Caloundra South

Wallum Sedge Frog Management Plan

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CONTENTS

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Document name: Wallum Sedgefrog Management Plan

Contact: Mark Stephens

Prepared by: Stockland Residential Communities

Stockland Sunshine Coast
Level 1, 8 Innovation Parkway,
Kawana Business Village, QLD. 4575

T: 07 5491 0133
F: 07 5491 0143

Date:	Revision:	Key Contributors	Reviewed by:	Distributed to:
November 2013	A	Cathy Crawley Mark Saunders Ed Meyer Mark Bayley	Mark Stephens	Department of the Environment
February 2015	B	Cathy Crawley Mark Saunders Ed Meyer Mark Bayley	Mark Stephens	Department of the Environment
April 2015	C	Cathy Crawley Mark Saunders Ed Meyer Mark Bayley	Mark Stephens	Department of the Environment
December 2015	D	Cathy Crawley Mark Saunders Ed Meyer Mark Bayley	Mark Stephens	Department of the Environment
August 2016	E	Mark Bayley	Mark Stephens	Department of the Environment and Energy
July 2017	F	Mark Bayley	Mark Stephens	Department of the Environment and Energy
May 2020	G	Mark Bayley	Mark Stephens	Department of the Environment and Energy

WALLUM SEDGEFROG MANAGEMENT PLAN

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INTRODUCTION

The Caloundra South development was referred to the Department of Environment and Energy's (DOEE) Minister in June 2011 to determine if it would require assessment and approval under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) (EPBC Ref: 2011/5987). The Minister determined that the action required approval, with a Public Environment Report (PER) being the mechanism for assessment.

The Minister determined that the action may proceed subject to conditions. A condition of the approval is that the person undertaking the action must implement a Wallum Sedgefrog Management Plan (WSFMP), approved by the Minister.

This WSFMP is prepared in accordance with Condition 8 and other relevant conditions of the EPBC Act approval (see section 1.2 below) and outlines specific management actions to protect the particular matters of national environmental significance (MNES), being the Federally listed Wallum Sedgefrog *Litoria olongburensis*, (Vulnerable under the *Environment Protection and Biodiversity Conservation Act, 1999*).

The Commencement of the Action must not occur until the Wallum Sedgefrog Management Plan has been approved by the Minister. However, Preliminary Works and Interim Works on the site are permitted to occur prior the approval of the WSFMP.

This WSFMP has been prepared with reference to the *National Recovery Plan for the Wallum Sedgefrog and other wallum dependent frog species* (Meyer, E., Hero, J-M., Shoo, L. and Lewis, B. 2006).

It is intended that the principles of this WSFMP will be applied to development under the approved Caloundra South Master Plan and subsequent development applications.

1.1 Management Plan Structure

The following table 1.1 outlines the Structure of the WSFMP.

Table 1.1: Structure of the WSFMP

Section of WSFMP	Section Title	Content	Application at Caloundra South
1	**Introduction**	Introduction to the WSFMP	Site-wide
2	**Wallum Sedgefrog**	Provides an overview of existing conditions, potential impacts and proposed mitigation	Site-wide
3	**Mitigation Strategy for Wallum Sedgefrog**	Summarises the proposed mitigation strategy which is made up of two key elements: a) the conservation of existing habitats that are to be retained on the site; and (b) habitat creation and enhancement along identified frog movement corridors.	Site-wide
Appendix A	**Latest Field Observations**	Provides details of field investigations undertaken, to provide greater confidence regarding the ability to create breeding habitat by monitoring local hydroperiods and groundwater quality in the areas proposed for pond construction.	Site-wide
Appendix B	**Habitat Restoration and**	Provides by way of an example one of the initial precincts to be developed on site (called Precinct 2), a detailed plan to deliver the mitigation strategy within the Frog Zone and	Specific to Precinct 2 (Lamerough Creek Catchment) with

Section of WSFMP	Section Title	Content	Application at Caloundra South
	Connectivity: Precinct 2	Frog Buffer in Lamerough Creek, the intent of this section is to demonstrate how the rest of the WSF mitigation strategy will be implemented across the site.	site-wide application
4	**WSF Success Criteria**	Provides details of the success criteria developed for monitoring the success of mitigation.	Precinct 2 and Site-wide
5	**Monitoring, Corrective Action and Reporting**	Provides details of the monitoring, maintenance, corrective action and reporting regime that would be applied site wide on completion of construction and rehabilitation activities.	Site-wide
6	**Summary of Wallum Sedgefrog Monitoring**	Provides a summary of all proposed monitoring proposed in the Plan including the monitoring regime proposed for the off-maintenance period.	Site-wide

1.2 Responding to EPBC Act Conditions

The following table identifies where in the WSFMP the applicable EPBC Act conditions are addressed:

Condition Number	Applicable EPBC Act Condition	Location within WSFMP
Condition No.5	Prior to **commencement of the action**, the person undertaking the action must provide a detailed map to the **Department** that identifies the areas of Wallum Sedgefrog (*Litoria olongburensis*) habitat that will be destroyed or removed on the **subject site**.	Section 2.3 & Figure 2.2d
Condition No. 6	The person undertaking the action must not destroy or remove more than 152 ha of Wallum Sedgefrog (*Litoria olongburensis*) habitat on the **subject site** as set out in the map to be provided in accordance with Condition 5 of this approval.	Section 2.3
Condition No.7	To minimise and compensate for the loss of a maximum 152 ha Wallum Sedgefrog (*Litoria olongburensis*) habitat at the subject site, the person undertaking the action must establish **created compensatory habitat** for Wallum Sedge Frog within the **subject site** in accordance with the Wallum Sedgefrog Management Plan. The **created compensatory habitat** must be established in stages, commensurate with-the area of habitat destroyed or removed though the construction of the **precincts** and must reach a minimum of 152 ha, prior to the completion of construction of the **Development**.	Section 2.4.3
Condition No.8	Prior to the **commencement of the action** the person undertaking the action must develop and submit to the **Minister** for approval a Wallum Sedgefrog Management Plan to monitor and manage the Wallum Sedgefrog (*Litoria olongburensis*) population at the **subject site** including its use of the **created compensatory habitat** within the **subject site**. The Wallum Sedgefrog Management Plan must be developed by an **appropriately qualified ecologist**. The Wallum Sedge Frog Management Plan must include: a) a review of the existing baseline *L.olongburensis* population and distribution within the **subject site**; b) a scientifically robust methodology for monitoring *L.olongburensis* population and **created compensatory habitat** success within the **subject site**; c) commitment to commencement of the construction of habitat ponds for the *L.olongburensis* concurrent with the commencement of works within each precinct; d) a *L.olongburensis* population and **created compensatory habitat** monitoring program with readily measurable objectives, performance	Section 2 Sections 4,5 & 6 Section 2.4.3 Section 4, 5 & 6

Condition Number	Applicable EPBC Act Condition	Location within WSFMP
	indicators and scientifically robust **success criteria**; e) timeframes for reporting and implementation; f) **corrective actions**, and/or mechanisms for developing **corrective actions**, and the parties responsible for implementing **corrective actions**; g) a requirement for pre-construction surveying on the **subject site** by an **appropriately qualified ecologist** immediately prior to the removal of any identified area/s of *L.olongburensis* habitat to record the size of the area to be destroyed/removed by the proposed action. This information must be included as a reporting requirement of the Wallum Sedgefrog Plan; h) an outline of the measures that will be undertaken to ensure that the **created compensatory habitat** will be protected in perpetuity; i) funding of at least $0.5 million (2013 dollars, indexed to the Consumer Price Index and excluding GST) over 10 years from the **commencement of the action**, for priority actions identified in the Wallum Sedgefrog Plan. The action must not commence until the Wallum Sedge Frog Management Plan is approved by the **Minister**. The approved Wallum Sedge Frog Management Plan must be reviewed by the· person undertaking the action within six (6) months of an audit undertaken in accordance with Condition 13. If the Wallum Sedgefrog Management Plan is amended following the review, the amended plan must be submitted to the **Minister** for approval. The approved Wallum Sedgefrog Management Plan must be implemented. Note: For clarification **Preliminary Works** may occur prior to approval of the Wallum Sedgefrog Management Plan.	Section 5.3.3 Section 5.2 Appendix B & 5.3.3 Section 3.10 Sections 2.4.1 & 3.8 Section 5.3
Condition No.9	Within one (1) year of the **commencement of the action**, the person undertaking the action must prepare and submit a detailed *L.olongburensis* Contingency and Offset Strategy (including offsets in accordance with the **department's Environmental Offset Policy**) that will be implemented if the **created compensatory habitat** does not meet the defined **success criteria**.	Section 5.4
Condition No.12	If the person undertaking the action wishes to carry out any activity otherwise than in accordance with approved management plans, reports, strategies and methods as specified in the conditions, the person undertaking the action must submit to the **Department** for the **Minister's** written approval a revised version of that management plan, report, strategy and method. The varied activity shall not commence until the **Minister** has approved the varied management plan, report, strategy and method in writing. The **Minister** will not approve a varied management plan, report, strategy and method unless the revised management plan, report, strategy, or method would result in an equivalent or improved environmental outcome over time. If the Minister approves the revised management plan, report, strategy, and method, that management plan, report, strategy, or method must be implemented in place of the management plan, report, strategy and methods originally approved.	Section 5.3
Condition No.13	Unless otherwise agreed to in writing by the **Minister,** within three (3) months of every three (3) year anniversary of the **commencement of the action**, for	Section 5.3.1

Condition Number	Applicable EPBC Act Condition	Location within WSFMP
	the first nine (9) years from **commencement of the action** and then within three (3) months of every five (5) year anniversary thereafter until the **cessation of the action**, the person undertaking the action must ensure that an independent audit of compliance with the conditions of approval and all management plans, reports, strategies and methods is conducted. For each independent audit, the independent auditor must be approved by the **Minister** and the audit criteria must be agreed to by the **Minister** prior to the commencement of the audit. The person undertaking the action must submit an audit report to the Minister for approval within three (3) months of the date of completion of the audit, identifying any remedial actions that have been taken in response to recommendations identified by the independent auditor, with any proposed changes to any management plan, report, strategy or method to be included.	
Condition No. 14	Within three (3) months of every twelve (12) month anniversary of **commencement of the action** (and until 12 months after the **cessation of the action**), the **person undertaking the action** must publish a report on their website, for the duration of the project, addressing compliance with the conditions of this approval over the previous twelve (12) months, including implementation of any management plans, reports, strategies and methods as specified in the conditions. Within five (5) days after publication, the person undertaking the action must provide the **Minister** with a copy of the report. Non-compliance with any of the conditions of this approval must be reported to the **Minister** within two (2) business days of becoming aware of the non-compliance.	Section 5.3.3
Condition No.17	Unless otherwise agreed to in writing by the **Minister**, the person undertaking the action must publish all management plans, reports, strategies and methods referred to in these conditions of approval on their website. Each management plan, report, strategy and method must be published on the website within one (1) month of being approved.	Section 5.3.3

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WALLUM SEDGEFROG

As per the requirements of the EPBC Act conditions of approval No. 8a this section of the WSFMP provides 'a review of the existing baseline L. olongburensis population and distribution within the subject site'. Please refer to Appendix C for L. olongburensis population and distribution information.

2.1 Characteristics and Habitat

The Wallum Sedgefrog (*Litoria olongburensis*) is a small, arboreal frog, found in wallum habitats, characterised by acidic conditions and semi-ephemeral wetlands. It is also known as one of the 'acid frogs' due to its tolerance (and preference) for mildly acidic ground and water conditions. The Wallum Sedgefrog is likely to be found in undisturbed wallum heath or sedgeland environments and is not generally known to inhabit disturbed environments.

The Wallum Sedgefrog is listed under the EPBC Act as vulnerable and had not been recorded on site prior to 2010. Surveys in 2012 following clearing of pine plantation and high rain fall, found Wallum Sedgefrog distributed throughout the site. Additional detailed habitat and species survey was undertaken to determine its abundance on the site. Field survey was undertaken in accordance with the *Survey Guidelines for Australia's Threatened Frogs* (DEWHA, 2010) in January to March 2012.

The Wallum Sedgefrog breed during warmer months (spring, summer, and early autumn) (Ehmann 1997) after heavy rain or when water is abundant. Eggs are laid in still water at the base of submerged reed stems in waters with a pH as low as 3.5 (Meyer 2004; Hines and Meyer 2011; Anstis 2002). Wallum Sedgefrog has been recorded dispersing and recolonising over distances of approximately 500m (James 1997; Lewis and Goldingay 2005; Meyer et al. 2006), suggesting the species is capable of short movements if suitable movement corridors are available.

A variety of disturbance factors have occurred on the Caloundra South site over the last 50-60 years. These include:

- Clearing of wetland vegetation after 1958. By 1967 two thirds of the site was cleared;
- Silvicultural practices (Slash Pine, *Pinus elliotti*) commenced in the early 1970's and created roads and artificial drainage across the site with uniform rills and furrows for pine planting;
- Clearing of pine between 2000 and 2008;
- Commencement of site management measures by Stockland to control pine wildings– ongoing; and
- Low intensity grazing, 2008 to present.

Despite the fact that the Wallum Sedgefrog is not generally found in disturbed environments, these early natural and later disturbance factors have caused the groundwater table to rise; and the presence of naturally acidic soils coupled with a break in the drought, have led to the creation of suitable conditions for Wallum Sedgefrog breeding and movement through the site.

Wallum Sedgefrog was identified in the north eastern portion of the site in ecological surveys in 2010. At the time of the 2010 survey, the highest densities were recorded in low-lying melaleuca wetland with a dominant sedge understory and wallum areas.

2.2 Investigations

The methodology adopted for this study included desktop analysis, field survey and habitat evaluation. The desktop analysis reviewed previous studies undertaken for the project site, and nearby areas.

Field survey methods included visual counts, call estimates, opportunistic presence/ absence data and recruitment surveys – breeding activity (tadpole counts and lifecycle stage).

Field investigations identified the Wallum Sedgefrog within remnant and non-remnant habitats across other parts of the site, generally in areas formerly under plantation pine, which are now dominated by exotic grasses, pine stumps and sedges. Of the Wallum Sedgefrog records amassed during surveys, the majority were from low-lying areas with standing water, sedges and grass cover.

The extremely wet conditions experienced during field surveys (75% and 41% above average rainfall conditions for 2010/12 and 2011/12 respectively, see Figure 2.2) influenced the expansion of breeding and recruitment opportunities for the Wallum Sedgefrog in atypical habitats across the site (such as in the furrows and artificial depressions created historically by pine forestry). Vegetation within areas of occupied habitats is highly variable, ranging from traditional wetlands with dense erect sedge to areas with isolated sedge clumps and abundant exotic grasses.

Due to the high influence of seasonal rainfall on habitat patch size of the Wallum Sedge Frog, the term 'habitat' in the context of the Wallum Sedge Frog on the Subject Site is defined as an area that supports semi erect semi-aquatic emergent vegetation consistent with ephemeral vegetation species common in wallum habitats (i.e. *Baumea articulata, B. juncea, B. rubiginosa, Juncus usitatus, Lepironia articulata)*. Such habitat, depending on the rainfall conditions will include areas of:

i. breeding habitat (the area of surface water supporting breeding/recruitment); and/or
ii. surrounding non-breeding habitat (used for foraging, shelter and localised movement of frogs).

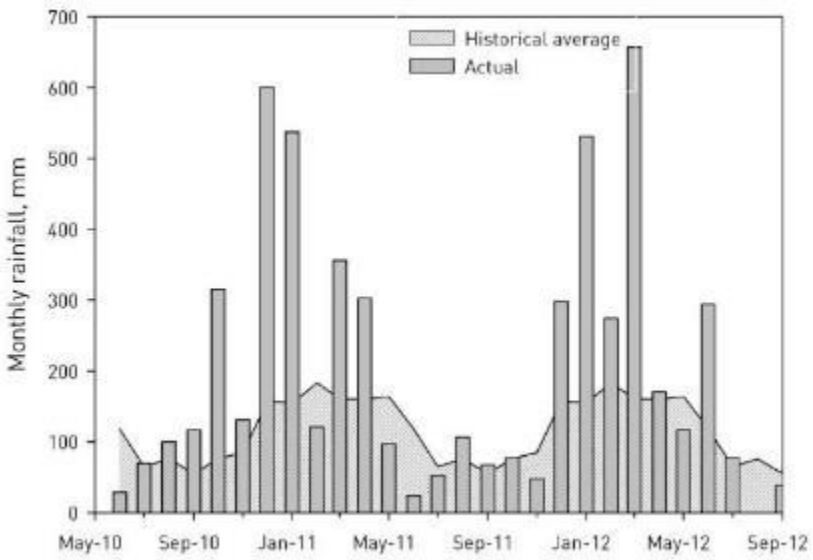

Figure 2.2: Actual and historical rainfall between March 2010 and September 2012

Once it was identified that there was a greater extent of Wallum Sedgefrogs on the site than expected, additional investigations were undertaken to assist in understanding why Wallum Sedgefrog was being found in atypical habitat. It was considered that in years with average rainfall, the extent of suitable breeding habitat (and hence opportunities for successful recruitment) are likely to be considerably reduced. These additional investigations were extended to surface and groundwater modelling to test this theory.

These studies were focused on the areas where Wallum Sedgefrog was found and included:

- Detailed habitat analysis of non-remnant vegetation across the site (surveys had been completed in September 2010);
- Detailed topographical analysis;

- Investigation of the pH of surface water where frogs were found to be breeding;
- Surface wetness modelling to better understand those areas of the site that would be wet in more typical rainfall and drier years;
- Groundwater analysis of both levels and quality;
- Near surface soil sampling in areas of Wallum Sedgefrog habitat; and
- Acid sulfate soils sampling.

The information gathered through the increased intensity field survey and the surface and groundwater modelling was used to establish a series of evaluation criteria that could be applied to 'habitat patches' identified across the site. It should be noted that a high degree of conservatism has been applied to the mapping due to 2012 climatic environment (greater than 95% rainfall over survey period) and evaluation of the importance of these 'habitat patches', shown in Figure 2.2a.

Surface and groundwater modelling was undertaken to identify potential 'dry season' refugia'. This modelling was undertaken to examine whether there was a relationship between weather conditions, and 'hydroperiod'- the length of ponding time in wetland habitat.

In addition to the habitat patches a number of potential movement corridors were identified across the site, these were generally identified by the presence of suitable breeding habitat shown in Figure 2.2b. While the movement of Wallum Sedgefrog is uncertain, anecdotal evidence suggests that re-colonisation can occur over short distances (approximately 500m) (Lewis and Goldingay 2005). Based on this information it was considered that movements ≤500m are likely, movements over distances of 500m - 1km are possible but less frequent, and movements over 1km are infrequent or unlikely.

Of note from investigations was the correlation identified between areas of higher Wallum Sedgefrog abundance and known breeding habitat, which occur above the modelled Q5 flood level, as discussed in Section 9.3.5 of the *Caloundra South Public Environmental Report* (Stockland 2012) shown in Figure 2.2c.

