlikely.

12.6 Predicted Outcome

The assessment of potential impacts on EPBC Act listed threatened and migratory fauna from the Proposal considered six threatened fauna and 12 migratory fauna. No threatened flora were recorded or were considered likely to occur within the Proposal area. Based on the significant impact criteria, after the implementation of mitigation measures, the Proposal was assessed as being unlikely to result in a significant residual impact to any threatened fauna confirmed, or assessed as likely to occur, comprising the following:

- Night Parrot (*Pezoporus occidentalis*) (En);
- Princess Parrot (*Polytelis alexandrae*) (Vu);
- Australian Painted Snipe (*Rostratula benghalensis*) (En);
- Greater Bilby (*Macrotis lagotis*) (Vu)
- Great Desert Skink (*Liopholis kintorei*) (Vu); and
- Grey Falcon (*Falco hypoleucos*) (Vu).

The Proposal was assessed as being unlikely to result in a significant residual impact to any remaining migratory species confirmed, or assessed as likely to occur, comprising the following:

- Red-necked Stint (*Calidris ruficollis*) (Mi: migratory shorebird);
- Sharp-tailed Sandpiper (*Calidris acuminata*) (Mi: migratory shorebird);
- Oriental Plover (*Charadrius veredus*) (Mi: migratory shorebird);
- Common Greenshank (*Tringa nebularia*) (Mi: migratory shorebird);
- Glossy Ibis (*Plegadis falcinellus*) (Mi);
- Gull-billed Tern (*Sterna nilotica*) (Mi);
- White-winged Black Tern (*Sterna leucoptera*) (Mi);
- Fork-tailed Swift (*Apus pacificus*) (Mi);
- Common Sandpiper (*Tringa hypoleucos*) (Mi: migratory shorebird);
- Pectoral Sandpiper (Calidris melanotos) (Mi: migratory shorebird);
- Oriental Pratincole (*Glareola maldivarum*) (Mi: migratory shorebird);
- Wood Sandpiper (*Tringa glareola*) (Mi: migratory shorebird); and
- Marsh Sandpiper (*Tringa stagnatilis*) (Mi: migratory shorebird).

Based on the assessment for each of these species in accordance with *Matters of National Environmental Significance: Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013), there is significant residual impact anticipated for any MNES. In accordance with Envir*onment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012), as there is no anticipated significant residual impact, there is no requirement for the implementation of environmental offsets for MNES. However, it is acknowledged that the Proposal has the potential to result in significant residual impact to critical and supporting habitat for the EPBC Act-listed Night Parrot, Greater Bilby and Great Desert Skink.

Specifically, Agrimin are committed to supporting the conservation of the Night Parrot. Survey work and analysis have substantially contributed to the knowledge on the ecology of this species. However, there are remaining knowledge gaps, which may better inform the conservation management of the species across its range. As a result, Agrimin have committed to two voluntary indirect offsets that have potential for meaningful conservation outcomes for the Night Parrot, while concurrently supporting Indigenous groups on the associated IPAs. These voluntary indirect offsets are discussed within Section 13.4.1.

13. Offsets

Agrimin understands its obligations to offset any significant residual impact that results from implementing the Proposal. After applying the mitigation hierarchy, it was assessed that the Proposal is unlikely to have significant residual impact on any key environmental factors or MNES. In addition to specific avoidance and mitigation measures proposed for each key environmental factor and MNES, Agrimin have also developed environmental management plans comprising the CEMP, FVEMP, IWEMP and TFEMP to avoid or minimise potential impacts (Appendix C). However, the Proposal has the potential to result in significant residual impact to critical and supporting habitat for the EPBC Act-listed Night Parrot, Greater Bilby and Great Desert Skink, and Agrimin will be required to offset any significant residual impact to compensate for the loss of this habitat for these species. Agrimin are also committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).

While offset requirements have not yet been confirmed, Agrimin are committed to supporting the conservation of the Night Parrot and have provisioned two packages of voluntary indirect offsets. These are summarised in Section 13.4.1 and below, and detailed within Appendix N:

- Research: funding of research to increase knowledge of the Night Parrot to better inform conservation management of the species; and
- Social: funding of ranger programs to manage existing key threats to the Night Parrot (and other threatened fauna that occur in the region) comprising feral predator control and fire management.

These voluntary offset programs will have the following benefits:

- direct engagement of Indigenous groups to manage land on respective IPAs; and
- meaningful conservation outcomes for the Night Parrot and other threatened fauna where feral predation and altered fire regimes are key threatening processes.

13.1 Policy and Guidance

The application and assessment of offset requirements for the Proposal have been undertaken with consideration to the following:

- State Policies and Guidelines:
  - *WA Environmental Offsets Policy* (Government of Western Australia 2011); and
  - *WA Environmental Offsets Guidelines* (Government of Western Australia 2014).
- Commonwealth Policies and Guidelines:
  - *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).

13.2 Offset Assessment Approach

The Proposal is currently being assessed under the State and Commonwealth government's Bilateral Agreement as an accredited assessment, led by the WA EPA. In accordance with the Bilateral Agreement, Agrimin understands that the submission of the ERD to the WA EPA will initiate inter-departmental consultation between both agencies with respect to offsets.