Furthermore, it should be noted that Wallum Sedgefrog populations (and therefore area of occupancy) are likely to be in a state of flux, expanding and contracting according to climatic conditions and the continued suitability of the atypical habitat on the site in terms of canopy cover and associated sedge communities.

2.3 Impact Summary

Impacts to existing Wallum Sedgefrog habitat will occur progressively on the site, however, based on mitigation measures proposed, corridor functionality is not likely to be impacted and a net gain in habitat will be achieved. Development of the site will progressively occur over 30 years with mitigation measures and monitoring of frog habitat to occur commensurate with development staging.

As such, the continued use of the habitat by frogs will be monitored and commencement of mitigation measures will be in advanced of expected impacts.

Potential indirect impacts to the Wallum Sedgefrog related to development of Caloundra South include changes in the site's water regime, habitat connectivity, vegetation composition and structure and human interference including increased risk of disease, introduced predators and light and noise pollution.

A summary of impacts associated with the proposal is provided in Schedule A to this WSFMP.

Overall 152 ha is permitted to be cleared as a result of the development. EPBC Act approval condition No. 5 states that the person undertaking the action must provide a detailed map to the Department that identifies the areas of Wallum Sedgefrog habitat that will be removed. Figure 2.2d (version 02/15) identifies Wallum Sedgefrog habitat proposed to be cleared as a result of the development. In deriving this map, survey data from the 2012 survey (as represented in the PER) is used as the base for areas that have not been subject to a pre-construction survey. Map 2.2d will be progressively updated and submitted to the department to reflect

the area of habitat being retained (and compliant with Table 4.2a and Sections 5 and 8 of this document), removed and/or recreated, ensuring compliance with Conditions 5, 6 and 7 enabling tracking as development progresses.

Pre-construction survey relationship to Map 2.2d

Pre-construction surveys undertaken in 2013 and 2014 in Precincts 1, 2, 3, 4 and 5 have enabled more detailed investigations into the amount of WSF habitat to be removed through development. The pre-construction survey methodology (Box 1, Appendix B) has been updated to reflect the accurate determination of habitat in either dry, extremely wet or normal seasonal rainfall conditions, as recent (2014) weather conditions highlighted the inadequacies of previous habitat survey techniques (i.e. reliance on seasonal ponding for WSF habitat delineation).

In accordance with Condition 8g of the approval, each precinct will be surveyed for the extent of Wallum Sedgefrog Habitat to be removed prior to commencement of construction (refer to Box 1, Appendix B,) with mapping and extent of habitat to be removed provided as part of Precinct Construction Environmental Management Plans (PCEMP). The PCEMP will provide the total area of Wallum Sedgefrog habitat removed as a result of the development for the current development precinct/s, and all those prior, to ensure that no more than 152ha of Wallum Sedgefrog habitat across the subject site is removed.

Map 2.2d will be progressively updated as a result of both Phase 1 and 2 preconstruction surveys (Box 1, Appendix B) commensurate with the progress of the development. An updated Map 2.2d will be provided to the department within relevant precincts CEMP's (Condition 3) and Annual report (Condition 14). The current approved Map 2.2d can be found on Stockland's website.

Given that existing values of the site for the Wallum Sedgefrog are predominantly the result of historic land use and ongoing land management practices, such as prescribed burns and chopper rolling (mechanical removal of pine stumps with dozer dragging a chopper roller (large metal drum with blades), if left, much of the site would revert to pine. This would lower groundwater levels, reduce suitable habitats and fragment movement corridors for the species. This would potentially lead to Wallum Sedgefrogs only persisting in small pockets of remnant habitat or areas dominated by native sedge regrowth, thereby diminishing the values and importance of the site for the Wallum Sedgefrog. Thus, by application of DOEE criteria pertaining to populations in degraded habitat, the Wallum Sedgefrog population at Caloundra South would not qualify as an important population. Notwithstanding this, the Wallum Sedgefrog population at Caloundra South has been treated as such in the development of conservation and mitigation measures.

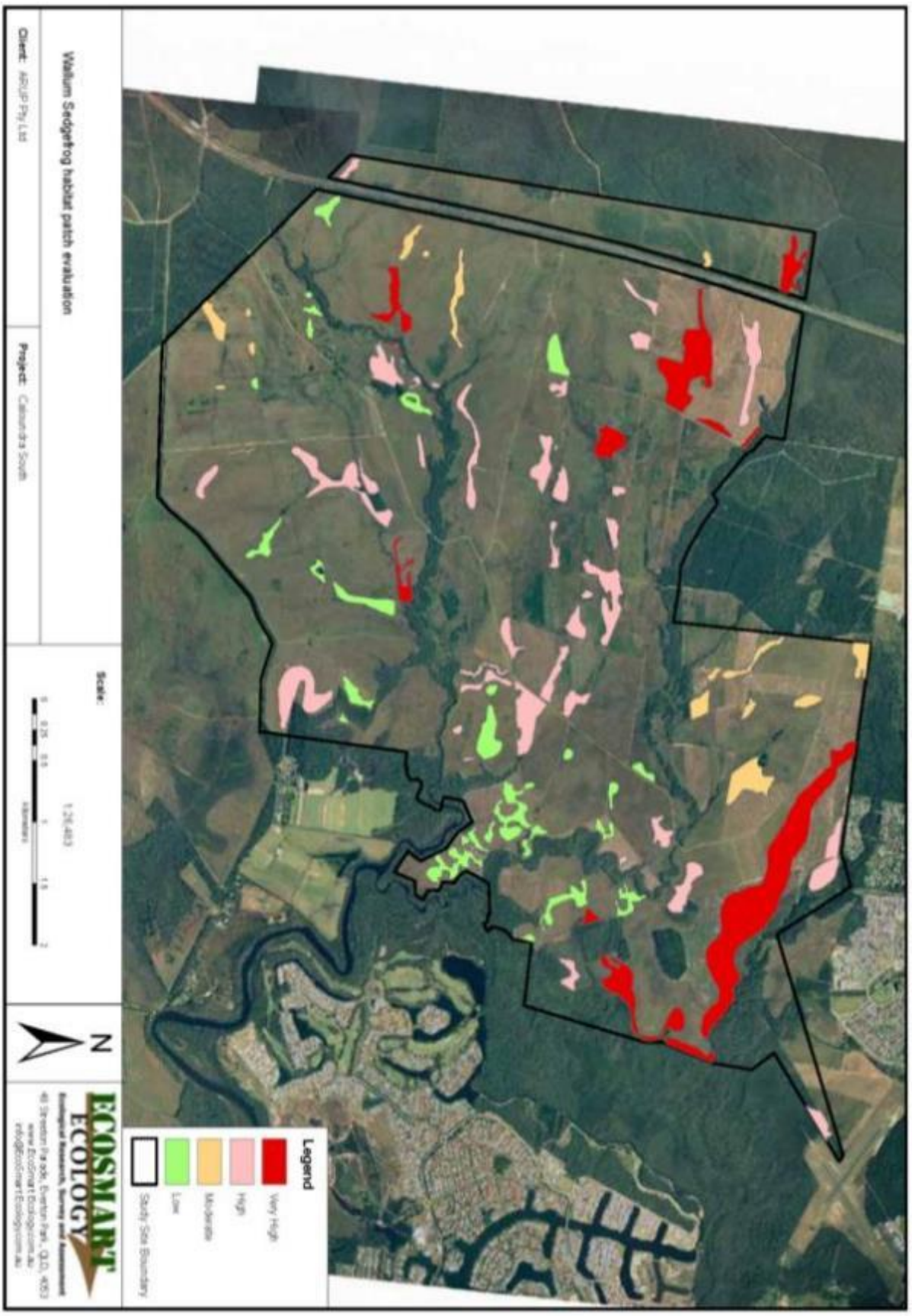

Figure 2.2a: Wallum Sedgefrog Habitat Patch evaluation (2012 WSF PER mapping)

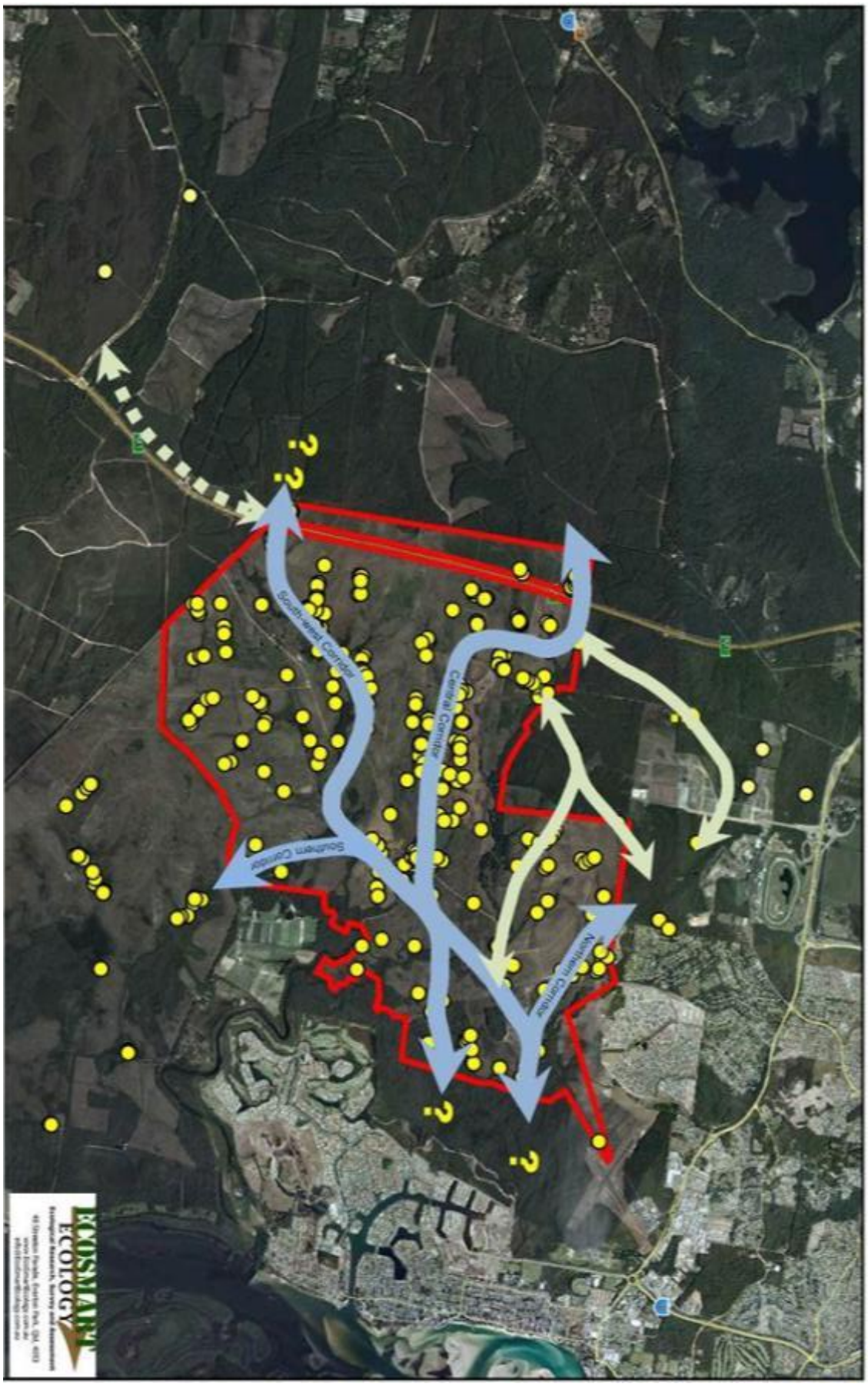

Figure 2.2b: Potential frog corridors (2012 WSF PER mapping). Yellow dots represent WSF presence.

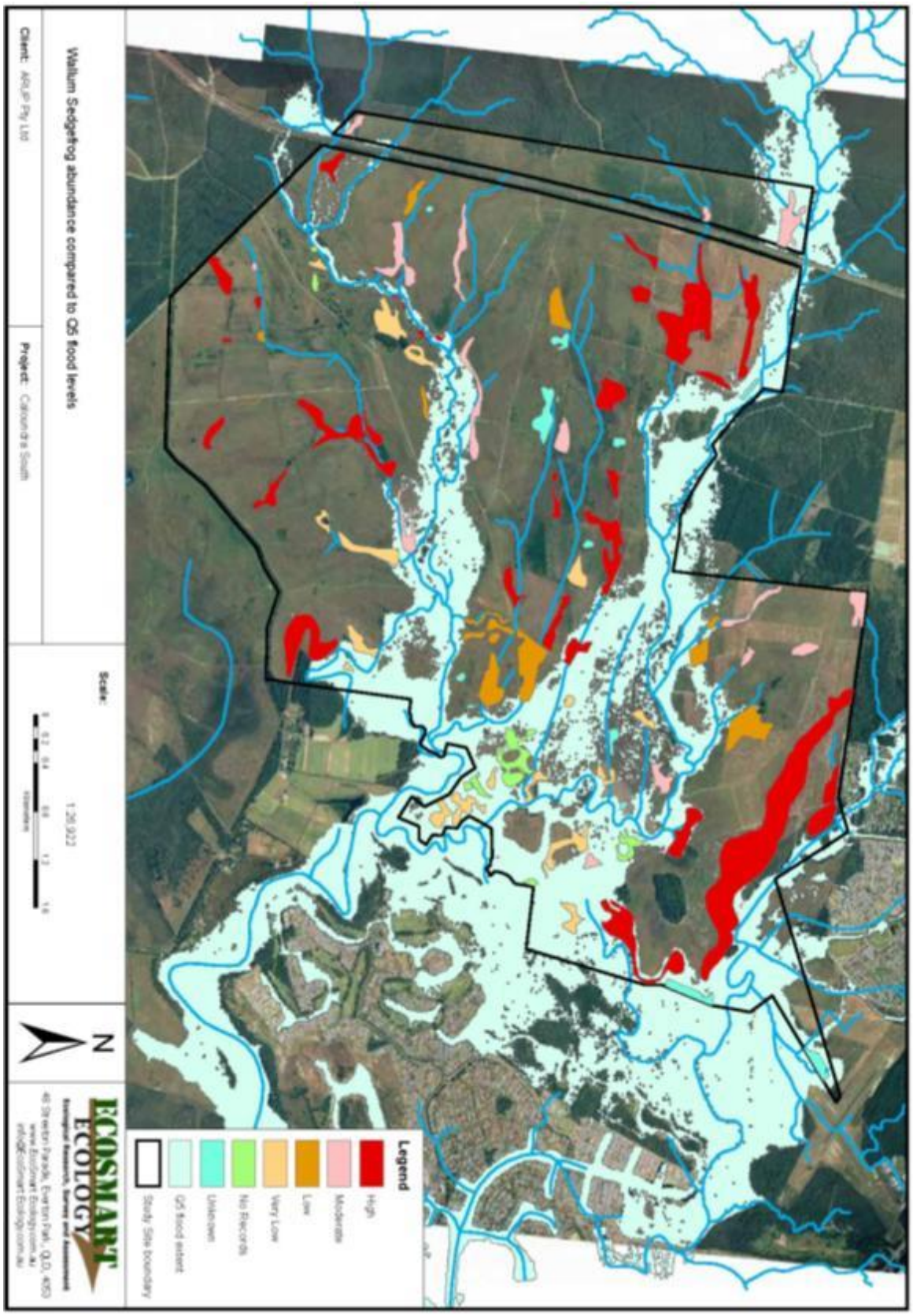

Figure 2.2c: Standardised Relative Abundance of Wallum Sedgefrogs compared to Q5 Flood Levels (2012 WSF PER mapping)

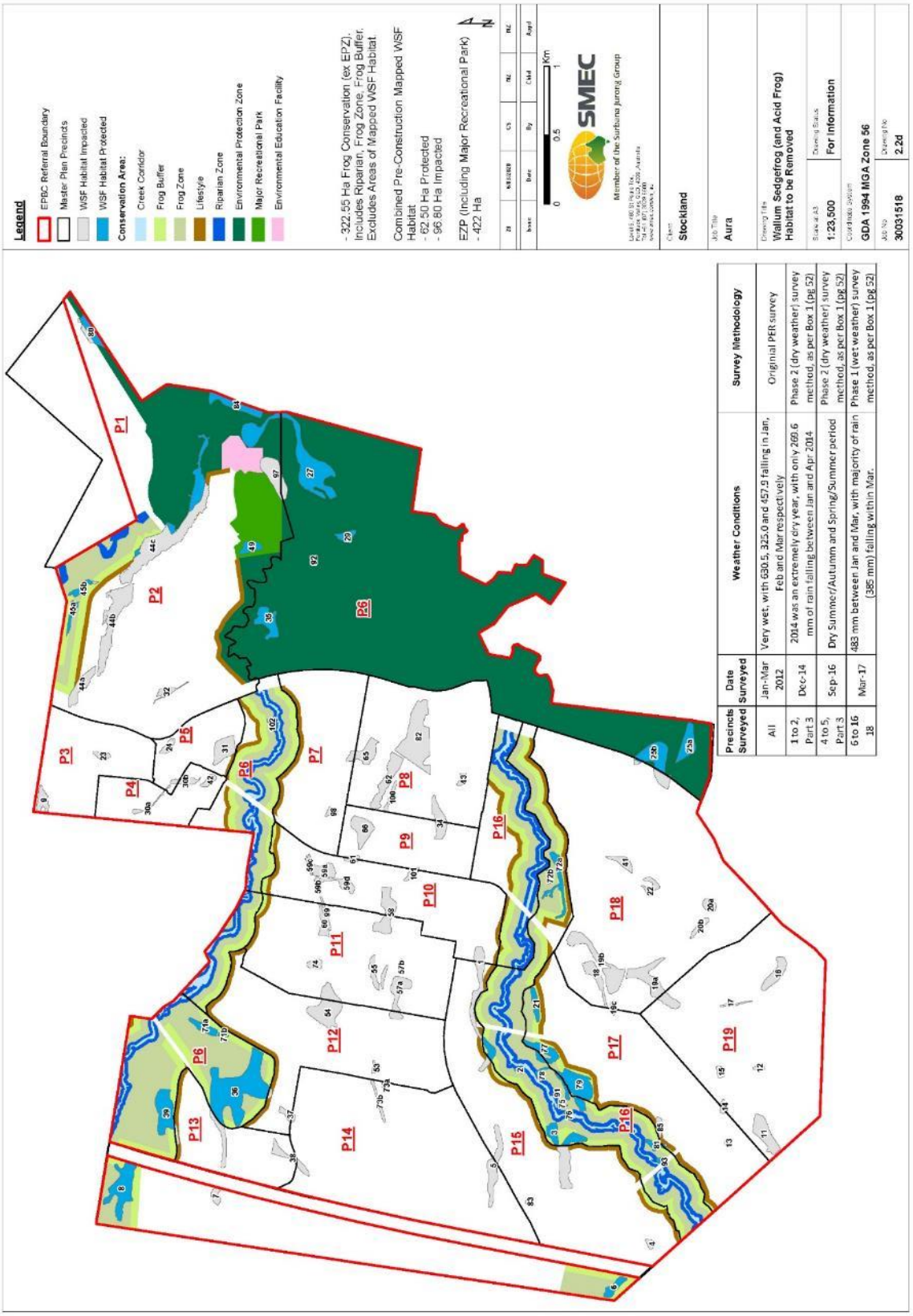

Figure 2.2d: Wallum Sedgefrog habitat (grey) to be removed (updated March 2017)

2.4 Mitigation Strategy

2.4.1 Site-wide Mitigation Principles

As a result of the investigations and impact assessment carried out on site, an over-arching mitigation objective was developed:

"*to maintain functioning populations of Wallum Sedgefrog, including connectivity between populations, within the site*".

The following principles underpin the approach to mitigating impacts to the Wallum Sedgefrog:

- To compensate for habitat lost to urban development. The approved PER states that up to 152 hectares of habitat may be removed and that removed habitat must -involve establishment of minimum 152ha of compensatory habitat (refer EPBC Act approval condition No.7).
- Where existing movement corridors are severed or lost to the development, to establish proximate corridors to enable movement to continue across and through the site.
- Conservation of two key areas of known refugia that are known to persist during 'dry' years, as identified in the Master Plan.
- Specify management measures and planning controls for what development and activities may/may not occur within frog habitat, frog buffers and adjacent land uses (see Section 2.4.2).
-
- Implement mitigation measures:
    - such as sediment and erosion control,
    - water quality monitoring,
    - weed management,
    - frog fencing, and
    - frog friendly fauna crossings (refer to separate Environmental Management Plan).
- Insure that land availability within the conservation zones where frog habitat to be recreated exceeds 200ha to provide flexibility in future design, and to assist in responding to local soil and groundwater conditions encountered on site at detailed design phase and realistically allow for some cases where habitat recreation is unsuccessful.
- Ensure that the habitat being re-created, rehabilitated and conserved is located within a conservation regime in perpetuity.
- The design and implementation of rehabilitation and habitat re-creation is informed through additional detailed soil and groundwater assessment.
- An adaptive management approach would be taken to enable the successful rehabilitation of Wallum Sedgefrog habitat.
- Dedicate funding of at least $0.5million over 10 years (2013 dollars, indexed to CPI ex GST) from commencement of the action, for priority actions identified in the Wallum Sedgefrog Management Plan. See section 3.8 of the WSFMP which identifies the priority actions.
- Retained WSF habitat (as shown in Figure 2.4d) within the Frog Buffer and Frog Zone will be monitored to ensure no unacceptable impact from the development. Monitoring will be conducted in accordance with Section 7 of this document, with data reported against the Site-wide Success Criteria (Table 4.2a).

2.4.2 Land Use Zones Delivering Conservation Outcomes

Four land use zones (Riparian Zone, Frog Zone, Frog Buffer and Lifestyle Buffer), shown in Figure 2.4, have been defined to conserve Wallum Sedgefrog habitat rehabilitation and recreation and encourage movement of the species through and beyond the site, in accordance with the site wide mitigation plan (refer to Section 3, Figure 3.1, Page 24). These zones have been developed to provide protection to the existing creeks across the site (Lamerough Creek, Bells Creek North and Bells Creek South) and frog conservation zones created outside of the wider EPZ. Figure 2.4 displays the four land use zones with Table 2.4 outlined the activities that are permissible within each zone. A description of each zone and its purpose is provided below.

Riparian Corridor – nominal minimum 25m wide corridor either side of the creek (from high bank). Main purpose of this zone is for the retention and rehabilitation of riparian vegetation, providing bank stabilisation and protecting remnant vegetation along creeks. This zone may include suitable frog habitat.

Frog Zone – a minimum of 50m from the boundary of each riparian corridor, encompassing known and potentially suitable Wallum Sedgefrog habitat and also created frog habitat. The main purpose of this zone is to conserve and reinstate key frog movement corridors through the rehabilitation of existing and newly created frog breeding ponds and foraging habitats. No WSUD detention basins or ponds to be located in this zone.

Frog Buffer – a minimum of 50m from the boundary of each Frog Zone. This zone will provide protection from development activities beyond the buffer to the main frog zone itself. The frog buffer will be designed, planted and managed in much the same way as the Frog zone, and as such may include areas of WSF breeding ponds and foraging habitat – depending on the seasonal rainfall conditions.

Lifestyle Buffer – a minimum of 30m, from the boundary of each Frog Buffer. This buffer provides for separation between development areas and residential (building) areas. To further reinforce this, the following table identifies the uses permitted in each of the zones described above.

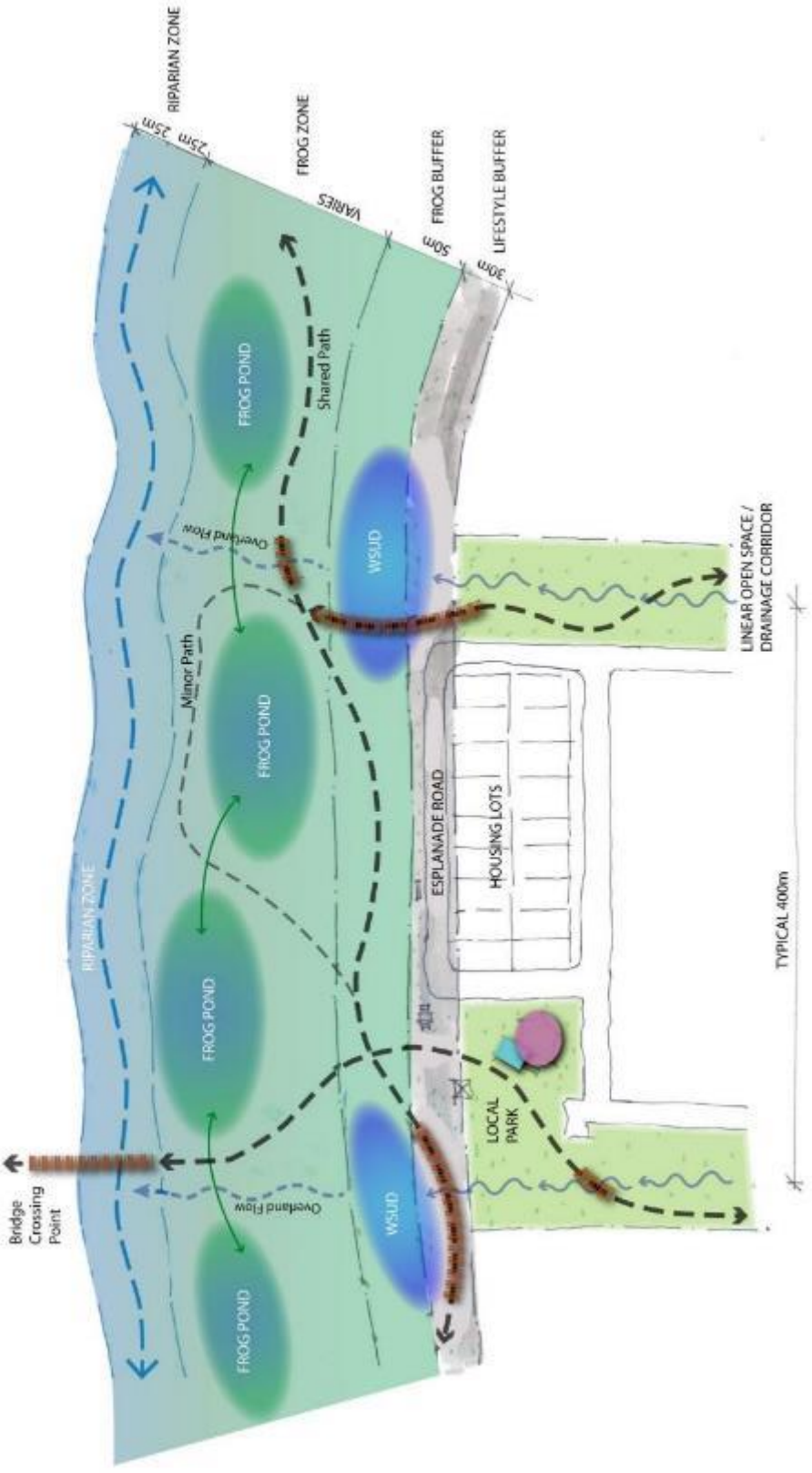

Figure 2.4: Conservation and Buffer Zones outside of EPZ

Table 2.4: Activities Compatible within Conservation and Other Zones

Activity	Riparian Corridor	Frog Zone	Frog Buffer	Lifestyle Buffer	Sports/ Rec/ Urban Zones	Comments
Boardwalks	✓	✓	✓	✓	✓	Acceptable in Frog Protection Zones, boardwalks have been constructed in areas of sensitive frog habitat without any obvious significant impact on frogs. Boardwalks in the riparian corridor will be sensitively designed and would not enable direct access to the creek.
Pedestrian paths	✓	✓	✓	✓	✓	Acceptable in Frog Protection Zones provided works do not affect hydrology/topography and/or involve importation of fill. Use of fertilisers and exotic plants to be avoided in frog Protection Zones. Paths in the riparian corridor will be sensitively designed and would not enable direct access to the creek.
Seating and interpretive /educational signage	✓	✓	✓	✓	✓	Acceptable in Frog Protection Zones provided works do not affect hydrology/topography and/or involve importation of fill. Use of fertilisers and exotic plants to be avoided in frog Protection Zones.
Cycleways	✓	✓	✓	✓	✓	Acceptable, provided works do not affect hydrology/topography and/or involve importation of fill. Use of fertilisers and exotic plants to be avoided in Frog Protection Zones (Inc. Frog Buffer). Cycleways in the riparian corridor would be sensitively designed and would not enable direct access to the creek.
Water Sensitive Urban Design (WSUD)	×	×	✓	✓	✓	WSUD within wallum frog breeding areas is inappropriate as this benefit's competitive species. As earthworks are likely to be required, location in Frog Buffer should be minimised. All WSUD should be off-line from frog breeding habitat to ensure no mixing of water chemistry/hydrology.
BBQ site/table and chairs	×	×	✓	✓	✓	Acceptable within Frog Buffer, provided works do not affect hydrology/topography and/or involve importation of fill. Use of fertilisers and exotic plants to be avoided.
End of trip cycle facilities	×	×	×	✓	✓	Acceptable, within Lifestyle Buffer and beyond. Hydrology/topography to not be substantially altered and use of fertilisers and exotic plants to be avoided.
Toilets	×	×	×	✓	✓	Acceptable (if not in-ground infiltration systems), within Lifestyle Buffer and beyond. Hydrology/topography to not be substantially altered and use of fertilisers and exotic plants to be avoided
Playgrounds	×	×	×	✓	✓	Acceptable, within Lifestyle Buffer and beyond. Hydrology/topography to not be substantially altered and use of fertilisers and exotic plants to be avoided.
Lakes	×	×	×	✓	✓	Acceptable within Lifestyle Buffer and beyond. Should be placed as far from frog habitat as possible. Hydrology/topography to not be

Activity	Riparian Corridor	Frog Zone	Frog Buffer	Lifestyle Buffer	Sports/ Rec/ Urban Zones	Comments
						substantially altered and use of fertilisers and exotic plants to be avoided.
Informal spaces/kick a bout	×	×	✓	✓	✓	Acceptable, within Frog Buffer and beyond. Hydrology/topography to not be substantially altered and use of fertilisers and exotic plants to be avoided. For use in Frog Buffer minimum 30m buffer is required from frog breeding areas.
Non habitable buildings and structures	×	×	×	✓	✓	Acceptable within the Lifestyle buffer and beyond, providing that during construction or operation there is no direct or indirect impact to created or retained WSF habitat

2.4.3 Habitat Creation and Enhancement

The core elements of the strategy to ensure long-term viability of the population of Wallum Sedgefrog at Caloundra South is as follows:

- In accordance with EPBC Act approval condition No.7 the person undertaking the action must minimise and compensate for the loss of a maximum 152 ha Wallum Sedgefrog (*Litoria olongburensis*) habitat at the subject site and establish created compensatory habitat for Wallum Sedgefrog within the subject site in accordance with this Plan.
- The created compensatory habitat will be established in stages and will as a minimum be commensurate with-the area of habitat destroyed or removed though the construction of the precincts and must reach a minimum of 152 ha of rehabilitated habitat prior to the completion of construction of the development.
- Recreation of Wallum Sedgefrog habitat involves the construction of breeding habitat ponds (as well as habitat to allow frog movement between ponds). The 152ha is comprised of foraging and breeding habitat areas contained within the newly created frog zone and frog buffer (in accordance with KPI's in Table 4.2a), and riparian buffer. Existing habitat identified for retention (as per preconstruction surveys) is excluded from the 152ha calculations.
- The person undertaking the action commits to commencing creation of habitat ponds for the Wallum Sedgefrog concurrent with the commencement of works within each precinct (as per EPBC Act approval Condition No.8c).
- Traditional movement corridors will be maintained or realigned through habitat creation within waterway buffers and zones to ensure smaller subpopulations are not isolated and at a greater risk of decline.

The feasibility of Wallum Sedgefrog habitat pond creation and enhancement on the site within the frog conservation, Frog Buffers and the EPZ areas of the site has been thoroughly investigated for Precinct 2 (see Section 5 of this Plan).

Based on the extensive survey, characteristics of known habitats on the site, the behaviour and tolerance of the species and experiences in habitat creation elsewhere, a detailed technical specification and concept design for the creation of Wallum Sedgefrog habitat has been developed (see Section 5 of this Plan).

Principles that are critical to success of habitat creation and enhancement are as follows (for details of specific success criteria, see Section 4.2 of the Plan):

- Proximity to existing/retained Wallum Sedgefrog habitat areas;
- While limited information is available on the correlation between Q5 flood levels and successful breeding habitat, created WSF habitat is to be encouraged in areas located / protected from the Q5 flood level. This may include the construction of small levee walls / bunds around habitat;
- Appropriate Wallum Sedgefrog breeding pond excavation depths and bathymetry;
- Appropriate pond density within created Wallum Sedgefrog habitat areas to facilitate movement (refer to Section 4.2 of the Plan)
- Delivery of water to ponds via seepage through soil profile (i.e. groundwater) to ensure water chemistry is maintained at appropriate levels for the species;
- Exclusion of surface water flows (including limitation of liming for acid sulfate soil treatment);
- The need for exclusion fencing and / or signage to limit human disturbance or interaction; and
- Maintaining natural groundwater hydroperiod and other water chemistry aspects (particularly pH) of retained and compensatory habitat areas.
- Plants colonising created WSF ponds must include a mixture of rigid and non-rigid grasses, with only a small percentage of open water.

Within retained habitats, a range of additional management and mitigation measures will be implemented including:

- Implementation of Water Sensitive Urban Design features that ensure the diversion of stormwater and surface runoff away from created and retained breeding habitat (to maintain pH, ensure habitat stability and limit introduction of competitor/predatory species);
- Maintaining natural groundwater hydroperiod and other water chemistry aspects (particularly pH and tannin levels) of retained habitat areas;
- Maintaining vegetation communities within retained habitat areas through weed and fire management plans;
- Ensuring community education, signage, vegetation planting and physical barriers to deter inappropriate recreational activities in frog conservation areas; and
- Taking practical measures to reduce lighting in proximity to areas of retained Wallum Sedgefrog habitat.

Provided habitat ponds (both retained and created) meet performance criteria and are located within the identified waterway corridors on the site, the potential for on-going colonisation by Wallum Sedgefrog is highly likely.

2.4.4 Habitat Connectivity

A number of potential movement corridors within the site and extending to the surrounding area are likely to facilitate dispersal and gene flow within and between acid frog populations (see Figure 2.2b).

Allowance was made for frog sensitive creek crossings in the Caloundra South Master Plan (June 2012) with additional management measures provided below, and specific design criteria provided in Section 3.5:

- Revegetate around and beneath underpasses;
- Use of frog fencing to funnel frog movement into underpasses;
- Locate created habitat at the mouth of underpass structures; and
- Exploring the benefits of co-locating frog fence and noise barriers along roads.

Section 3 of this WSFMP details the measures and specifications for habitat conservation, rehabilitation and creation.

2.5 Summary

The management measures outlined in this WSFMP are to achieve the long-term viability of Wallum Sedgefrog populations within the broader Caloundra unit.

The successful implementation of the measures proposed would:

- establish 152ha of compensatory habitat (including ponds and movement habitat) within frog conservation buffers located along riparian corridors;
- conserve and enhance certain areas of existing Wallum Sedgefrog habitat; and
- maintain habitat connectivity for Wallum Sedgefrog populations to allow for movement within and outside the site.

3

STRATEGY TO PROTECT WALLUM SEDGEFROG

3.1 Introduction

The aim of the WSFMP is to create Wallum Sedgefrog habitat and conserve and enhance the existing Wallum Sedgefrog habitat within the waterway corridors of Lamerough Creek, Bells Creek North and Bells Creek South, to enable habitat connectivity for Wallum Sedgefrog populations both within and outside the Caloundra South site. These management measures are illustrated on Figure 3.1.

3.2 Habitat Conservation and Re-creation - Strategy

The person undertaking the action has committed to protecting and enhancing existing and creating new Wallum Sedgefrog habitat in corridors along Lamerough Creek, Bells Creek North and Bells Creek South, to address the impact of the development footprint on these corridors that have and will contain breeding habitat (ponds).

Key measures to protect and enhance habitat within the waterway corridors include:

- defining frog habitat areas (Frog Zone, Frog Buffers) and the Lifestyle Buffer, and the specific activities that cannot occur in these areas;
- conserving the Riparian corridor, frog habitat areas (Frog Zone and Frog Buffer);
- providing frog and other fauna friendly crossings where infrastructure crosses frog movement corridors, in association with appropriate fencing and/or movement barriers; and
- creating additional frog breeding habitat.

In summary the key aspects of the compensation proposed are as follows:

- The areas evaluated as low to very high significance habitat patches lost to the development will be included in the compensation amount. Noting that the determination of habitat patches was highly conservative, and that the habitat impacted by the development footprint is located in highly disturbed habitat, not necessarily representative of 'typical' Wallum Sedgefrog habitat, as it consists of pine furrows, and exotic grasses interspersed with sedges.