Agrimin supports the early engagement process to ensure that if an offset was to be developed that it would be proportionate to the residual impact and environmental values of the region. It should also achieve real on-ground environmental benefits for the local communities. The above State and Commonwealth offset policies and guidelines have been applied, and the impact assessments have determined that, at this stage, there is no significant residual impact to key environmental factors or MNES as a result of the Proposal. However, it is acknowledged that the Proposal has the potential to result in significant residual impact to critical and supporting habitat of the Night Parrot, Greater Bilby and Great Desert Skink, and Agrimin will continue to work with State and Commonwealth agencies regarding offsets for these species.

13.3 WA Environmental Offsets

In WA, offsets are only required where the residual impact of a project is determined to be significant, after avoidance, minimisation and rehabilitation measures have been applied (Government of Western Australia 2014). Consideration of *WA Environmental Offsets Policy* (Government of Western Australia 2011) for a Proposal includes consideration of the following principles:

- Principle 1 – Environmental offsets will only be considered after avoidance and mitigation options have been pursued.
- Principle 2 – Environmental offsets are not appropriate for all projects.
- Principle 3 – Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted.
- Principle 4 – Environmental offsets will be based on sound environmental information and knowledge.
- Principle 5 – Environmental offsets will be applied within a framework of adaptive management.
- Principle 6 – Environmental offsets will be focused on longer term strategic outcomes.

The *WA Environmental Offsets Guidelines* (Government of Western Australia 2014) residual impact significance model provides further guidance on determining the significance of related impacts for a Proposal, in the context of determining potential offsets requirements. The model identifies four levels of significance for residual impact, including:

- Unacceptable impacts – those impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset.
- Significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level.
- Potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. That is, the context of impacts plays a role in determining the requirement for and scale of an offset. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision maker based on information provided by the proponent or applicant and expert judgement.
- Impacts which are not significant – impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset.

For the Proposal, the potential for significant residual impact has been considered for each of the key environmental factors in accordance with Part IV of the *WA Environmental Offsets Policy* (Government of Western Australia 2011) principles and the residual impact significance model (Table 13-1). Additionally, within each of the relevant key environmental factors, consideration was also given to criteria under Part V (Clearing Principles) of the *WA Environmental Offsets Policy* (Government of Western Australia 2011) principles:

- occurrence of rare flora;
- TECs;
- remnant vegetation;
- wetlands;
- conservation areas;
- high biological diversity; and
- habitat for fauna.

Based on the substantial number of studies, key findings, avoidance and mitigation measures, and outcomes of the impact assessments, there is no significant residual impact that would require the implementation of offsets. Detailed impact assessments and mitigation, following the mitigation hierarchy, are provided for each of the key environmental factors in the ERD, summarised as follows:

- Section 6: Flora and Vegetation – no significant residual impact
  - The Proposal will not impact upon any TECs, PECs o conservation reserves. Vegetation types and significant flora are not restricted locally and are distributed widely in the regional context.
  - No groundwater-dependent vegetation has been shown to occur in the Proposal area, and precautionary mitigation and monitoring actions will be implemented to protect any potential impacts to riparian vegetation.
- Section 7: Terrestrial Fauna – no significant residual impact
  - Habitats: In total, a relatively small percentage of the identified habitats for significance fauna species and waterbirds will be impacted by the Proposal. The salt lake playa comprises the largest proportion of any habitat to be impacted by the Proposal, comprising only 5.49% of this habitat's extent within the Study Area. The remaining off-lake disturbance will be largely confined to the spinifex sandplain, dunefield and gravel spinifex plain habitats. Disturbance to these habitats is proposed to be no greater than 2.6% of their individual extents in the Study Area. Disturbance within each of the remaining habitats is proposed to be individually less than 45 ha or less than 1.5% of their individual extent within the Study Area.
  - Bilby: The species has high mobility, low site fidelity and occupies multiple burrows. Realignment of the Indicative Footprint would be unlikely to mitigate potential impacts as the species will establish new burrows, potentially in the new footprints. Mitigation will involve pre-clearance surveys and encouraged relocations in alignment with DBCA (2018) guidelines.
  - Night Parrot: The species has been recorded foraging in two areas with long unburnt spinifex along drainage features that run between 5 km and 10 km perpendicular to the proposed haul road alignment. The species uses multiple roosts in the landscape, primarily within long unburnt spinifex. The population is estimated to be 2-5 individuals in the north and 2-3 individuals in the south. Given that the proposed width of clearing for the haul road in these areas is only 24 m, it is highly unlikely that clearing will directly impact upon roosting individuals. As a precautionary mitigation measure, pre-clearance listening surveys will be undertaken to identify the potential occurrence of any roost sites within the Indicative Footprint so that further mitigation can be undertaken (if required).
  - Great Desert Skink: A new population of the species, the Yagga Yagga population, was identified during survey work. Given the sedentary nature of this species, the proposed haul road was realigned (approved 43a) to avoid direct impacts and potential secondary impacts from road strike and population fragmentation. There are no other known occurrences of active burrows within the Proposal area or Indicative Footprint.
  - Waterbirds: During inundation events, Lake Mackay is an important foraging and breeding ground for waterbirds. Lake infrastructure has the potential to influence areas of inundation and drawdown has the potential to influence duration of inundation events. Mitigation has involved the design and modelling of survey infrastructure to reduce potential impacts to areas of inundation, and to buffer all islands from direct impacts. Modelling of inundation events under operational conditions compared to base conditions has demonstrated that during the large important inundation events, conditions will continue to be suitable for both foraging and breeding of waterbirds.
- Section 8: Subterranean Fauna – no significant residual impact
  - The majority of the Proposal area has limited or no habitat prospectivity for stygofauna and troglofauna. The lake bed sediments and hypersaline groundwater associated with the playa are not conducive to subterranean fauna, while the SIDE borefield also has limited habitat within the fine textured alluvials. Complete recovery of groundwater levels in the lake bed sediments is predicted to occur following cessation of pumping, with 95% recovery to occur within two to five years.