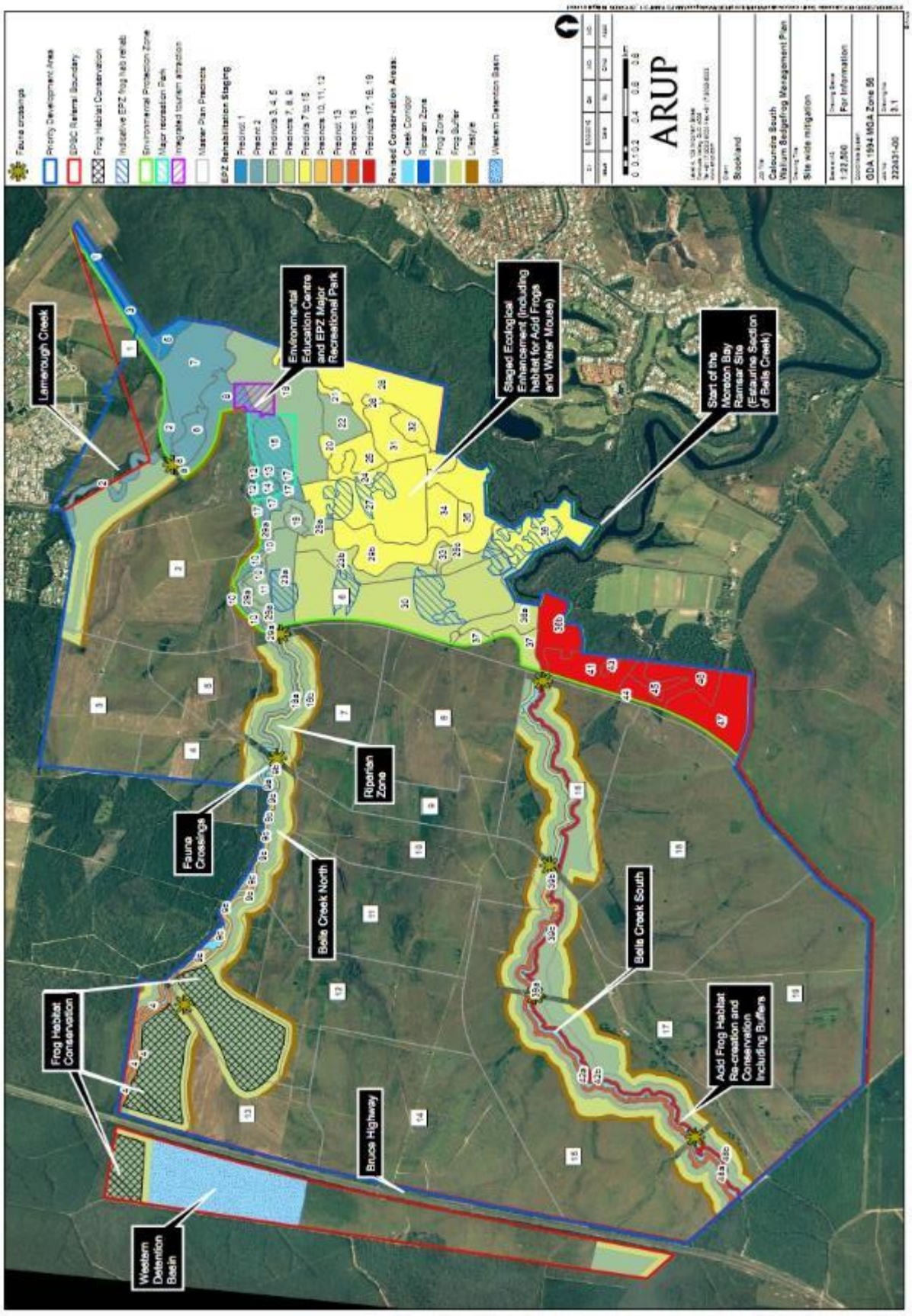

Figure 3.1: Updated (02/2015) Overarching Mitigation

- The objective for created habitat is to provide a self-sustaining 'typical' habitat, to have minimal weeds and with pine wildings removed, providing a better chance of sustaining a population onsite, and maintaining regional connectivity.
- Compensated habitat will comprise of a percentage of breeding habitat (i.e. constructed ponds) and other habitat suitable for movement of frogs between breeding ponds (i.e. sedgeland, wet heath and tall grasslands). Impact mitigation is dependent on both habitat retention and habitat re-creation to compensate for habitat loss, with habitat ponds, either created or retained, spaced no more than 300m from each other.

The Frog Zones (i.e. the Frog Zone and Frog Buffer), as described above, extend the area of protected habitat identified under the provisions of the approved Caloundra South Master Plan (June 2012).

3.3 Breeding Habitat - Design Criteria

The criteria necessary for the design and construction of breeding ponds is set out below:

- Have seasonal hydrological conditions which allow for:
  - Persistence of surface water for a minimum of eight weeks during the summer wet season; and
  - Complete drying at some time during the year (thereby reducing the likelihood of predatory fish persisting).
- Have surface water with:
  - pH levels similar to or lower than pH levels recorded during surveys (i.e., <4.9 [mean = 4.41, std dev = 0.34]), and as such, positioned entirely within sandy soil which does not buffer water acidity to the extent more clayey soils do;
  - Tannin-staining at levels comparable to, or higher than, the median level recorded during surveys (i.e. around 9.5 tannic acid equivalents [mg/L] or higher);
  - Low levels of monomeric Aluminium consistent with (non-toxic) levels in siliceous sand and Wallum waters generally;
  - Heavy metals at no more than trace levels, commensurate with very low levels typical of Wallum waters;
  - Low levels of dissolved Calcium consistent with levels typical of wallum waters (i.e. [Ca2+] 80 µM or less); and
  - Salinity levels broadly consistent with levels recorded on site during surveys (i.e. salinity < 50 ppm).
- Support semi erect semi-aquatic emergent vegetation consistent with species common in existing habitats (i.e. *Baumea articulata, B. juncea, B. rubiginosa, Juncus usitatus, Lepironia articulata);*
- Located 50-200m away from other areas of breeding habitat;
- Located as far away as practicable from habitat that may support the common sedgefrog (including detention basins and sediment ponds);
- Stormwater runoff from urban development zones or discharge from WSUD infrastructure is diverted away from Wallum frog breeding habitat (re-created or retained habitats); and

To reinforce the above, those factors needed for successful construction of Wallum Sedgefrog breeding ponds, are considered to include:

- Proximity to existing Wallum Sedgefrog habitat areas to be retained;
- Location of ponds above modelled Q5, (plus climate change) flood levels, where possible;
- Excavation depths and bathymetry such that groundwater is intercepted and a 'window' for groundwater expression is created at depths corresponding to the depths of habitat ponds surveyed;
- Delivery of water to ponds via groundwater, in areas of appropriate soil conditions to ensure the water chemistry reflects the observed pH range;

- The exclusion of directed surface water flows which have potential to carry contaminants which may negatively affect water chemistry and quality within Wallum Sedgefrog habitat ponds;
- Buffers of a minimum 50m from areas of intensive land use (roads, urban areas etc.); and
- Exclusion fencing and signage so that habitat areas are not impacted by trampling or disturbance.

3.4 Additional On-Going Site Investigations

The on-going success of the compensatory habitat measures will be demonstarted threough a range of on-going investigations that include pre-construction site surveys of Wallum Sedgefrog presence, abundance and habitat quality; localised groundwater modelling (taking into account dewatering activities, and examining the effects of rainwater infiltration on groundwater); soil chemistry testing (in situ and in adjacent fill areas) to inform selection of appropriate breeding pond sites; and confirmation of hydroperiod in key habitat areas.

Specifically studies will be the responsibility of the person undertaking the action, undertaken prior to works and would include:

- Pre-construction surveys of Wallum Sedgefrog to confirm currency of habitat in accordance with Figure 2.2d.
- The extent of impact, timing and duration of dewatering groundwater for construction, which may affect habitats partially affected by, or immediately adjacent to, development;
- Determination of the typical hydroperiod of existing Wallum Sedgefrog habitat ponds to document and classify the wetting/drying regimes of the wetland areas;
- Finer-scale groundwater modelling for the post-development scenario (particularly focussing on the saturated hydraulic conductivity of retained habitats). Groundwater level loggers have already been installed within several key habitat areas within the Northern Locality of the site in order to provide a seasonal profile of groundwater and response to rainfall events;
- The impact of development on rainwater infiltration and hence groundwater levels and fluctuations in both retained habitats and in areas where habitat would be created;
- The relative importance of indurated material (e.g. coffee rock) in retarding soil drainage and maintaining high groundwater levels at specific locations where habitats would be retained;
- Soil structure (i.e. clay content) at locations were created habitat is planned; and
- Characteristics of fill used in retained habitats that would be partially affected (i.e., clay content and monomeric aluminium).

As the proposed development is expected to progress over 30 years, there will be considerable opportunity to apply lessons learned from previous stages to the next stage of habitat design and creation. This adaptive approach to habitat design and implementation will rely on partnerships between research teams, the approval holder, and relevant government agencies.

This information and data will be used along with the outputs of future surveys of frog habitat usage and abundance on the site to review the relative significance of habitats over time.

In general, information and data will be collected progressively across the site over the life of the construction of the development, concentrating on habitats and areas to be conserved within the Northern Locality first as the initial stage of development.

3.5 Road, Creek Crossing and Barrier Design

The performance criteria that will be met in relation to future frog passage design is provided in Table 3.5a. This table also provides some design option examples which may be considered as long as they meet the performance criteria.

In addition, appropriate guidance such as the *Queensland Fauna Sensitive Road Design Guidelines* (Volume 2; TMR, 2010), will also be used as a reference for design options to meet the performance criteria in Table 3.5a.

In addition to the site wide mitigation and management measures for Wallum Sedgefrog, a number of location specific mitigation measures have also been identified. These are listed in Table 3.5b.

Table 3.5a: Design Guidelines for Fauna Passage

Type	Management Objectives	Example Design Option	Design Consideration
Creek Bridges	• An area of dry passage (i.e. above creek water) for ~ 5m on one side of the creek at times of low flow. • Vegetation (sedges and grasses) extending well back under bridges, minimising the extent of bare substrate to ~ 3m.	• Footings set back from high bank; • Substrate under bridges comprising of natural soil and rocks, not concrete; • Mouth of bridge vegetated with low heath and sedges; Lomandra and erect sedges/grasses established under bridge; and • Clearing of vegetation for bridge construction minimised. • Use of span bridges or piers where feasible. • Use of pre-fabricated girders and deck units where feasible.	• Optimise light penetration as far as practical. • Minimal extent of dry bare substrate under bridges. • Minimise footprint of bridge design and construction as far as practical. • Maximise the open areas and height clearance under bridges as far as practical. • Reduce construction works and disturbance in sensitive areas as far as practical. • Implement monitoring in sensitive areas during construction.
Frog underpasses	• Created or retained Wallum Sedgefrog habitat within at least 50m either side of underpass. • Extent of dry bare substrate under underpasses minimal, with surface to consist of >30cm natural organic material and intermittently spaced large woody debris to provide shelter. • Underpasses to be used in conjunction with directional fencing restricting movement onto roads (where practical)	• Underpass positioned between two areas of re-created Wallum Sedgefrog habitat, each within 30m of the roadway, providing 'line-of-sight' passage; • Underpass height minimum 900mm • If carriage ways are separated, plant out gaps with sedges and grasses; • Extent of road batter reduced in order to minimize culvert length; • Base/floor of culverts covered with soil; • Erect grasses and sedges planted at mouth of culvert; tall shrubs and trees cleared from culvert entrances to improve light penetration; and • Woah-boys directing surface runoff into culverts.	• Underpasses can be amalgamated with bridge crossings.

Type	Management Objectives	Example Design Option	Design Consideration
Frog Fencing		• Frog and noise barrier constructed 30m either side of designated crossings. • Frog barriers should be >1.5m high, or if less than 1m, include a 5cm long overhang bent at 45° on habitat side. • Frog barriers may be noise barriers • Vegetation adjacent to barriers is managed so that frogs are unable to climb up and over barriers. • Barriers positioned between frog habitats and roadways, and at frog underpasses or creek crossings. • Where roads abut Wallum Sedgefrog habitat, barriers extend for 50m or more, depending on the extent of nearby breeding habitat.	• Minimise land use conflicts between habitat/corridor and roads etc

Table 3.5b: Management and Mitigation Commitments for Wallum Sedgefrog – Location Specific

Location	Management Actions to maintain corridor function
Northern Development Zone	• Partial retention and protection of habitat patch 45.
	• Inclusion of frog friendly underpasses / crossings across existing sedge habitats associated with habitat patch 44.
	• Wallum Sedgefrog fauna friendly crossings and frog movement barriers at Bellvista Boulevard
Central Development Zone	• Partial retention of habitat patches 36 and 39 where not impacted by the developable footprint, and complete retention of patch 71.
	• Retention of possible drought refugia in habitat patch 36.
	• Frog friendly creek structures and frog movement barriers at each of the three roads crossing Bells Creek North. Where sufficient passage is provided by a bridge structure, there is no need to provide a frog culvert •
Southern Development Zone	• Retention of habitat patches 75, 76 and 78 in their entirety.
	• Partial retention of habitat patches 79, 72, 3 and 1.
	• Retention of likely drought refugia within habitat patches 91, 76, 75, 72 and 3.
	• Frog friendly creek structures and frog movement barriers at each of the four roads crossing Bells Creek South. Where sufficient passage is provided by a bridge structure, there is no need to provide a frog culvert •

3.6 Site Preparation and Construction

Site preparation works include bulk earthworks, and construction of temporary and/or permanent stormwater treatment devices.

Exclusion fencing will be established around 'no go' areas, which generally are located within the frog habitat or frog buffer areas. This is to avoid physical impacts to habitat areas and introduction of disease elements such as chytrid fungus.

Temporary stormwater treatment devices will be designed to avoid directing run off into or across areas of identified habitat. Development and implementation of an adaptive management plan to address water quality issues during and after construction is part of the monitoring program as outlined in Section 5 of this Plan.

To maintain continuity of habitat connectivity, construction of some ponds (particularly along Bells Creek North) will proceed ahead of the development front.

Other management measures to be implemented during the construction phase include:

- Only appropriately trained personnel will undertake the removal of native fauna.
- In stream works will be completed as quickly as possible to minimise disturbance to aquatic species.
- Fauna fencing and wildlife structures installed during construction and maintained during the operational stage will be designed to minimise harbourage and roosting opportunities for pest species.
- Induction training for wildlife management for contractor staff and other personnel that enter the construction site.
- A licensed spotter and catcher will be on-call for the duration of bulk earthworks and clearing activities.
- Visual inspection of the site for animals will occur immediately prior to and during vegetation clearance works.
- Construction crew will not be permitted to bring domestic animals to the project area.
- Putrescible waste generated during construction will be stored in contained on site to list access by scavenger animals and will be transported off site for disposal.
- Fill material used in close proximity to retained habitats will have low-medium clay content, consistent with findings from the assessment of soils at the Control Sites. Construction and maintenance of silt traps/fencing upslope of creek lines and areas of frog habitat.
- Construction and maintenance of temporary drains and or bunding diverting sediment-laden runoff away from areas of frog habitat.
- Construction and maintenance of detention basins for containing silt-laden runoff, away from areas of sensitive frog habitat.
- The temporary use of sterile sorghum to stabilise loose fill in proximity to areas of Wallum Sedgefrog habitat. Sorghum should be used as a temporary stabilising agent. Slower native vegetation should replace or be used in preference to sorghum where ongoing soil disturbance would not occur.

3.7 Summary of Commitments

Commitments made by the person undertaking the action towards the mitigation and management of existing and created Wallum Sedgefrog within the Caloundra South site are summarised in Table 3.7 below.

Table 3.7: Summary of Mitigation and Management Commitments for Wallum Sedgefrog

Objective: To conserve, enhance and re-create Wallum Sedgefrog breeding and movement habitats along key conservation corridors.		
Management Action	Responsibility	Timing
• Retention, or partial retention, of existing Wallum Sedgefrog habitats within and adjacent to movement corridors along Lamerough Creek, Bells Creek North and Bells Creek South in perpetuity.	Person undertaking the action	Prior to commencement of works and during works
• Creation of artificial Wallum Sedgefrog breeding habitat in areas above Q5 (where possible) in the Frog Zone (and not existing Wallum Sedgefrog habitat) with a maximum distance between breeding opportunities being less than 400m.	Person undertaking the action/ Building Contractor	During works
• Provision of frog buffers between retained and re-created Wallum Sedgefrog habitat and earthworks and other development-related threats (refer Figure 3.1).	Person undertaking the action/ Building Contractor	Prior to commencement of works
• Revegetation and rehabilitation of waterway movement corridors using flora species that will extend the extent of existing ecosystems and enhance habitat for Wallum Sedgefrog.	Person undertaking the action/ Building Contractor	During works
• Installation of movement barriers (i.e. frog proof fencing to 'funnel' frog movement under bridge crossings and culvert underpasses.	Person undertaking the action/ Building Contractor	During works
• Ongoing land management to support existing habitats in undeveloped portions of the site	Person undertaking the action/ Ongoing maintenance	Until cessation of the action
• Periodic slashing and/or pruning of vegetation adjacent to frog barriers.	Person undertaking the action/ Ongoing maintenance	Post construction
• Construction of creek bridges and dedicated frog underpasses (in accordance with design recommendations) are to be used to facilitate movement of sedgefrogs under roads bisecting movement corridors.	Person undertaking the action/ Building Contractor	During works
• Construction and maintenance of silt fencing, bunding and detention basins for containing and treating silt laden runoff, away from areas of sensitive frog habitat.	Building Contractor	During works
Performance requirements: • Minimise potential impacts of construction on Wallum Sedgefrog. • Conservation corridors provide suitable movement corridors and breeding habitat to maintain Wallum Sedgefrog populations.		

Objective: To conserve, enhance and re-create Wallum Sedgefrog breeding and movement habitats along key conservation corridors.
• Provision of frog buffers between retained and recreated frog habitat provides suitable separation between frog conservation and developed areas. • Frog breeding ponds are designed to address success criteria identified in Table 6.2a. • Roadway crossing structures and fencing that are contributing to movement corridors are completed prior to major earthworks for the relevant stage.
Monitoring: As per frog breeding pond success criteria set out in Table 6.2a: • Water chemistry; • Surface water runoff (i.e. silt traps); • Hydroperiod; • Vegetation; • Habitat connectivity (please refer to Table 4.2a, Key Performance Indicator 5); • Wallum Sedgefrog presence. • As per Frog Buffer and frog rehabilitation zone success criteria set out in Table 6.2a: - Vegetation; - Weed presence; and - Presence of potential threats. In addition, seasonal monitoring of groundwater, breeding success in retained and re-created frog ponds and in stream water quality is to occur until areas have been accepted off maintenance.
Reporting: Reporting will be as per those outlined in Section 5 of this Plan. A log of the effectiveness of frog breeding ponds will be maintained and compiled in an annual review.
Corrective Action: Corrective actions with respect to Wallum Sedgefrog will be as per those outlined in Section 5 of this Plan.

3.8 Research Program

In addition to the on-site compensatory habitat measures outlined above, the Person undertaking the action has also committed (as per EPBC Act Condition 8), to 'funding of at least $0.5million (2013 dollars indexed to the Consumer Price Index and excluding GST) over 10 years from commencement of the action, for priority actions identified in the Wallum Sedgefrog Management Plan'. The priority actions are those identified below.

The scope of research funding and research priorities includes:

- Undertaking studies identified in the National recovery plan for the Wallum Sedgefrog and other wallum dependent frog species (Meyer et al 2006) such as:
  - Identification of essential habitat that is critical to the survival of the species through determining non-breeding habitat use and determining genetic structure within and between populations;
  - Characterising threats to Wallum Sedgefrogs including, but not limited to; predicted rises in sea levels, storm-water drainage, competition etc.; and
  - Monitor existing important populations, both within protected estate and on free-hold populations.
- Investigating the impact of noise and light on Wallum Sedgefrog behaviour and breeding.
- Monitoring frog populations and the success of mitigation measures within and adjacent the Caloundra South estate including:
  - The success of created habitats, noting key biotic factors which might be affecting/promoting breeding success;
  - Changes in frog composition, or breeding success in retained habitats adjacent to, or partially affected by, fill and development;
  - Downstream water quality, and frog populations, in Lamerough Creek and Lot 480; and
  - Monitoring and documenting the success of weed control measures.
- Provide recommendations for amendments to the WSFMP, including changes to the future design of frog ponds and or frog habitat areas. This will form part of the adaptive management approach.

Stockland is committed to improving long-term management of Wallum Sedgefrog populations, and as such, will ensure that monitoring results are made publically available through scientific publication. This would ensure that failures and successes may be documented allowing future improvement for measures for mitigating impacts.

3.9 Staging of Rehabilitation

The following section describes the intent with regard to site wide rehabilitation activities which also includes the creation of compensatory habitat for the Wallum Sedgefrog.

Rehabilitation activities are intended to occur in a staged manner across the site, that is, sequenced with development of the various stages and precincts within the site.

This staged approach takes into account the 30 year duration and scale of the proposed project and will also contribute to:

- Allowing development and rehabilitation works to be undertaken in parallel by a common contractor within a defined works area which will reduce cost and timing delays;
- Reducing the likelihood of the active construction works interfering with or otherwise compromising achievement of intended long term conservation outcomes; and
- Providing for the integrated consideration of developed areas and conservation areas in terms of on-maintenance and management handover (off-maintenance) processes.

Figure 3.9a shows the development precincts, which are indicative of the proposed staging of the site over an approximately 30 year development period.

The rehabilitation of Habitat Management Units or HMU's (which include frog conservation and frog buffer areas) will occur for those HMU areas that are adjacent to or share a common boundary with land which is the subject of a reconfiguring of a lot development application.

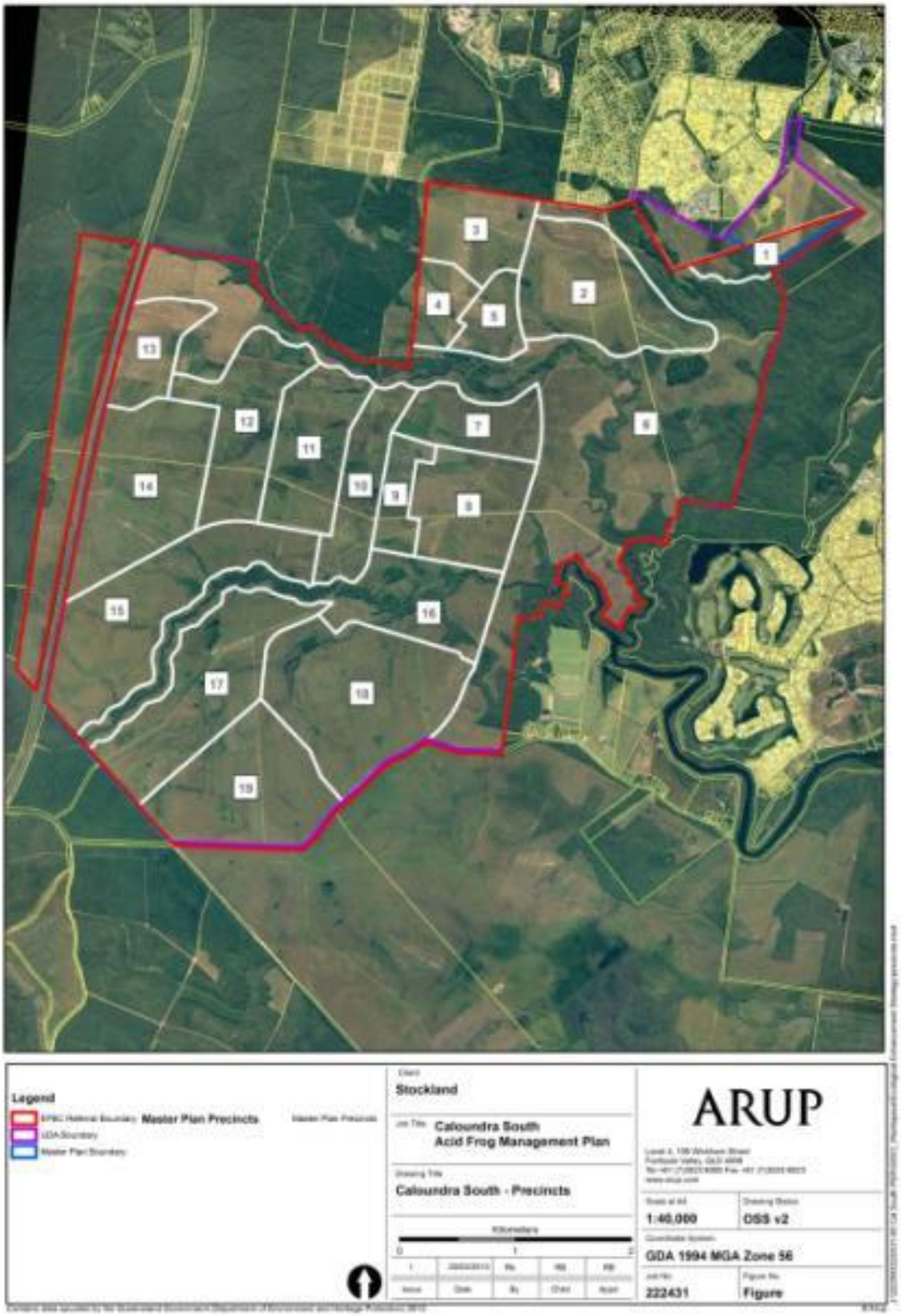

Figure 3.9a:Development Precincts

In terms of timing (refer Figure 3.9b), it is proposed that:

- Rehabilitation of an HMU including creation of compensatory WSF habitat must commence within 5 years prior to commencement of civil (subdivision) works within a Development Stage or Precinct that adjoins an HMU;
- Rehabilitation of an HMU including creation of compensatory WSF habitat will be undertaken in accordance with relevant performance objectives and success criteria outlined in Section 4 of this Plan);
- Rehabilitation may be completed incrementally in stages within an HMU with a minimum handover of 5ha for each stage of rehabilitation. These stages would not necessarily coincide with separately titled allotments; and
- Across the site, all rehabilitation must be completed five years prior to the finalisation of the development (this commitment is in accordance with Condition 36 of the Preliminary Approval conditions for the Master Plan).

Undeveloped areas of the site will continue to be managed in accordance with the current site management regime as outlined in the Environmental Managament Plan for the project (this includes current and ongoing management of weeds, fire, pests and feral animal control).

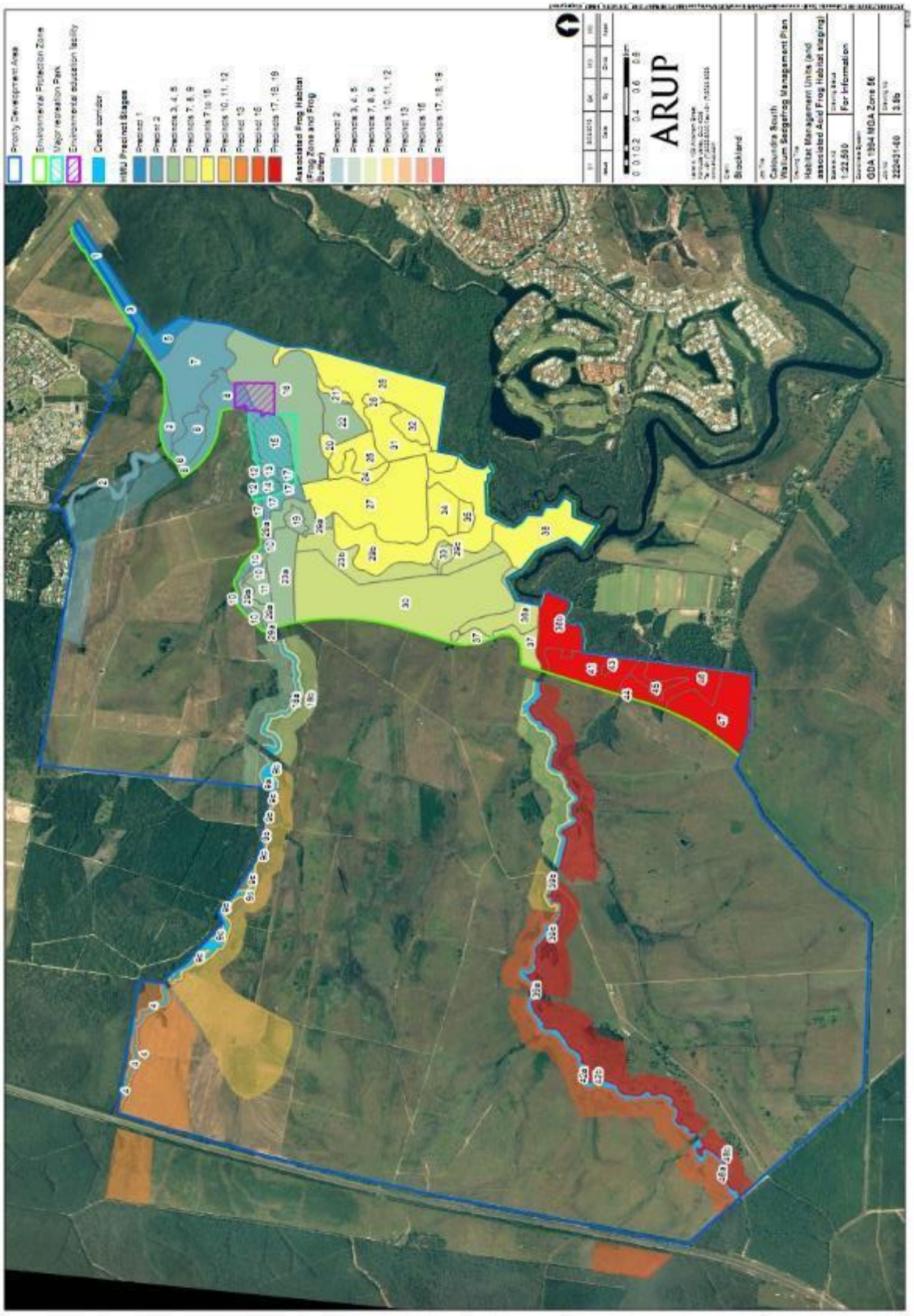

Figure 3.9b: Updated (02/2015) Habitat Management Units and Associated Staging

3.10 Conservation of WSF Habitat

A key deliverable of the project is not just the successful creation of Wallum Sedgefrog compensatory habitat, but also its protection in perpeuity as per the requirement of EPBC Act Condition No. 8h.

At the time of writing of this WSFMP the exact or preferred governance and long-term conservation arrangements that will be applied to the EPZ and other Conservation Areas of the site are not known. In accordance with EPBC Act Condition No.2 'the person undertaking the action must submit to the Minister for approval a detailed Environmental Protection Plan which outlines the actions that will be taken to implement legally binding mechanisms to ensure the protection of the EPZ and buffer zones.

As the Conservation Areas would be rehabilitated in stages in parallel with development, it is envisaged that transfer of a rehabilitated stage could occur in not less than 5ha, unless otherwise specified in this document.

In this context, the Environmental Protection Plan submitted to the Minister is intended to identify the following:

- A description of land within the parcel or Precinct that is to be transferred (as defined by a survey plan, plan of subdivision or else a meter and bounds description);
- The conservation status and condition of the land in terms of achievement of relevant performance objectives/success criteria for restoration and rehabilitation as set out under the Ecological Enhancement Strategy or Wallum Sedgefrog Management Plan;
- The legal entity that will be responsible for management responsibility following the transfer of ownership or management responsibility;
- Identification of the legally binding mechanism that is to be used for protection of the Conservation Areas to which the Environmental Protection Plan relates, noting that different mechanisms may be applied for different parts of the Conservation Areas;
- The continuing or on-going management actions required for the Conservation Areas that are the subject of the Environmental Protection Plan, in accordance with the Approval, specified conditions and approved management plans (namely this EMP, the Water Quality Management Plan and the Wallum Sedge Frog Management Plan); and
- How responsibility for compliance with the Approval, specified conditions and approved management plans is to be allocated and managed.

Unless otherwise directed by the Minister, the transfer of management and responsibility for the Conservation Areas would take place in accordance with the approved Environmental Protection Plan and the Minister will be provided a written notification once the transfer has been affected.

4

WSFMP SUCCESS CRITERIA

4.1 Introduction

A Wallum Sedgefrog population and created compensatory habitat monitoring program with readily measurable objectives, performance indicators and sceintifically robust success criteria is a requirement of EPBC Act approval Condition 8d.

The sections below outline requirements during the monitoring period to ensure the success of the Wallum Sedgefrog management plan. These include:

- The success criteria which will be applied to all conservation and open space areas containing wallum sedge frog habitat being claimed for compensation
- The stages by which this success criteria will be applied
- The monitoring tasks which will be implemented to measure the success criteria;
- A monitoring and reporting calendar that conveys monitoring results effort in relevant conservation and open space areas; and
- The likely maintenance activities that will be required to meet the success criteria.

While the specific habitat requirements for the WSF are broadly known, their widespread coverage across the Subject Site during the 2012 surveys found WSF's in higher pH water (5.5) and more degraded ecosystems than that which has been commonly recorded across South East Queensland. This may have been partly due to the extreme wet weather conditions that occurred during the 2012 survey.

Our current knowledge of WSF's and their habitat across the site indicates that clayey soils result in wetlands that hold water for longer than 6-8 weeks, generally with a pH of >6.0. This creates an environment that supports other frog species over that of the WSF. Across the site, no WSF's where found in wetlands on clayey soils that supported long inundation periods and high pH water (>6.0). However, through ongoing research of the WSF and its habitat across the Subject Site over the 30-year development time frame, a greater level of knowledge is anticipated on the behaviour of the WSF and their interaction with habitat across the site.

Ultimately, the presence of WSF's within a defined conservation area is the successful endpoint of the mitigation strategy. As such, the presence of breeding WSF's within defined conservation areas is seen as the most important success criteria of the management plan.

4.2 Establishment of Success Criteria

Establishment of Success Criteria

The establishment of success criteria is an important element of monitoring and achieving the successful protection and creation of Wallum Sedgefrog habitat and the recreation of the habitat corridors. The aim of the success criteria is to ensure that suitably created and retained existing Wallum Sedgefrog habitat can be demonstrated, and is monitored and maintained to safeguard Wallum Sedgefrog habitat and corridor connectivity.

Management performance against success criteria will be assessed and reported at a six (6) monthly frequency via a detailed monitoring regime during the On-Maintenance period (the period of time between habitat being constructed and KPI's being met), with maintenance activities within the relevant conservation and open areas guided by the results from the monitoring activities compared to the success criteria.

As mentioned previously, Wallum Sedgefrog habitat is characterised by specific vegetation and water depth, chemistry and hydroperiod resulting from seasonal rainfall. As such, key success criteria that will be used to assess management activities within the Frog and Buffer Zones, and report on the successful creation and maintenance of Wallum Sedgefrog habitat ponds and maintenance of Wallum Sedgefrog habitat corridor connectivity, will include:

- Water chemistry;
- Surface water runoff;
- Hydroperiod;
- Vegetation;
- Habitat connectivity;
- Wallum sedgefrog presence;
- Predatory fish presence; and
- Weed presence.

Upon completion of the construction and rehabilitation activities within the Frog and Buffer Zones of Precinct 2 and each following precinct, a detailed monitoring and maintenance regime will be implemented to ensure the successful Wallum Sedgefrog habitat restoration and functional corridor connectivity (refer to Section 6). Construction of Frog and Buffer Zones will be deemed to be completed following the Stage 2 rehabilitation works, detailed in Appendix B .

Upon completion of the On-Maintenance Period for each precinct, and providing all success criteria are achieved (refer to Table 4.2a) at that time, it is intended that the responsibility for and ownership of the Frog Zone and Frog Buffer will be transferred from the person undertaking the action to the relevant local or regional planning authority (eg Sunshine Coast Council).

Table 4.2a outlines success criteria by which created Wallum Sedgefrog habitat will be assessed. These criteria will be monitored via the On-Maintenance Monitoring methodology detailed in Tables 6.2a, b, and d, including with reference to the results from monitoring of Control Sites across the subject site and broader adjoining landscape (refer to Section 4.3). In order for a defined area of the conservation corridors (Riparian Zone, Frog Zone, Frog Buffer excluding drainage reserves and WSUD) to be deemed successful and be classed "created compensatory habitat" (as per Condition 7 of the approval), all the success criteria within Table 4.2a must be met for a maximum distance of 250m from each recorded Wallum Sedgefrog. The area within this distance, having met all the success criteria, will be calculated and used to report the success of the created compensatory habitat required under Condition 7 of the approval.

Monitoring tasks during the On Maintenance period are presented in Section 5, which have been developed to inform attainment of success criteria on a biannual basis for each precinct or precincts as they are developed.

Table 4.2b provides a description of vegetation species suited to the Conservation and Buffer Zone, and **Schedule B** provides a description of relevant Regional Ecosystems.