- Section 9: Inland Waters – no significant residual impact
    - There are no Ramsar wetlands or wetlands of national importance the vicinity of the Proposal area.
    - Major inundation events that cause a boom cycle of primary producers and aquatic invertebrates supporting waterbirds are rare. Modelling indicates there will be limited effects on the frequency, maximum extent, depth and duration of surface water on the lake in these larger inundation events. This will be aided by engineered crossovers within the trench network to assist in maintaining hydrological processes and ecological function, with no expected direct or indirect impacts to the lake.
    - Buffer zones have been established for the islands to maintain habitat and reduce groundwater drawdown. Groundwater modelling also suggests that during operations, the Proposal is not expected to impede biological productivity of the lake during major flood events. Large rainfall events will assist with naturally mitigating drawdown and complete recovery is expected within seven years. There is also a predicted increase in extreme rainfall events that may offset any potential changes associated with development and operation of the Proposal.
    - Progressive breaching of bunds following cessation of BMU mining will return flows to the lake and breaching of the evaporation ponds and bunding at closure will also assist a gradual reintegration of salts back into the environment, with no expected changes to the overall salt balance of the lake.
- Section 10: Social Surrounds – no significant residual impact
    - Agrimin have undertaken extensive consultation with relevant Traditional Owners for the Proposal area, all of whom are supportive of the development of the Proposal. These groups will benefit from improved infrastructure, increased connectiveness of communities and the generation of valuable long-term opportunities, including employment, for the Native Title groups and Indigenous communities throughout the Central Desert and the broader Kimberley region via employment and regional supply chain.
    - Agrimin is committed to undertaking further consultation with the relevant Traditional Owners to manage interactions and engagements and ensure the safety, protection, and sustainable cultural management of the landscape and environment within the Proposal area.

Additionally, there is no expected significant residual impact to any of the key environmental factors when considering cumulative impacts from the Proposal. Cumulative impacts in the vicinity of the Proposal are largely associated with development within the remote Indigenous communities, exploration of resources and access roads or tracks. Land use is predominantly restricted to Indigenous land use practices within their respective determinations.

Currently, there are no other proposals that comprise development of salt lakes in the Great Sandy Desert or Tanami bioregions, and therefore no cumulative impacts. Within the entirety of WA, the proposed disturbance from this Proposal comprises only 0.5% of the total extent of salt lakes. Cumulatively, impacts from all approved salt lake potash projects and this Proposal will only result in a disturbance of <1% of all salt lake habitat within WA (Table 7-15, Figure 7-25).

Table 13-1: Significance of residual impact to key environmental factors.

Part V Environmental Factors	Flora and Vegetation	Terrestrial Fauna	Subterranean Fauna	Inland Waters	Social Surrounds
Residual impact that is environmental unacceptable or cannot be offset	×	×	×	×	×
Significant residual impact that will require an offset	×	×	×	×	×
Significant residual impact that may require an offset – Any significant residual impact to potentially threatened species and ecosystems, area of high environmental value or where the cumulative impact may reach critical levels if not managed	×	×	×	×	×
Residual impact that is not significant	✓	✓	✓	✓	✓

13.4 Commonwealth Offset Guidelines

The *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012), including the *Offsets Assessment Guide* calculator, will be used where relevant, to assist the WA EPA in determining the quantum of offset contributions for the Proposal (if required). Additionally, Agrimin understands its obligations to take into consideration the principles of the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012), including:

- Principle 1 - Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.
- Principle 2 - Suitable offsets must be built around direct offsets but may include other compensatory measures.
- Principle 3 - Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.
- Principle 4 - Suitable offsets must be of a size and scale proportionate to the residual impact on the protected matter.
- Principle 5 - Suitable offsets must effectively account for and manage the risks of the offset failing.
- Principle 6 - Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.
- Principle 7 - Suitable offsets must be efficient, effective, timely, transparent, scientifically robust, and reasonable.
- Principle 8 - Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited, and enforced.

As the Proposal has been determined to be a 'Controlled Action' in accordance with the EPBC Act, consideration of the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012) is required for MNES, specifically, listed threatened species and communities (section 18 and 18A of the EPBC Act). These listed threatened species may comprise:

- Night Parrot (*Pezoporus occidentalis*) – Endangered;
- Princess Parrot (*Polvtelis alexandrae*) – Vulnerable;
- Australian Painted Snipe (*Rostratula australis*) – Endangered
- Greater Bilby (*Macrotis lagotis*) – Vulnerable;
- Great Desert Skink (*Liopholis kintorei*) – Vulnerable;
- Grey Falcon (*Falco hypoleucos*) – Vulnerable; and
- Dwarf Desert Spike-rush (*Eleocharis papillosa*) – Vulnerable.

Potential impacts from the Proposal were assessed for each of these species in accordance with the *Matters of National Environmental Significance: Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013). This is detailed in Section 12 of the ERD and is summarised in Table 13-2. Based on this assessment, no significant residual impact is anticipated for any of the EPBC Act-listed species. However, offsets requirements have not yet been finalised and there is the potential for the Proposal to result in significant residual impact to critical and supporting habitat for the EPBC Act-listed Night Parrot, Greater Bilby and Great Desert Skink. Agrimin will be required to offset any significant residual impact to compensate for the loss of this habitat for these species. Agrimin are committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).

Table 13-2: Significance of residual impact on threatened species identified by DAWE.

Species	Conservation Status	Primary Habitat	Records	Potential Impacts	Mitigation And Avoidance	Significant Residual Impact
Night Parrot (*Pezoporus occidentalis*)	En	• Old growth spinifex in association with Claypan & claypan mosaic habitat and Saline flats and depressions	• 2 populations identified within drainage features that run between 5 km and 10 km perpendicular to the proposed haul road alignment. 2-5 individuals in the north, 2-3 individuals in the south. • Targeted surveys identified foraging calls on 58 units of which two calls were from within the Indicative Footprint. • 3 additional populations discovered outside Proposal area	• Old growth spinifex 11,522 ha in SA of which 0.2% in Indicative Footprint, with additional 46,199 ha of mapped habitat within 10 km. • Proposed clearing for the haul road (24 m) highly unlikely to intersect any roost sites.	• Avoidance: The Indicative Footprint has been aligned to minimise direct clearing of old growth spinifex hummocks within the broad drainage features. • Precautionary mitigation: pre-clearance listening surveys will be undertaken in the vicinity of the records to identify the potential occurrence of any roost sites within the Indicative Footprint. Additional mitigation is detailed within Section 6.3.2 and 12.4.1 if required.	No
Princess Parrot (*Polvtelis alexandrae*)	Vu	• Dunefield	• Sighting of a flock of 12-30 parrots near Lake Mackay (2012) • Sightings of a flock of 11 parrots flying over an island on Lake Mackay (2021)	• Dunefield: 41,418 ha in Study Area of which 0.68% occurs within Indicative Footprint	• No records from Indicative Footprint • Fire and weed management provisioned within CEMP and TFEMP	No
Australian Painted Snipe (*Rostratula australis*)	En	• Claypans and claypan mosaic habitat • Saline flats and depressions habitat	• Single record during an inundation event in 2016.	• Claypans and claypan mosaic: 15,960 ha in Study Area of which 0.26 % occurs within Indicative Footprint • Saline flats and depressions: 8,069 ha in Study Area of which 0.04 % occurs within Indicative Footprint	• No records from Indicative Footprint • Fire, feral predator and weed management provisioned within CEMP and TFEMP	No
Greater Bilby (*Macrotis lagotis*)	Vu	• Gravel spinifex plan • Spinifex sandplain	• 130 records (burrows, diggings, scats) including 77 active burrows in Study Area • 7 active burrows in Indicative Footprint	• Spinifex sandplain 103,435 ha in Study Area of which 0.73% in Indicative Footprint • Gravel spinifex plain 9,646 ha in Study Area of which 2.57% in Indicative Footprint • Proposed clearing has the potential to intersect active burrows.	• Realignment of the Indicative Footprint would be unlikely to mitigate potential impacts as the species continually establishes new burrows, potentially in the new footprints. • Mitigation will involve pre-clearance surveys and encouraged relocation in alignment with guidelines within DBCA (2018).	No
Great Desert Skink (*Liopholis kintorei*)	Vu	• Spinifex-sandplain	• Yagga Yagga population (64 active burrows) • No known active burrows in the Development Envelope or Indicative Footprint despite extensive survey work.	• Spinifex-sandplain 103,435 ha in SA of which 0.73% occurs in Indicative Footprint.	• Avoidance: Haul road re-alignment to avoid the Yagga Yagga population (sedentary species forages within 150 m of burrow), • Precautionary mitigation: pre-clearance surveys and relocation if required (unlikely)	No
Grey Falcon (*Falco hypoleucos*)	Vu	• Gravel spinifex plan • Spinifex sandplain	• One sighting of three Grey Falcons (a pair of adults with one juvenile) in 2020.	• Gravel spinifex plain 9,646 ha in Study Area of which 2.57% in Indicative Footprint • Spinifex sandplain 103,435 ha in Study Area of which 0.73% in Indicative Footprint	• The species is rare and forages widely in the landscape. Specific mitigation is not required.	No
Dwarf Desert Spike-rush (*Eleocharis papillosa*)	Vu	• Margins of lakes and claypans.	• No records from the Study Area. Closest record is 36 km NE of the Study Area in the NT.	• Species has not been recorded within the Study Area or Indicative Footprint	• Weed management provisioned within CEMP and FVEMP	No