Table 4.2a: Site-wide Success Criteria for establishment of ponds and corridors

No.	Performance Area	Success Critera (ie measurable and reportable targets)
Created and retained Wallum Sedgefrog habitat ponds		
1	Water chemistry	Water chemistry to be comparable (ie between 25th – 75th %ile) to that recorded from control sites (refer to Section 6.3). This data is presented in the monitoring reports, where control site water quality data is compared to created and retained WSF habitat ponds.
2	Surface water runoff	No concentrated stormwater runoff from the development directly (i.e. pipe / channel flow into created or retained habitat) or indirectly (pipe or channel flow into natural landscape, which then flows into created or retained habitat) is discharged to a created or retained Wallum Sedgefrog habitat pond.
3	Hydroperiod	Created ponds must retain water for a continuous period of at least six weeks. Such ponding is to occur under a summer/spring rainfall exceeding the 65%ile (refer to Appendix A for detail) or consistent with ponding regime results recorded at control sites (refer to Section 4.3). This will be determined through the monitoring regime and included within the monitoring report.
4	Vegetation	Created Wallum Sedgefrog ponds have a vegetation community consistent with that measured within existing Wallum Sedgefrog habitat. This includes (PER,2012): ○ >25% native rigid rushes/reeds/sedges comprising *Baumea articulata*, *Baumea juncea*, *Baumea rubiginosa*, *Juncus usitatus*, *Lepironia articulata* ○ <25% open water ○ No more than 25% non-native grasses for example *Setaria sphacelata*, *Axonopus fissifolius*, *Paspalum scrobiculatum* ○ <25% combined litter, bare ground, ferns, forbs, shrubs jointed rushes/reeds/sedges, limp rushes/reeds/sedges.
5	Habitat connectivity	Constructed Wallum Sedgefrog habitat ponds at a minimum size of 50m^2 at a maximum distance of 300m from the nearest retained or constructed Wallum Sedgefrog pond. Note benchmark of habitat adequacy at 150m^2 every 250m.
6	Wallum Sedgefrog presence in created compensatory habitat	The total area of created compensatory habitat specified in Condition 7 of the approval contains Wallum Sedgefrog. The total area of created compensatory habitat containing Wallum Sedgefrog will be calculated in accordance with the following: • for retained or created habitat ponds, the area of the retained or created habitat pond in which one or more Wallum Sedgefrogs are detected, and for a defined conservation corridor (Frog Zone, Frog Buffer, Riparian Zone), up to a radius of 250m from the location of a Wallum Sedgefrog and that is within the created or retained habitat pond. Due to natural variability, frogs may not be present within all created habitat ponds or conservation corridors at one point in time, and so presence may be cumulative over time to demonstrate conditions supporting a viable population. Please refer to Box 1 which outlines Wallum Sedgefrog survey methodolgy.
Frog Buffer and Frog Rehabilitation Zone (excluding created and retained Wallum Sedgefrog habitat ponds)		
8	Vegetation	75% native vegetation cover consistent with Regional Ecosystems 12.2.12, 12.2.15 (not 12.2.15a), 12.2.7 (refer to Table 5.2c) including species identified in Table 7.2b. This is to be achieved 3 years post practical completion (the completion of the construction of the created habitat) of the Wallum Sedgefrog habitat ponds and Frog Zone and Buffer Zone in accordance with construction phase sequencing.
9	Weed presence	100% free of *Baccharis halimifolia* and *Pinus elliottii* and all Class 1 and 2 Declared plants of Queensland.

No.	Performance Area	Success Critera (ie measurable and reportable targets)
Maintenance and Asset Handover		
10	On Maintenance	The acceptance of 'on maintenance' of frog habitat areas within conservation corridors ponds and habitat corridors applies when the relevent rehabilitation area commences 'on maintenance' in accrodance with state and local government infrastructure agreement. Areas of 5ha (or as agreed by relevant governing authority) may be accepted "on maintenance" at any one time. These may be contained within part of a titled allotment and do not require separate titling. Areas are required to be maintained for a period of three years at which time, provided the above success criteria are met during that period, habitat polygons may be accepted "off maintenance".
11	Off Maintenance	Conservation areas may only be accepted "off maintenance" following a minimum maintenance period of 3 years from "on maintenance" or when the above success criteria are met, whichever is the latter.

Table 4.2b: Vegetation species for Frog Zone and Buffer Zone. (B) indicates priority species for the Frog conservation and buffer zone.

Botanical name	**Common name**
Baeckea frutescens	weeping baeckea
Baloskion pallens (B)	bog rush
Banksia robur	swamp banksia
Baumea articulata (B)	jointed twig-rush
Baumea rubiginosa (B)	twig-rush
Blechnum indicum(B)	water fern
Cyperus exaltatus	giant sedge
Cyperus haspan (B)	sedge
Cyperus melanostachys (B)	sedge
Eucalyptus robusta	swamp mahogany
Gahnia sieberiana (B)	saw-sedge
Glichenia dicarpa	pouched coral fern
Hakea actites	hakea
Ischaemum austral	bluegrass
Juncus usitatus (B)	common rush
Lepironia articulata (B)	lepironia
Leptospermum liversidgei	teatree
Leptospermum polygalifolium	native may
Lophostemon suaveolens	swamp box
Melaleuca nodosa	prickly teatree
Melaleuca pachyphylla (B)	swamp teatree
Melaleuca salignus	willow bottlebrush
Melastoma malabathricum	blue-tongue
Philydrum lanuginosum(B)	frogsmouth
Schoenus brevifolius(B)	zig-zag bog rush
Strangea linearis	strangea
Xanthorrhoea fulva	wallum grasstree

4.3 Establishment of Control sites to help demonstrate wetland creation success

Numerous Wallum Sedgefrog habitat control sites will be established across the Subject Site and within the wider SEQ area. These control sites will ensure that the success of the created compensatory habitat (as defined in Table 4.2a and b) over the course of the monitoring regime accurately reflects that which would occur in remnant habitat - both within and surrounding the broader Caloundra South site. These control sites will be established to measure:

- wetland hydro period,
- extent of surface water ponding (breeding habitat) following significant rainfall; and
- water chemistry.

At each site, a real time water level logger (Odyssey water level logger) will be deployed to measure and record wetland water level at 1 hour intervals for a minimum period of 5 years. Following significant rainfall (3-4 weeks after an initial 150-200mm event), each control site will be assessed for the extent of surface water ponding and water pH and tannin levels. The information derived from monitoring control sites will help determine the success of the created compensatory habitat. For example, if Wallum Sedgefrog habitat control sites did not provide inundated conditions for a period of 6-8 weeks, then it would not be expected that the created compensatory habitat provide inundated conditions for the same time period. Conversely, if the control sites did provide inundated conditions for a period of 6-8 weeks, then it would be expected that the created compensatory habitat does provide inundated conditions.

Control sites will be visited at least three times per year, twice to download and service the hydro period loggers and once to assess Wallum Sedgefrog habitat and extent of inundation following rainfall. Should significant rainfall not occur in any one year, then the control sites will be visited prior to the end of April in order to assess Wallum Sedgefrog habitat in accordance with Wallum Sedge Frog habitat assessment during dry weather outlined in Box 1.There are a total of 16 control sites, 13 within the Caloundra South Development and a further 3 outside of the development area, as described in Table 4.3a.

Table 4.3a: Detail of control sites

Control Site		Location
Onsite	1	North section of 2012 mapped polygon 27
	2	Polygon 36 – hypothesised drought refuge area
	3	Polygon 59 of 2012 PER mapping
	4	Polygon 54 of 2012 PER mapping
	5	Polygon 65 of 2012 PER mapping
	6	Polygon 19 of 2012 PER mapping
	7	Polygon 11 of 2012 PER mapping
	8	Polygon 5 of 2012 PER mapping
	9	Polygon 3 of 2012 PER mapping
	10	South section of 2012 mapped polygon 27
Offsite	1	South of Caloundra Landfill / east of Racecourse Road
	2	Halls Creek
	3	Beerwah Scientific Reserve
Precinct 2	1	Within south eastern section of habitat polygon 44, which will be retained as part of the Lamerough Creek movement corridor
	2	
	3	
	5	Within habitat polygon 45, which will be retained as part of the Lamerough Creek movement corridor.
	6	
	7	
	8	

5

MONITORING, CORRECTIVE ACTION AND REPORTING

5.1 Introduction

Monitoring of the success of the rehabilitated Frog conservation zones including retained Wallum Sedgefrog habitat will deliver the successful establishment of a Wallum Sedgefrog habitat corridor and connectivity between habitats within precincts across the site. As mentioned, the success of the Frog Rehabilitation will be measured by the success criteria. The proposed site-wide monitoring activities during the on maintenance period are summarised in Table 5.1a.

Table 5.1b presents a schedule for the tasks listed in Table 5.1a. This schedule represents one year of monitoring but is applicable to all years the Frog Conservation Zone is on maintenance, to be the responsibility of the approval holder.

The results from the monitoring effort will be presented in an annual report and used to direct maintenance activities and gauge the progress of the creation of the northern Wallum Sedgefrog corridor within the Frog Conservation Zonesof Precinct 2.

Table 5.1a: Monitoring tasks for On Maintenance Period

ID	Area to be Monitored	Monitoring Tasks (applicable to all Precincts)	Aspects Specific to each Precinct 2	Success Critera addressed
A	Measure pond water quality	At six (6) monthly intervals the quality of water will be measured in all created and retained Wallum Sedgefrog habitat ponds/polygons.		1
B	Hydrology of Wallum Sedgefrog ponds	The hydroperiod of created Wallum Sedgefrog Ponds will be compared to that of the hydroperiod of retained Wallum Sedgefrog habitat polygons within the precinct. Data from the hydroperiod loggers will be recorded at 1 hourly interval and downloaded and analysed at six (6) monthly intervals. A total of two wet weather events will be monitored annually for stormwater and surface water flow within the Frog Rehabilitation Zone in all precincts as they are developed, sourced from the adjoining urban development. A wet weather event will be defined as >20mm of rain falling within 24 hours. While conducting six (6) monthly pond water quality assessments visual observations of surface water flows will be undertaken for the possible indication of wet weather flow pathways through the Frog Zone. During water quality investigations the depth of water within each pond will be	In Precinct 2 six permanent water level loggers would be distributed throughout the Frog Conservation zones (as per Figure A.2a, Appendix A).	2 and 3

ID	Area to be Monitored	Monitoring Tasks (applicable to all Precincts)	Aspects Specific to each Precinct 2	Success Criteria addressed
		recorded at five (5) random locations within each pond.		
C	Survey Vegetation	A sample of created Wallum Sedgefrog habitat ponds will be surveyed every six (6) months, randomly selected from the created Wallum Sedgefrog ponds. Vegetation type and cover will be assessed within each pond, of which is defined from top of bank to top of bank. A sample of $20m^2$ nested vegetation monitoring quadrats will be permanently established and monitored on a six (6) monthly basis for % cover of native and non-native species consistent with Success Criteria 7 and 8. Photographic monitoring locations will be established on the north-east corner of each quadrat, shooting to the south-west.	In Precinct 2 a total of 10 created Wallum Sedgefrog habitat ponds will be surveyed every six (6) months during the on maintenance period, randomly selected from the created Wallum Sedgefrog ponds. A total of 10 $20m^2$ nested vegetation monitoring quadrats will be permanently established and monitored on a six (6) monthly basis for % cover of native and non-native species consistent with Success Criteria 7 and 8.	4, 7, 8 and 9
D	Wallum Sedgefrog monitoring	Survey both created and retained Wallum Sedgefrog habitats for the presence of Wallum Sedgefrog in accordance with methods outlined in Box 1 (Appendix B)		5, 6, 7
E	Habitat connectivity	The compliance of created Wallum Sedgefrog habitat ponds will be assessed in respect to performance objective 5 and confirmation of habitat connectivity measured. This will be based on the above listed monitoring outputs and reported in a six (6) monthly monitoring report.		5

Table 5.1b: Annual monitoring tasks within the Frog Rehabilitation Zone/Precinct, shaded cells indicate aooriximate action month (ofetn weahter dependant).

Monitoring Task ID.	Monitoring Task	Success Criteria	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A	Water quality assessment	1												
B	Wet weather event assessment	2	As required											
B	Visual pond observations	2												
B	Hydroperiod assessment	3												

Monitoring Task ID.	Monitoring Task	Success Criteria	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
C	Vegetation assessment of Wallum Sedgefrog habitat ponds	4												
C	Vegetation assessment of broader Frog Conservation and Buffer Zone, including quadrats and photo-monitoring points. Monitoring of vegetation in culverts and crossings.	7, 8, 9												
D	Wallum Sedgefrog monitoring	5, 6, 7												
E	Monitoring report, outlining results, performance objective compliance and suggested maintenance activities to achieve and maintain success criteria	5												

5.2 Maintenance and Corrective Actions

As per Condition No. 8c of the EPBC Act approval this section of the WSFMP identifies the corrective actions, and/or mechanisms for developing corrective actions, and parties responsible for implementing corrective actions on site.

While the specific maintenance activities that will be required within the Frog conservation areas to meet and maintain the success criteria will vary slightly from precinct to precinct, it is likely to consist of basic weed control and supplementary planting. However, should a risk be identified that will compromise achieving the success criteria, targeted and specific management actions will be implemented.

As presented in Table 5.2, there are a variety of risks to the successful establish of Wallum Sedgefrog habitat ponds, preservation of the northern Wallum Sedgefrog habitat corridor and the successful attainment and maintenance of all success criteria. This table also outlines the corrective action that will be implemented to address the issue that may be experienced. The approval holder is responsible for undetaking all actions outlined in Table 5.2.

Table 5.2: Corrective Actions that may be required to meet success criteria

Aspect Impacted	Issue Experienced	Possible reason	Monitoring activity and Corrective Action
Water chemistry	Elevated pH and conductivity combined with a reduce tannin concentration within created Wallum Sedgefrog habitat ponds.	An indication of surface water flows from the development entering the habitat ponds.	Relocate surface water flow pathway and redirect to drainage infrastructure. Monitoring tasks A & B will identify the occurrence of this risk.
Surface water runoff	Ineffective drainage from development.	Blocked pipes and culverts.	Clearing of block drainage infrastructure. Monitoring task B will identify the occurrence of this risk.
Hydroperiod	A significant increase or decrease in ponding time when compared to that achieved within retained existing Wallum Sedgefrog habitat.	Possibly the result of stormwater driven surface water inflows or a created Wallum Sedgefrog pond that is too shallow.	Identify surface water flows and redirect. Excavate pond deeper. Monitoring task B will identify the occurrence of this risk.
Vegetation	Incorrect establishment of plant species and hence development of habitat not preferred by the Wallum Sedgefrog.	The incorrect hydroperiod and/or ineffective weed control will result in the establishment of an inappropriate plant community.	Develop correct hydroperiod, as stated above and implement a weed management regime. Monitoring tasks C will identify the occurrence of this risk.
Wallum Sedgefrog presence	Created and retained Wallum Sedgefrog ponds do not support Wallum Sedgefrog	Incorrect hydroperiod, water chemistry and vegetation.	Activities as stated above. Monitoring task D will identify the occurrence of this risk.
Habitat connectivity	The poor establishment of created Wallum Sedgefrog habitat ponds not meeting the success criteria. Frog movement and hence habitat connectivity is disrupted by poor use of frog underpasses	Reasons as stated above. Poor vegetation establishment ar entry/exit of culverts and/or underpasses. Poor habitat connectivity to culverts/underpasses. Culvert too long, in incorrect location, or too dry.	Monitoring task D will identify the occurrence of this risk. All monitoring tasks will assist in identifying the occurrence of this risk.

5.3 Implementation of the WSFMP

The Commencement of the Action must not occur until the WSFMP has been approved by the Minister. However, Preliminary Works or Interim Uses on the site are permitted to occur prior the approval of the WSFMP.

In accordance with Condition 12, if the person undertaking the action wishes to carry out the action, other than in accordance with the WSFMP, the person undertaking the action must submit to the Minister for approval, a revised WSFMP. The varied activity must not commence until the Minister has approved the varied WSFMP. If the Minister approves the varied WSFMP, the varied WSFMP must be implemented in place of this WSFMP.

This Plan may require updating from time to time in response to further study and research undertaken as part of the development.

5.3.1 Auditing the WSFMP

As per Condition No.13 of the EPBC Act approval, within three months of every three year anniversary of the commencement of the action, for the first 9 years of the approval and then within three months of every five year anniversary for each anniversary thereafter until the cessation of the action, an independent audit of compliance of this WSFMP is proposed for precincts for which the development has not been completed for a period of two years. An audit report will be provided to the Minister for Environment for approval within 3 months of the date of completion of the audit, identifying any remedial actions that have been taken in response to recommendations identified by the independent auditor, with any proposed changes to any management plan, report, strategy or method to be included.

5.3.2 Updating the WSFMP

As per Condition No 8 of the EPBC Act approval, the Wallum Sedge Frog Management Plan will be reviewed within 6 months of the audits outlined above. If the WSFMP requires amendment following the review, the amended Plan will be submitted to the Minister for approval. The approved Wallum Sedgefrog Management Plan must be implemented until Cessation of the Action. Two years after Development within a Precinct is complete and the Minister has been notified, the Wallum Sedgefrog Management Plan no longer applies to that Precinct.

5.3.3 Reporting

In accordance with Condition 14, the person undertaking the action must publish a report on their website, for the duration of the project, addressing compliance with the conditions of this approval over the previous twelve (12) months, including implementation of this WSFMP and other management plans, reports, strategies and methods as specified in the conditions. The results of any pre-construction survey conducted within this timeframe will be included within this report (as per EPBC Act approval Condition No.8g).

In accordance with Condition 17, unless otherwise agreed to in writing with the Minister, the person undertaking the action must publish this WSFMP and other management plans, reports, strategies, and methods referred to in the conditions of approval on their website. Each management plan, report, strategy, and method must be published on the website within one (1) month of being approved.

5.4 Contingency and Offset Strategy

Within one year of commencement of the action, the person undertaking the action must prepare and submit a detailed Wallum Sedgefrog Contingency and Offset Strategy (including offsets in accordance with the Department's Environmental Offset Policy) that will be implemented if the created compensatory habitat does not meet the defined success criteria as outlined in Table 4. 2a determined under the Off Maintenance Monitoring regimes detailed in Section 6 (as per EPBC Act approval Condition No. 9).

6

SUMMARY OF WALLUM SEDGEFROG MONITORING

6.1 Introduction

To ascertain the condition and success of the management measures detailed in this plan and to ensure the presence of Wallum Sedgefrog's within completed precincts, a comprehensive and detailed monitoring program has been developed. The program will monitor habitat use by the Wallum Sedgefrog and the success of management measures employed and to demonstrate the success of the created Wallum Sedgefrog movement corridors (refer to Figure 2.2d). Aspects of the monitoring programme have been presented in Section 5 (Pre-construction survey, Box 1, Appendix B) and Section 5 (on maintenance survey, Table 5,1a and b).

This section of the Plan provides a concise summary of all proposed monitoring activities, which can be summarised as follows:

- **Pre-construction phase** - Wallum Sedgefrog habitat survey to determine habitat to be removed on a precinct or group of precincts basis; and
- **On maintenance phase** - monitoring of Wallum Sedgefrog presence and habitat during the establishment of the Frog conservation areas, including retained existing Wallum Sedgefrog habitat.

6.2 Monitoring Intent and Summary

The aim and relevant conditions for each of these monitoring stages are summarised in Table 8.2a. Specific detail related to each stage of surveying is contained within Table 8.2b, outlining the hierarchy of monitoring effort that will be employed, monitoring triggers for commencement and conclusion of monitoring and reporting requirements and frequencies. As the aim for each monitoring stage differs, monitoring tasks and the degree of effort alters. Tables 6.2c, and 6.2d present monitoring tasks for pre-construction and on-maintenance surveys respectively.