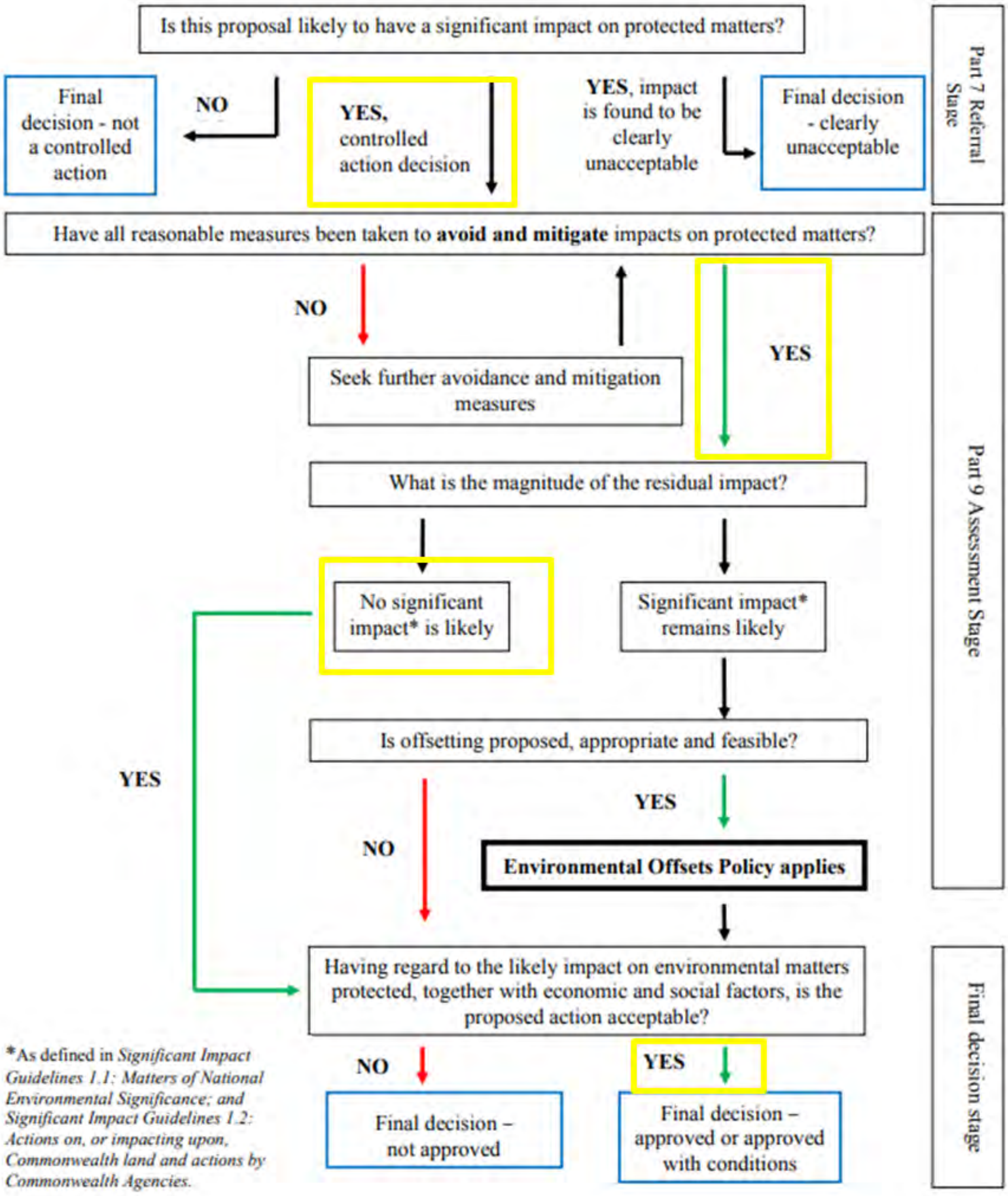

Figure 13-1: Environmental impact assessment process (DSEWPC 2012). As there is no significant residual impact to MNES, an offset is not required (pathways in yellow highlight).

13.4.1 Night Parrot (En): Voluntary Indirect Offset Strategy

Although there is no expected significant residual impact to the Night Parrot, Agrimin are committed to supporting the conservation of this species. Survey work and analysis (detailed in Section 7.6.3.2 and Section 12.4.1) have substantially contributed to the knowledge on the ecology of this species. However, it is acknowledged that there are remaining knowledge gaps, which may better inform the conservation management of the species across its range. As a result, Agrimin have committed to two voluntary indirect offsets that have potential for meaningful conservation outcomes for this species, while concurrently supporting Indigenous groups on the associated IPAs.

13.4.1.1 Occurrence with respect to the Proposal

The Night Parrot is a small green, highly cryptic nocturnal parrot. The species uses multiple roosts in the landscape primarily within long unburnt spinifex. Key threats to the species likely comprise predation by feral predators and broad scale fires that burn old growth spinifex.

During baseline studies for the Proposal, foraging calls were recorded in two areas with long unburnt spinifex along drainage features that run between 5 km and 10 km perpendicular to the proposed haul road alignment. The population is estimated to be 2 to 5 individuals in the north and 2 to 3 individuals in the south. Both of these areas comprised mosaic habitats of claypans which are likely prevented the spread of broadscale fires into the old growth spinifex. Subsequent surveys by indigenous rangers and Desert Support Services (DSS) have identified a further three populations outside the Proposal area.

Based on fine scale desktop mapping, it is estimated that a total of 11,522 ha of old growth spinifex occurs within the Study Area, of which only 23.55 ha (0.20%) occurs within the Indicative Footprint. Additionally, regional modelling has identified 46,199 ha of additional habitat within 10 km of the Proposal which is likely to be suitable for the Night Parrot. The regional modelling was verified by the subsequent discovery of the three populations outside the Proposal area by indigenous rangers and DSS.

Given that the proposed width of clearing for the haul road in these areas is only 24 m within these broad drainage basins, it is highly unlikely that clearing will directly impact upon roosting individuals. However, as a precautionary mitigation measure, pre-clearance listening surveys will be undertaken to identify the potential occurrence of any roost sites within the Indicative Footprint so that further mitigation can be undertaken (if required). Additional mitigation measures will include haulage restricted to daytime hours and implementation of the CEMP and TFEMP which include mitigation measures to reduce any potential increase in fires or feral predators as a result of the Proposal.

In accordance with *Matters of National Environmental Significance: Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013), assessed in Section 12.4.1, there will be no significant residual impact to the Night Parrot and consequently offsets are not required.

13.4.1.2 Voluntary indirect offset

While offset requirements have not yet been confirmed for the Night Parrot, Agrimin are committed to supporting the conservation of the species. As a result, Agrimin have provisioned two packages of voluntary indirect offsets which are summarised below and detailed within Appendix N:

- Research: funding of research to increase knowledge of the Night Parrot to better inform conservation management of the species; and
- Social: funding of ranger programs to manage existing key threats to the Night Parrot (and other threatened fauna that occur in the region) comprising feral predator control and fire management. These programs will have the following benefits:
    - direct engagement of indigenous groups to manage land on respective IPAs; and
    - meaningful conservation outcomes for the Night Parrot and other threatened fauna where feral predation and altered fire regimes are listed as key threatening processes.

In developing the voluntary indirect offsets for the Night Parrot, Agrimin have aligned, where appropriate, with the *Offsets Assessment Guide* (DSEWPC 2012), which provides an appropriate basis for calculating the offset quantum for the final Proposal (noting Principle 3 and 4 of the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012)). As the Proposal area is located within the State's Extensive Land-use Zone, and intercepts three Native Title Determination Areas, Agrimin has proposed a strategic approach (Principle 6 of *WA Environmental Offsets Policy* (Government of Western Australia 2011)) through establishing a managed offset fund within the bioregion. A managed fund model is considered an appropriate mechanism to enable funding of a third party to undertake agreed offset actions, such as on-ground conservation management (i.e. feral animal control and fire management) and research of the species to better inform conservation management. A draft governance framework has been developed for the Proposal and is presented in Appendix N.

13.5 Stakeholder Consultation

The scope, objectives and quantum of the voluntary indirect offset may be refined in consultation with relevant Government departments and stakeholders.

13.6 Finalisation and Implementation of Offsets

Agrimin are committed to working with State and Commonwealth agencies to ensure that suitable avoidance and mitigation measures are implemented and, where appropriate, offsets are applied in accordance with *WA Environmental Offsets Policy* (Government of Western Australia 2011) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPC 2012).

14. Holistic Impact Assessment

As part of the EIA process, Agrimin have commissioned numerous studies to understand the local environment, and potential impacts as a result of implementing the Proposal. The outcomes of these studies have assisted with the refinement of the Proposal, allowing for the application of the mitigation hierarchy (avoid, minimise, manage, monitor, rehabilitate, offset). Agrimin has sought to understand the environmental processes and environmental values of the Lake Mackay ecosystem as a whole, including the potential to impact the environmental values of the NT side of the lake (a jurisdictional component of ~25% of the lake) (Table 14-1). Agrimin has recognised the inextricable links between flora and vegetation, terrestrial fauna, inland waters and social surroundings and connections and interactions between parts of the environment to inform a holistic view of impacts to the lake.

Agrimin recognises that Lake Mackay is an integral part of the landscape and to the way of life of the Traditional Owners. Consequently, the need to manage the impacts on environmental factors that integrate with ongoing use of the area for the sense of place for these communities is a vital component of the Proposal. There has been, and remains, ongoing consultation with the Traditional Owners. In addition to this, consultation has been undertaken with the relevant NT government departments and NT EPA as part of the assessment process, to inform them of the Proposal's potential to impact Lake Mackay (Table 14-1). Agrimin propose further consultation as part of the WA EPA's assessment process.

Groundwater (brine) abstraction from Lake Mackay via the proposed network of trenches is a key part of the Proposal. However, the placement of trenches and groundwater drawdown can impact all four key environmental factors (both at a WA and NT level) by influencing surface and groundwater regimes, potentially resulting in the potential loss of habitat for terrestrial flora and fauna and subterranean fauna. Groundwater drawdown has the potential to impact surface water regimes, resulting in greater infiltration and reducing the duration of ponding on the lake following rainfall events. However, modelling demonstrated a high level of understanding of this connectivity, and there is confidence that impacts to surface water and predicted groundwater drawdown have been adequately characterised and can be managed to avoid or minimise environmental impacts (including in the NT section of the lake).

A conceptual model has been developed to demonstrate the interaction between the key environmental factors, predicted impacts and mitigation measures implemented during the construction and operation phases of the Proposal, for the On-LDE, Off-LDE, SIDE and NIDE (Figure 14-1). This figure highlights the scale, connections and interactions of the various components of the Proposal, while delineating where impacts will occur spatially and temporally.

The holistic view of potential impacts to the lake's ecosystem and implementation of the proposed management measures and environmental management plans will avoid and minimise environmental impacts. This has provided Agrimin with confidence that any changes in the surface hydrological or groundwater regimes will not significantly impact the aquatic ecology of the lake, including migratory birds, or the riparian zone, with no known groundwater dependent vegetation in the area (including the WA and NT jurisdictions). In addition, drawdown is expected to be managed to minimise impacts to subterranean fauna inhabiting low salinity groundwater occurring above the lake sediments and driven by recharge from rainfall.