The results from Pre-construction survey will form the foundation of on-maintenance monitoring, identifying the specific area/s subject to monitoring activities. Figure 8.2 provides a schematic overview if the monitoring framework and how it has been formulated to ensure and demonstrate the success of the proposed Wallum Sedgefrog mitigation actions.

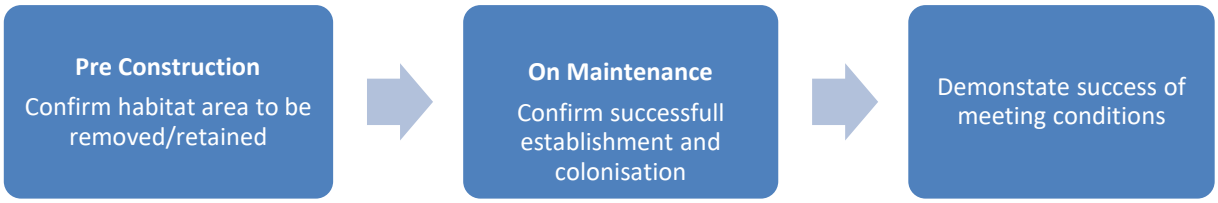

Figure 6.2: Wallum Sedgefrog monitoring framework

Table 6.2a: Survey aims and relevant conditions

	Stage 1 Pre-Construction	Stage 2 On Maintenance
Survey Aim	To confirm the size of Wallum Sedgefrog habitat to be removed on a precinct or group of precincts basis.	To assess the success of the created compensatory habitat within the subject site, via monitoring of Wallum Sedgefrog populations and created and retained habitat
Relevant Condition	5, 6, 7, and 8 (g)	8 (b) (d) and 9

Table 6.2b: Summary of monitoring objectives

	Survey	
	1: Pre-construction	2: On-Maintenance
Aim	To record the size of Wallum Sedgefrog habitat to be removed on a precinct or group of precincts basis.	To assess the success of the created compensatory habitat within the subject site.
Objective	To provide DOEE with detailed map which identifies the areas of Wallum Sedgefrog habitat to be removed in a precinct or precincts.	To monitor Wallum Sedgefrog populations and habitat suitability within both the created compensatory habitat areas and retained existing habitat.
Survey methodology	See Box 1, Appendix B and Table 6.2c below.	See Tables 5.1a&b, Section 5.1 and Table 6.2d below.
Implementation timeframe	Every 5 years (Phase 1), plus immediately prior to works commencing in prencint or group of precincts (Phase 2). Refer to Box 1,)	3 years or until KPI's are addressed for a maximum period of 12 years (refer to Table 4.2d a). If after 12 years the KPI's of a particular created habitat pond (or series of ponds) are not met, the WSF Contingency and Offset Stratergy is triggered.
Trigger for commencement	Prior to works commencement	Conclusion of works related to Wallum Sedgefrog recreated compensatory habitat works.
Trigger for conclusion	Commencement of works in the precinct or precincts that have been the subject of the survey.	When KPI's are addressed (refer to Table 4.2a).
Reporting requirement / frequency	Results to be used to update Map 2.2d which is provided in the PCEMP and annual report to the Minister.	Document to report progress of created compensatory habitat, with specific reference to control sites. Results to be provided in annual report to the Minister.

Table 6.2c: Survey tasks for Pre-construction monitoring

Survey stage	1: Pre construction
Commencement	Prior to works commencement in a precinct or precincts
Aim:	To record the size and function of Wallum Sedgefrog habitat to be removed.

Monitoring element	Task and Method	Frequency and timing
Wallum Sedgefrog presence / habitat assessment	Undertake Wallum Sedgefrog presence/absence assessment to determine the extent of habitat use. Methodology as per Box 1Appendix B. Control sites within existing habitat to be retained are also to be identified.	Phase 1 monitoring: within 5 years of works within a precinct or group of precincts commencing. Phase 1 monitoring: immediately prior to the commencement of works in a precinct or group of precincts..
Vegetation assessment	Undertake qualitative vegetation assessment to ensure habitat area supports semi erect semi-aquatic emergent vegetation community consistent with that measured within existing Wallum Sedgefrog habitat (See Table 4.2a).	
Water quality assessment	Undertaken pH and conductivity water measurements of identified habitat area/s to confirm suitability (as defined in Box 1 Appendix B). Undertake a visual assessment of Tannin levels within habitat area to confirm suitability.	
Hydrologic assessment	Undertake a water depth analysis of possible habitat polygons to ensure a mixture of shallow water (0.05 – 0.5m) within vegetated and non-vegetated zones. Deploy shallow groundwater / surface water level loggers (minimum of one, maximum of three) within any existing retained Wallum Sedgefrog habitat. This will provide 'control site/s' hydro-period information when completing on and off-maintenance assessments. The total number of loggers deployed will be determined based on the occurrence of existing retained Wallum Sedgefrog habitat across the subject area.	

Scale of assessment	Survey to cover entire works area of habitat to be removed.

Table 6.2d: Survey tasks for on-maintenance monitoring

Survey stage	2: On Maintenance
Commencement	Conclusion of physical works to create Wallum Sedgefrog habitat.
Aim:	To assess the success of the recreated compensatory habitat within the subject site.

Monitoring element	Task/method	Frequency, timing and length	
		Annually	Biannually
Wallum Sedgefrog presence assessment	Undertake Wallum Sedgefrog presence/absence assessment to determine habitat use (as per methods specified in Box 1 Appendix B).	✓	
Vegetation assessment	Undertaken qualitative vegetation assessment of to ensure created compensatory Wallum Sedgefrog habitat supports semi erect semi-aquatic emergent vegetation consistent with a vegetation community consistent with that measured within existing Wallum Sedgefrog habitat (as per methods outlined in Table 5.1a).	✓	
Water quality assessment	Undertake pH, conductivity and Tannin measurements of water within both created compensatory and existing retained Wallum Sedgefrog habitat area to confirm suitability. Methods specified in Table 5.1a).		✓
Hydrologic assessment	Retrieve and review shallow groundwater / surface water level logger data within both created compensatory and retained existing Wallum Sedgefrog habitat. Compare information gained from water level loggers deployed within existing retained habitat (from Pre-construction surveys) with that sourced within created compensatory Wallum Sedgefrog habitat during.		✓

Scale of assessment	Includes Frog zone and Frog buffer for permanently retained and new habitat relevant to each precinct.

DEFINITIONS

Action - the Action is the construction of a master planned community on Lot 505 RP 884348, Lot 3 RP 910849 and part of Lot 22 SP 190373 being the Development of Caloundra South.

Buffer Zones – buffer areas from the Development that consist of the Riparian Corridor, Frog Zone, Frog Buffer and Lifestyle Buffer.

Cessation of the action – 2 years after following the completion of construction of the Development for all precincts.

Commencement of the action - The clearing of vegetation, excavation, earth works, provision of drainage or stormwater controls or devices, provisions of access or construction of any dwelling, building or infrastructure. It does not include Preliminary Works or Interim Uses.

Construction Stage - Construction of the Development.

Corrective actions – actions taken in response to performance criteria/objectives failing outside of set objectives.

Department – the Australian Government department administering the Environment Protection and Biodiversity Conservation Act.

Development - means the development of Caloundra South in stages, being the construction activities for the subdivision of a stage including vegetation clearing, site establishment, bulk earthworks, civil works, drainage, stormwater controls and devices, services, roads and other infrastructure, rehabilitation and landscape construction works. Development does not include the subsequent construction of structures or buildings, including housing or commercial or industrial buildings and associated infrastructure and hardstand.

Environmental Protection Zone – the area marked as 'Environmental Protection' in Annexure A of the conditions of Approval.

Frog Conservation areas – Wallum Sedge Frog habitat either created or retained in any of the conservation zones including riparian buffer, frog zone, frog buffer, environmental protection zone.

Frog Zone – a minimum of 50m from the boundary of each Riparian Corridor encompassing known and potentially suitable Wallum Sedge Frog habitat and also created frog habitat. No WSUD detention basins or ponds are to be located in this zone.

Interim Uses - include existing rural uses, including grazing and property management associated with existing rural uses.

Minister – the Minister administering Environment Protection and Biodiversity Conservation Act and includes a delegate of the Minister.

Person undertaking the action – Stockland Development Pty Ltd.

Precinct/s – Precincts 1 to 19 as defined by the Caloundra South Urban Development Area Master Plan within Annexure A or as amended and approved by the Minister.

Preliminary Works - include:

a) minor physical disturbance necessary to undertake pre-clearance surveys, to establish monitoring programs, for geotechnical investigations or associated with mobilisation of plant, equipment, materials, machinery or personnel;

b) surveying or the construction of boreholes;

c) works associated with maintenance of the subject site including chopper rolling and weed management.

d) works necessary for rehabilitation including construction of frog ponds, installation of monitoring devices and necessary access tracks;

e) other activities that are necessary for commencement that are associated with mobilisation of plant and equipment materials machinery and personnel prior to start of Development only if such activities will have no adverse impact on Matters of National Environmental Significance and only if the proponent has notified the Department in writing before an activity is undertaken.

Public Environment Report (PER) – includes the Draft PER and Supplementary PER assessed under the EPBC Act 1999 Ref:2011/5987

Publish/ed – documentation available on the person undertaking the action's website for the life of the approval.

Qualified Ecologist – an ecologist with formal qualifications in ecology and with more than 5 years' experience in carrying out ecological assessment and monitoring activities.

Riparian Corridor – minimum 25m wide corridor either side of any creek (from high bank) for retention and rehabilitation of riparian vegetation, providing bank stabilisation and protecting remnant vegetation along creeks.

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Schedule A: Impact Assessment summary for Wallum Sedgefrog

Impacting Processes	Mitigation inherent in the Master Plan	Mitigation measures proposed in the PER	Residual Risk (and likelihood)
Do-Nothing Scenario - with no land management, much of the site is likely to revert to pine forest. This would affect long term population viability and movement along existing corridors to adjacent populations.	Not applicable.	Not applicable.	**Extreme** **(almost certain x high)**
Direct Habitat Loss (reduced area of occurrence)	~Conversion of areas of urban development in the Master Plan to Wallum Sedgefrog conservation, particularly along Bells Creek North adjacent the Bruce Highway and an area in the south of the EPZ. ~Provision of the Environmental Protection Zone (a 460ha rehabilitation area to the east of urban development) and Open space waterway buffers on Bells Creek North and South and Lamerough Creek. ~~ Provision for the preparation of an Acid Frog Management Plan.	To be implemented through subsequent applications: ~Redefine the open space waterway buffers and some portions of the Sports and Recreation areas within the Master Plan, to denote specific areas for Frog Zones and Frog Buffers. ~Provide a 1:1 compensation ratio for lost Wallum Sedgefrog habitat. ~Retain existing sedgefrog habitat within Frog Zone and buffer. ~Prescribe performance criteria for habitat re-creation. ~Additional more detailed site investigations (soils, groundwater etc) to specifically assist in the location of breeding ponds.	**Low** **(minor x possible)**
Mortality (during clearing)		N/A. None considered effective.	**Medium** **(almost certain** **x minor)**
Altered hydrology (ground and surface water)	Creation of breeding ponds within Frog Zones to compensate for the direct loss of breeding and other habitat.	To be implemented through subsequent applications: ~Seasonal groundwater monitoring (to understand seasonal fluctuations); ~More detailed groundwater modelling of specific areas of the site; ~Soil and ground condition surveys; ~Fill characterisation studies for suitability for use in areas	**Medium** **(likely x minor)**

Impacting Processes	Mitigation inherent in the Master Plan	Mitigation measures proposed in the PER	Residual Risk (and likelihood)
		proximal to conserved frog habitat; and ~Ongoing monitoring and evaluation of breeding habitat success, to determine corrective actions or enhancements to maintain appropriate hydroperiod in breeding habitats.	
Altered water chemistry/ quality	~~ Implement Water Sensitive Urban Design (WSUD) features to improve the quality of surface water runoff – for the construction and operation phases of development. ~~Construct and maintain silt traps/ fencing upslope of creek lines and areas of frog habitat - during construction and operation. ~~Construct and maintain temporary drains and/or bunding diverting sediment-laden runoff away from areas of frog habitat - during construction and operation. ~~Construct and maintain detention basins for containing sediment-laden runoff- during construction and operation. ~~ Prohibit the use of fertilisers in proximity to waterways or areas of known or likely Wallum Sedgefrog habitat – during construction and operation. ~~ Planting of wallum-native plant species tolerant of low-nutrient soils in preference to non-wallum native species. ~~Minimal usage of pesticides in proximity to waterways and areas of known/likely Wallum Sedgefrog habitat. ~~Develop and implement a fill management plan ensuring appropriate management and placement of fill during construction.	To be implemented through subsequent applications: ~Studies to characterise and select appropriate fill material; ~Avoid soil disturbance during periods of high rainfall (i.e., summer and autumn); ~Use sterile sorghum to stabilise loose fill in proximity to areas of Wallum Sedgefrog frog habitat; ~Place sandy soil instead of clay fill in areas adjoining Wallum Sedgefrog frog habitat; ~Use of pre-fabricated concrete (where practicable) during construction of infrastructure in proximity to waterways; ~Develop and implement an adaptive management plan to address water quality issues during and after construction (including regular] monitoring of water quality during and after construction); and ~Prohibit liming of acid soils in areas with the potential to influence acid frog habitat.	**Low** **(possible x minor)**
Changes in vegetation composition and structure	~~Designation of frog conservation areas and buffers to urban development. ~~ Preservation and/or replication of habitats considered important for maintaining population viability, particularly	To be implemented through subsequent applications: ~Continue chopper-rolling activities in areas heavily affected by Slash Pine	**Low** **(possible x minor)**

Impacting Processes	Mitigation inherent in the Master Plan	Mitigation measures proposed in the PER	Residual Risk (and likelihood)
	refugia and/or corridor habitat and maintaining corridor function. ~Fauna fencing and fauna crossing to roadways, esplanade roads to buffer residential development. ~Signage and community education. ~Net gain of Wallum Sedgefrog habitat within the development site to be conserved in perpetuity. ~Ongoing chopper rolling, fire and weed management as the site develops. ~Develop a weed management plan	wilding until commencement of development; ~Develop and implement an adaptive management plan to address alteration of vegetation composition and structure during and after construction (including regular] monitoring of habitat species during and after construction; and ~Weed management plan contained in the EMP.	
Fire	~As above. ~Inclusion of open space between development (ignition sources) and native vegetation.	~~ Fire management plan contained in the EMP.	**Low** **(unlikely x minor)**
Localised disturbance of habitat by humans	~Designation of frog conservation areas and buffers to urban development. ~Preservation and/or replication of habitats considered important for maintaining population viability, particularly refugia and/or corridor habitat and maintaining corridor function. ~Signage and community education. ~Net gain of Wallum Sedgefrog habitat within the development site to be conserved in perpetuity.	To be implemented through subsequent applications: ~Educate local residents and visitors about the significance of adjoining wetland habitat for Wallum Sedgefrogs through interpretive signage, community workshops, pamphlet drops, school visits and the provision of educational material to local schools; ~Erect signage and limit access through physical barriers or other measures to areas of habitat that could conceivably be accessible by motorbike or 4WD; ~Inclusion of open-space (i.e. the Lifestyle Zone) between urban development and protection zones; ~Planting of tall dense vegetation in proximity to areas of Wallum Sedgefrog habitat; and ~Permanent signage prohibiting inappropriate activity (e.g., riding of mountain bikes and	**Low** **(unlikely x minor)**

Impacting Processes	Mitigation inherent in the Master Plan	Mitigation measures proposed in the PER	Residual Risk (and likelihood)
		trailbikes) within areas of sensitive frog habitat.	
Noise pollution	Buffers provided to urban development and noise polluting uses as above.	To be implemented through subsequent applications: ~Evaluate the benefits of co-locating frog fence/ noise barriers along roadways adjacent to Wallum Sedgefrog habitat.	**Low** **(unlikely x minor)**
Light pollution	Buffers provided to urban development and light polluting uses as above.	To be implemented through subsequent applications: ~Further research and monitor Wallum Sedgefrog populations to better understand the impact of light and noise on this species; ~Separate wetlands from intense light-sources; ~Eliminate or reduce lighting in proximity to areas of occupied habitat; ~Fit lights adjacent Wallum Sedgefrog habitat with low wattage bulbs and glare guards; and ~Plant tall dense vegetation between areas of frog habitat and adjacent development	**Low** **(unlikely x minor)**
Road kill	Fauna fencing and fauna crossing to roadways, esplanade roads to buffer residential development, signage and community education.	To be implemented through subsequent applications: ~Construct of frog underpasses; ~Install and maintain frog barriers along roadways adjacent Frog Protection Zones and the EPZ; and ~Develop and implement an adaptive management plan to monitor the success of frog underpasses and continue to build knowledge about suitable design measures to be implemented in subsequent infrastructure.	**Low** **(possible x minor)**
Disease	Buffers provided to urban development and human use.	To be implemented through subsequent applications: ~Adoption of standard hygiene protocols by persons working within sensitive frog habitat areas; and	**Low** **(unlikely x minor)**

Impacting Processes	Mitigation inherent in the Master Plan	Mitigation measures proposed in the PER	Residual Risk (and likelihood)
		~Signage in proximity to sensitive frog habitat areas prohibiting dumping of aquarium water, aquarium fish and/or aquarium plants.	
Increased competition	~Designation of frog conservation areas and buffers to urban development. ~Preservation and/or replication of habitats considered important for maintaining population viability, particularly refugia and/or corridor habitat and maintaining corridor function. ~Net gain of Wallum Sedgefrog habitat within the development site to be conserved in perpetuity. ~Advanced WSUD across the site that achieve downstream water quality objectives.	Detailed specifications and performance criteria to be implemented through subsequent applications: ~Definition of proposed uses within conservation areas and buffers; ~Diversion of stormwater/surface runoff away from Wallum Sedgefrog breeding habitat; ~Locating detention basins/ settlement ponds away from sensitive frog habitat (i.e., Wallum Sedgefrog breeding habitat); ~Frog exclusion fencing around Frog Zones, subject to further design and research; and ~Ensuring detention basins and settlement ponds remain free of vegetation (in particular sedges and lily pads).	**Medium** **(likely x minor)**
Mortality: Adult Predation	As above.	N/A. None considered necessary.	**Negligible** **(negligible x negligible)**
Mortality: Tadpole Predation	As above.	To be implemented through subsequent applications: ~Mitigation would focus on reducing conditions suitable for predators (i.e., maintaining semi- ephemeral hydroperiods); and ~Draining of ponds if/ when Gambusia have become established.	**Low** **(possible x minor)**