The majority of the impacts relevant to the key terrestrial environmental factors from the Proposal, relate primarily to the loss of vegetation from clearing. On the playa, placement of infrastructure occurs on unvegetated areas, avoiding direct impacts to *Tecticornia* communities, which may be of high value. However, there is a predicted residual impact following the application of the mitigation hierarchy, with clearing to result in loss of vegetation and also loss of a small area of fauna habitat. There may also be some habitat fragmentation and potential loss of individuals. Where a residual impact remains, an offset has been proposed (Section 13). For aquatic biota and migratory waterbirds, Agrimin have designed the Proposal to avoid important habitat and maintain areas of the lake that support hydrological processes to maintain ecological function. This has been guided by a range of surface, groundwater and climate modelling to assist in the development of appropriate engineering measures for proposed development on the lake.

Therefore, a holistic impact assessment of the Proposal demonstrates that the environmental risk is acceptable and aligns with the WA and NT EPA's principles and objectives. Impacts resulting from implementation of the Proposal are able to be avoided, mitigated or managed, following application of the mitigation hierarchy. No key environmental factors or MNES were assessed as having a significant residual impact as a result of implementing the Proposal.

Table 14-1: Table 2 Summary of the key environmental impacts and the proposed avoidance and mitigation measures specific to the NT portion of Lake Mackay.

	Key NT Environmental Factor and Objective *	Environmental Values	Environmental Component	Potential Impact	Mitigation	Predicted Outcomes
Water	Hydrological Processes Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained Inland Water Environmental Quality Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are maintained. Aquatic Ecosystems Protect aquatic habitats to maintain environmental values including biodiversity, ecological integrity, and ecological functioning.	• Locally supports productive communities of aquatic biota and waterbirds during major flood events (every 10-20 years). • Riparian zone characterised by *Tecticornia* spp., with some species of significance, albeit widespread. • Island formations and peripheral claypans support aquatic biota and waterbird foraging and breeding habitat during major floods and low salinity groundwater hosts new and potentially restricted subterranean fauna species.	• Surface Water	• No change to the hydrological regime in the NT predicted to occur.	• Staged trench network (1 km apart) • Pond design to maintain hydrology (strategic crossovers and breaching) • Additional strategic breaching at closure to maintain hydrological processes • Avoidance of claypan habitat	• There are no biological receptors considered at risk within the NT portion of Lake Mackay for surface water • Surface water modelling predicts no change to major flood events (>1 in 10-year event), maintaining ecosystem integrity and function
			• Groundwater	• Negligible groundwater drawdown extending into the NT portion of the Lake (<7 cm 1 km from WA/NT border).	• 250 m buffer zone between trenches and NT border, with potential to increase to 500 m if required • Buffer zones for islands and riparian vegetation from trenches of up to 500 m	• Maximum drawdown 40 cm at NT border and<7 cm at 1 km from border (modelled prediction) • Seasonal variation up to 50 cm, much greater than any anticipated drawdown in NT
People	Culture and Heritage Protect sacred sites, culture, and heritage.	• No registered Aboriginal heritage sites are known to occur within the WA portion of the on-lake development envelope. • Areas of elevated mythological significance have been excluded from the Proposal's development envelope. • Database searches of the NT government found no known registered sites on-lake.	• Registered Aboriginal Heritage Site and areas of significant mythological value	• Potential to affect the cultural or heritage values important to Traditional Owners in the NT.	• Areas of elevated mythological significance within WA have been excluded from the Proposal's development envelope • Fire Management Procedure and Incident Investigation and Reporting Procedures	• No direct or indirect impacts to culturally significant areas of the lake • Further consideration will be afforded to understanding heritage values with relevant NT Traditional Owner groups

*Note: * In the context of the WA EPA's assessment framework, the environmental factors corresponding to the listed NT EPA's environmental factors include Water Theme: Inland Waters (Objective - to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected) and People Theme: Social Surroundings (Objective - to protect social surroundings from significant harm).*

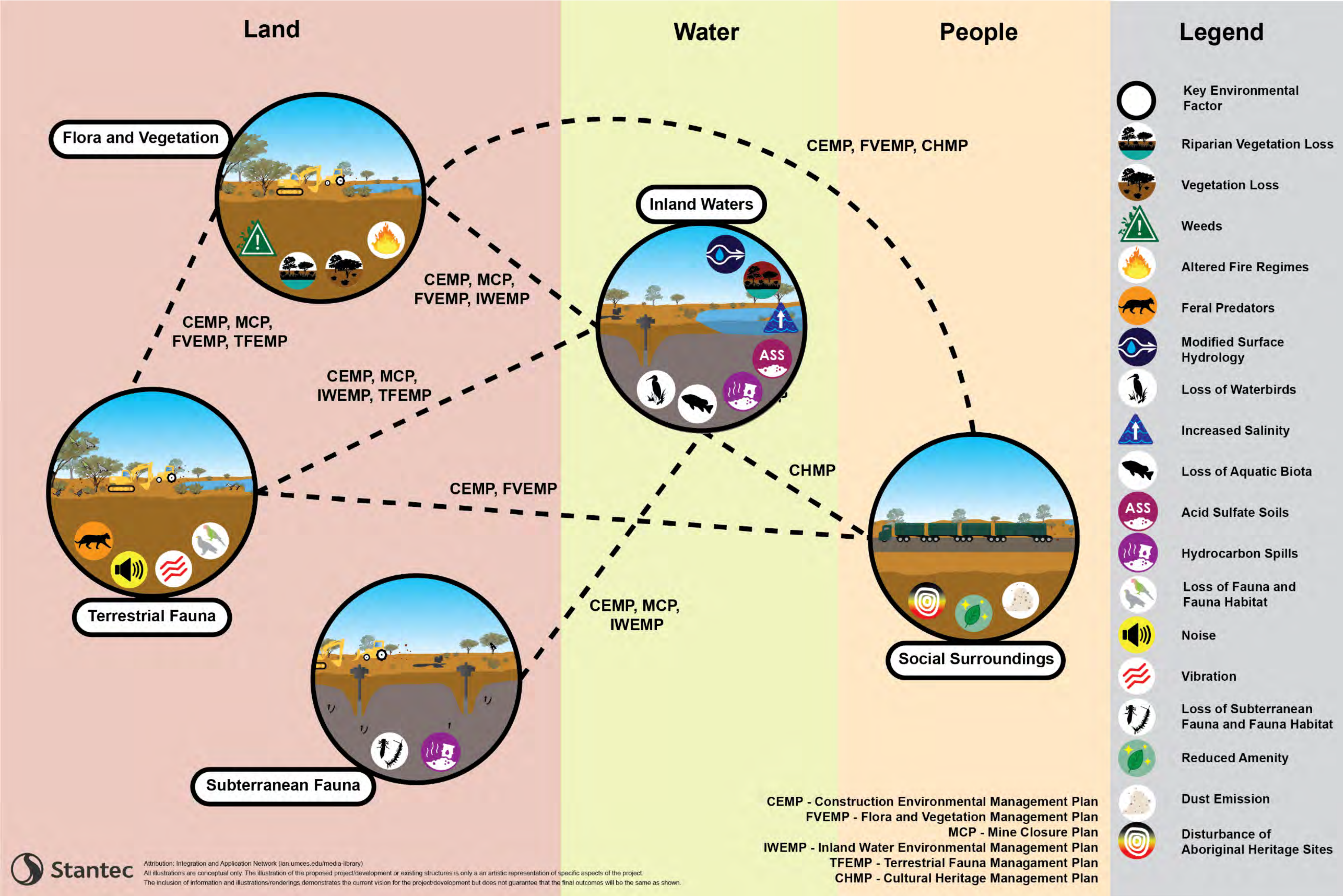

Figure 14-1: Interactions between the key environmental factor impacts, activities and mitigation measures developed for the Proposal

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Appendices

Appendix A Environmental Scoping Document

Appendix B Stakeholder Engagement Register

Appendix C Environmental Management Plans

C.1 Construction Environmental Management Plan

C.2 Flora and Vegetation Environmental Management Plan

C.3 Terrestrial Fauna Environmental Management Plan

C.4 Inland Waters Environmental Management Plan

Appendix D Mine Closure Plan

Appendix E Agrimin Limited Environmental Policy

Appendix F Consolidated Flora and Vegetation Report 2021

Appendix G Consolidated Terrestrial Fauna Reports

G.1 Appendix G Consolidated Terrestrial Fauna Report 2021

G.2 SRE Survey Report 2021

Appendix H Subterranean Fauna Report 2021

Appendix I Hydrogeology and Hydrology Studies

I.1 Mackay Drilling Report - Murray Brooker

I.2 Trench Pump Test Analysis Report - Stantec

I.3 MM-HG-0073 Infilling Drilling – Agrimin

I.4 MM-HG-0070 Infiltrometer Memo - Agrimin

I.5 Mackay Potash Project Island Drilling - Agrimin

I.6 MM-HG-0069 Lysimeter Memo – Agrimin

I.7 MM-HG-0071 Shelby Tube Sampler Memo - Agrimin

I.8 LMKA-SS-19001 Recharge Lab Assessment Memo - Stantec

I.9 Recharge Assessment Memo - Stantec

I.10 Islands Characterisation Memo (January 2020) - Stantec

I.11 Lake Mackay Stage 1 and Stage 2 Surface Water Assessment - Stantec

I.12 Water Supply Assessment for Mackay SOP Project: Groundwater Modelling Report – CDM Smith

I.13 Integrated Groundwater Flow and Solute Transport Model - Stantec

I.14 Long Term Pump Test Memo – Agrimin

I.15 Island Characterisation Memo (October 2020) – Agrimin

I.16 Regional Lake Groundwater Levels Memo – Agrimin

I.17 Island Impacts Groundwater Memo – Agrimin

I.18 Salt Balance and Ionic Composition Memorandum - Stantec

I.19 Hydrology and hydrogeology of the Lake Mackay SOP Proposal, Western Australia – Agrimin

I.20 Groundwater Sampling and Analysis Memo – Agrimin

I.21 Lake Mackay Inundation and Water Balance Modelling Memo

Appendix J Baseline Aquatic Ecology Report 2021

Appendix K Traditional Owners Letters of Support

K.1 Tjurabalan Letter or Support

K.2 Parna Ngururrpa Letter of Support

Appendix L Acid Sulphate Soils Investigation Report

Appendix M Greenhouse Gas Assessment

Appendix N Voluntary Indirect Offsets Strategy

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