Schedule B: Regional Ecosystem Descriptions

RE number	Description
12.2.12	Closed or wet heath +/- stunted emergent shrubs/low trees. Characteristic shrubs include Banksia spp. (especially B. robur) Boronia falcifolia, Epacris spp., Baeckea frutescens, Schoenus brevifolius, Leptospermum spp., Hakea actites, Melaleuca thymifolia, M. nodosa, Xanthorrhoea fulva with Baloskion spp. and Sporadanthus spp. in ground layer. Occurs on poorly drained Quaternary coastal dunes and sandplains. Low part of sand mass coastal landscapes where water collects from both overland flow and infiltration from adjoining sand dunes. (BVG1M: 29a).Major vegetation communities include: **12.2.12a: Palustrine wetland** (e.g. vegetated swamp). *Empodisma minus, Baumea rubiginosa, Epacris microphylla* closed-heathland with emergent low shrubs of Leptospermum liversidgei. Occurs on Poorly drained Quaternary coastal dunes and sandplains. Low part of sand mass coastal landscapes where water collects from both overland flow and infiltration from adjoining sand dunes. (BVG1M: 29a). **12.2.12b: Palustrine wetland** (e.g. vegetated swamp). *Xanthorrhoea fulva* wet heathland. Occurs on Poorly drained Quaternary coastal dunes and sandplains. Low part of sand mass coastal landscapes where water collects from both overland flow and infiltration from adjoining sand dunes. (BVG1M: 29a).
12.2.15	Coastal sedgeland with *Baumea spp., Juncus spp. Lepironia articulata, Gahnia spp. and Eleocharis spp.* and associated water bodies. Occurs on Quaternary coastal dunes and beaches. Low part of coastal landscape where water collects from both overland flow and infiltration from adjoining sand dunes. (BVG1M: 34c). Major vegetation communities include: **12.2.15b: Palustrine wetland** (e.g. vegetated swamp). *Lepironia articulata* closed-sedgeland. Occurs on Quaternary coastal dunes and beaches. Low part of coastal landscape where water collects from both overland flow and infiltration from adjoining sand dunes. (BVG1M: 34c). **12.2.15c: Palustrine wetland** (e.g. vegetated swamp). *Cladium procerum* closed-sedgeland. Occurs on Quaternary coastal dunes and beaches. Low part of coastal landscape where water collects from both overland flow and infiltration from adjoining sand dunes. (BVG1M: 34c). **12.2.15d: Palustrine wetland** (e.g. vegetated swamp). *Baumea rubiginosa* closed-sedgeland, with Cyclosorus interruptus and Blechnum indicum. Occurs on Quaternary coastal dunes and beaches. Low part of coastal landscape where water collects from both overland flow and infiltration from adjoining sand dunes. (BVG1M: 34c). **12.2.15e: Palustrine wetland** (e.g. vegetated swamp). *Leersia hexandra* closed-grassland. Occurs on Quaternary coastal dunes and beaches. Low part of coastal landscape where water collects from both overland flow and infiltration from adjoining sand dunes. (BVG1M: 34c). **12.2.15f: Lacustrine wetland** (e.g. lake). Permanent and semi-permanent perched lakes. Occurs perched on Quaternary coastal dunes. (BVG1M: 34a).
12.2.7	Melaleuca quinquenervia or M. viridiflora or M. dealbata open-forest to woodland. Other species include Eucalyptus tereticornis, Corymbia intermedia, E. bancroftii, E. latisinensis, E. robusta, Lophostemon suaveolens and Livistona decora. A shrub layer may occur with frequent species including Melastoma malabathricum subsp. malabathricum or Banksia robur. The ground layer is sparse to dense and comprised of species including the ferns Pteridium esculentum and Blechnum indicum the sedges Schoenus brevifolius, Baloskion tetraphyllum, Baumea rubiginosa and Gahnia sieberiana and the grass Imperata cylindrica. Occurs on Quaternary coastal dunes and seasonally waterlogged sandplains usually fringing drainage system behind beach ridge plains or

RE number	Description
	on old dunes, swales and sandy coastal creek levees. (BVG1M: 22a). Major vegetation communities include: **12.2.7a: Palustrine wetland** (e.g. vegetated swamp). *Melaleuca quinquenervia* low woodland with *Gahnia sieberiana* shrub layer. Occurs on Quaternary coastal sand dunes fringing swamps. (BVG1M: 22a). **12.2.7b: Palustrine wetland** (e.g. vegetated swamp). Whipstick *Melaleuca quinquenervia*. Occurs at base of frontal dunes on Quaternary coastal dunes and beaches. (BVG1M: 22a). **12.2.7c: Palustrine wetland** (e.g. vegetated swamp). *Melaleuca quinquenervia, Eucalyptus robusta, Melicope elleryana* open forest with understorey of *Todea barbara*. Occurs along watercourses on Quaternary coastal dunes and beaches and seasonally waterlogged sandplains. (BVG1M: 22a) **12.2.7d: Palustrine wetland** (e.g. vegetated swamp). *Eucalyptus bancroftii* woodland. Other canopy species include *Lophostemon suaveolens* and *Melaleuca quinquenervia*. A shrub layer may occur with frequent species including *Melaleuca nodosa, Hakea actites* and *Melaleuca pachyphylla*. The ground layer is sparse to dense and comprised of heath species. Minor wet depressions sometimes occur and sedges dominate these areas. Occurs on Quaternary coastal dunes and seasonally waterlogged sandplains. (BVG1M: 9f).

APPENDIX A: LATEST FIELD OBSERVATIONS

A.1 Introduction

This section of the WSFMP provides details of data collected since September 2012. This included data collection regarding hydroperiod at selected locations across the site; water quality at those same locations and initial soil test pits dug to establish depth to groundwater, groundwater quality and soil type.

A.2 Hydroperiod data

The depth and time that water ponds within individual wetlands can be defined as the wetland/s 'hydroperiod'. The hydroperiod is extremely important in determining suitable Wallum Sedgefrog habitat.

Hydroperiod data has been gathered from 12 sites across the South Caloundra project area, located within both known Wallum Sedgefrog habitat areas and possible Wallum Sedgefrog habitat recreation areas. The 12 hydroperiod logger sites are shown in Figure A.2a.

The water level at each site was recorded using Odyssey Capacitance Water Level sensors and data loggers. These sensors measure and log the level of standing water at the deployed site every 60 minutes. Each sensor is placed in a drilled PVC pipe for protection and secured to a star picket embedded in the ground. Figure A.2b shows the typical set up of a water level logger.

The water level loggers were deployed on the 12th and13th September 2012 with data most recently retrieved in late March / early April 2014. From the hydroperiod data displayed in Figure 4.2d, all monitored sites displayed a wetting / drying regime suitable for Wallum Sedgefrog habitation and breeding – that is ephemeral conditions and summer/autumn ponding for 6-8 weeks in the Summer/Autumn period of 2013 (Myer *et. al* 2006).

Shown in Figure 4.2c, little rain was recorded in late 2012 leading to no recorded surface water or shallow groundwater at any of the 12 water level logger locations (Figure A.2a). Following heavy rainfall in late January and early February 2013, water ponded at most of the 12 water level logger locations for greater than a 6 week period, indicating suitiable conditions for Wallum Sedgefrog habitation and breeding (Figure A.2d). Conversely, during the summer and autumn of 2013/14 little rain was recorded (Figure 4.2c), resulting in the lack of any shallow groundwater or surface water ponding in any of the water level logger locations (Figure 4.2d) and previously mapped Wallum Sedge Frog Habitat polygons across the Caloundra South site.

Following the 211mm rainfall over the Australian Day long weekend on 2013 there was an initial large increase in the water level across all 12 water level logger locations (between 12 and 57 cm, mean of 21.9 cm), followed by a subsequent rapid decrease in water level (mean 7.31cm level reduction / 24 hours). Shown in Figure A.2e, the water level at each of the water level logger locations generally decreased at a rate between 2-5 cm /day except where daily rainfall exceeded 20mm, whereby the water level in the ponds increased relative to the volume of rainfall over the previous 48hr period . For example, following 100mm of rainfall over two days, water level within the WSF ponds increased between 2cm and 20cm.

Based on this data, for WSF habitat identified in the *Caloundra South Public Environmental Report* (Stockland 2012) to become inundated to depth suffcient for breeding to occure, an initial 200mm+ of rain is required following an extended dry period. Additionally it has been identified that:

- Daily rainfall between 10-15mm is required to maintain surface water levels within the WSF ponds;
- Rainfall <10mm / day results in a decrease in water level in the ponds at a mean rate of about 1cm/day;
- Rainfall >15mm /day increased the water level of the ponds at an increasing rate relative to the amount of rainfall Figure 4.2e);
- High water levels associated with large rainfall events (>150mm) only last 1-3 days; and

- To maintain a 30cm deep pond, a minimum of 60mm rain needs to fall every two weeks in 2-3 rainfall events.

Using this data, rainfall patterns dating back to 1987 (using BoM station 040759 Corbould Park Race Course) have been reviewed to assess the likelihood of the occcurance of successful breeding habitat for the WSF over time (Table 4.2). Ignoring all other factors that may contribute to habitat suitability (presence of pine trees, altered use and management of land, the occurance of pest animal species), only 12 of the last 27 years presented rainfall conditions that would have likely resulted in the prolonged ponding of WSF habitat, as diagramtically displayed in Table A.2 and Figure A.2f.

Based on this information, an above average rainfall year (≥65%ile) is required to generate the rainfall conditions favorable for the prolonged ponding of WSF habitat pond (>6 weeks, sufficient for breeding to occur) and the occurance of the functional Wullum Sedgefrog movement corridors presented in the *Caloundra South Public Environmental Report* (Stockland 2012). It is enviages that the information sourced from the Control Sites (refer to Section 4.3) will help refine rainfall conditions needed for succesful Wullum Sedgefrog breeding.

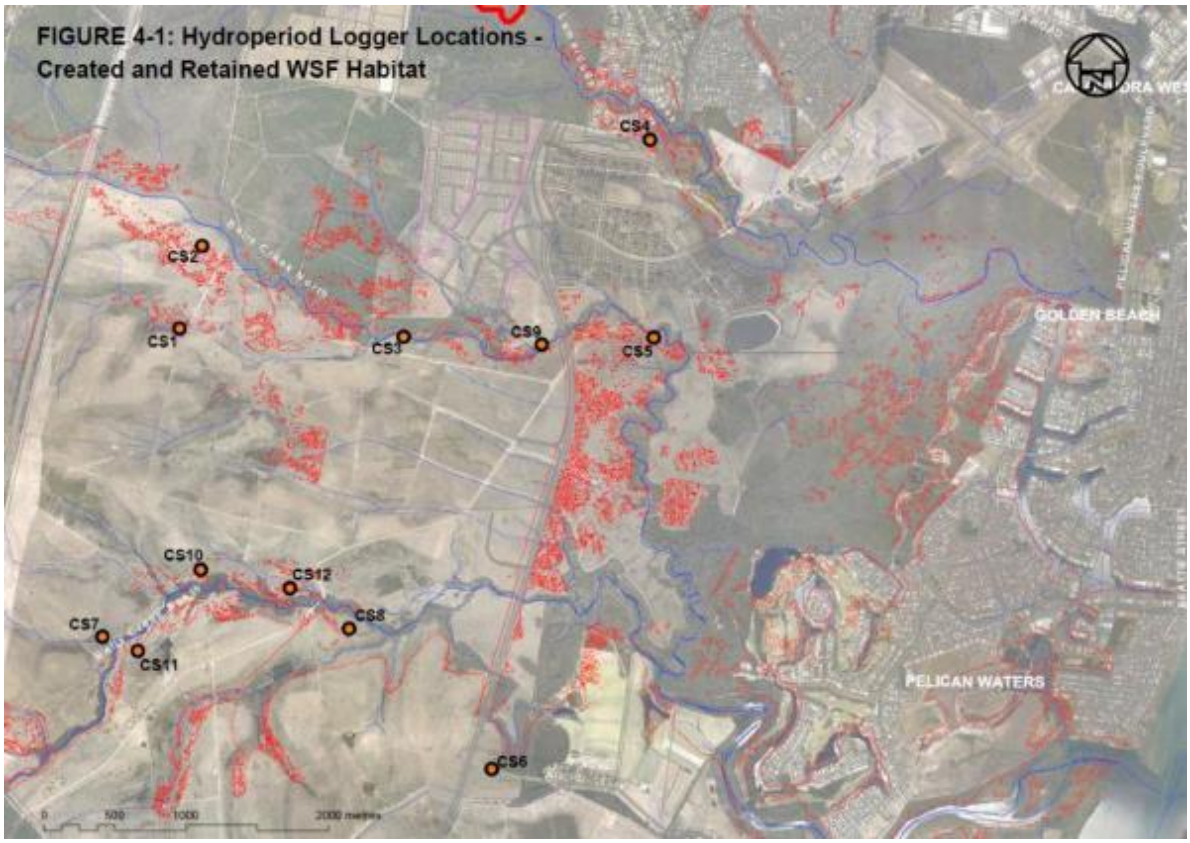


Figure A.2a Hydroperiod logger locations – Created and retained habitat

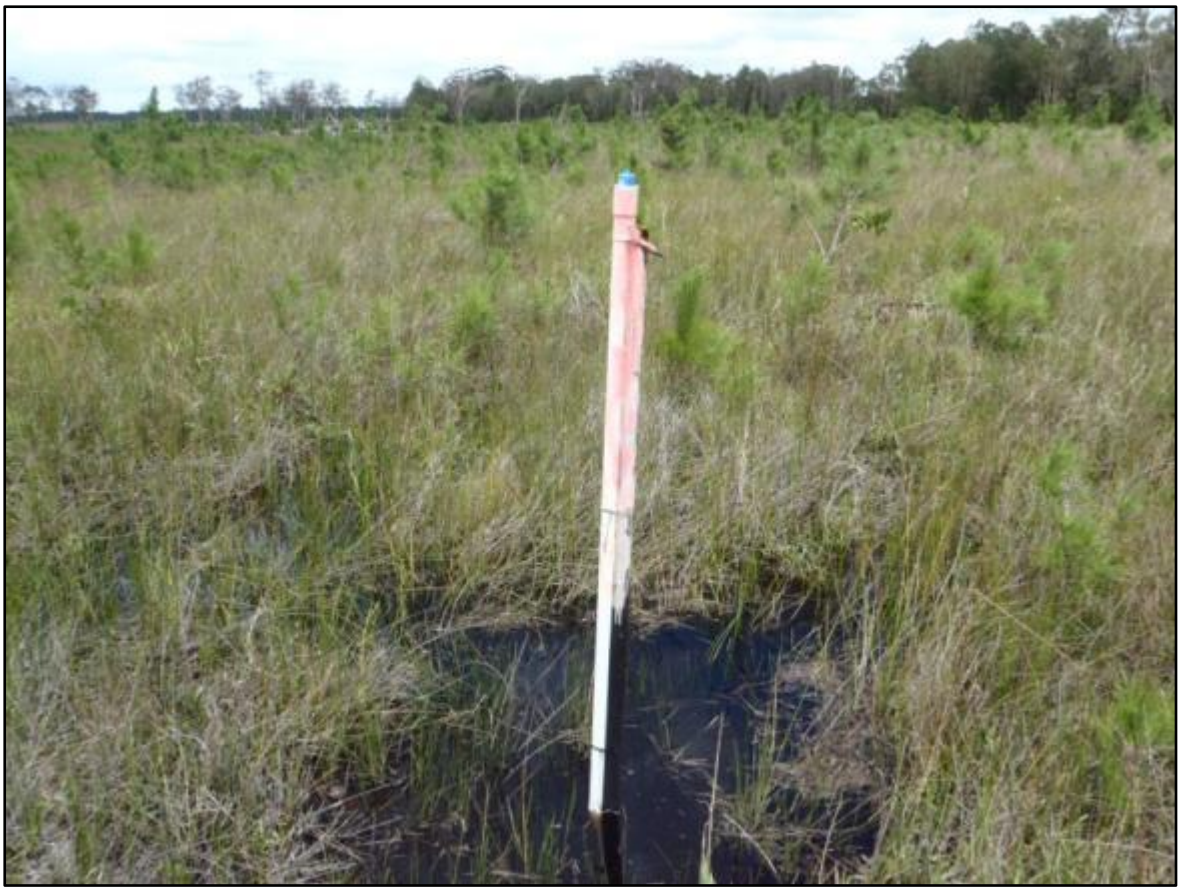


Figure A.2b: Example of water level sensor deployment

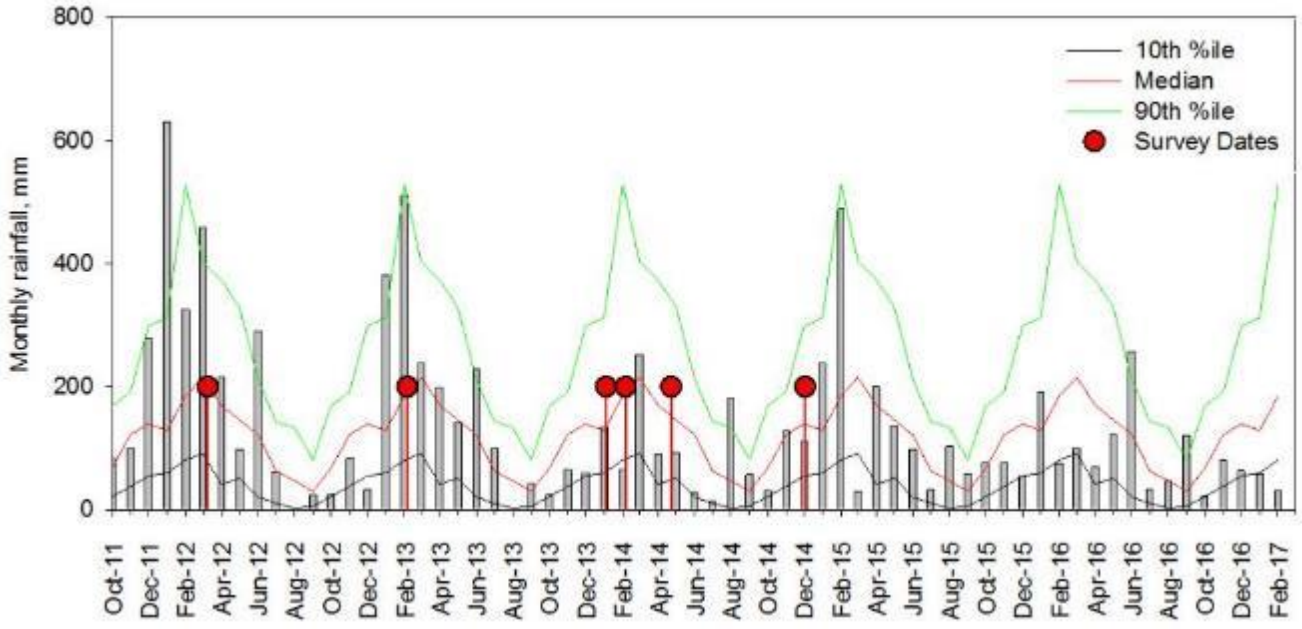


Figure A.2c: Monthly rainfall between Octber 2011 and Feb 2017

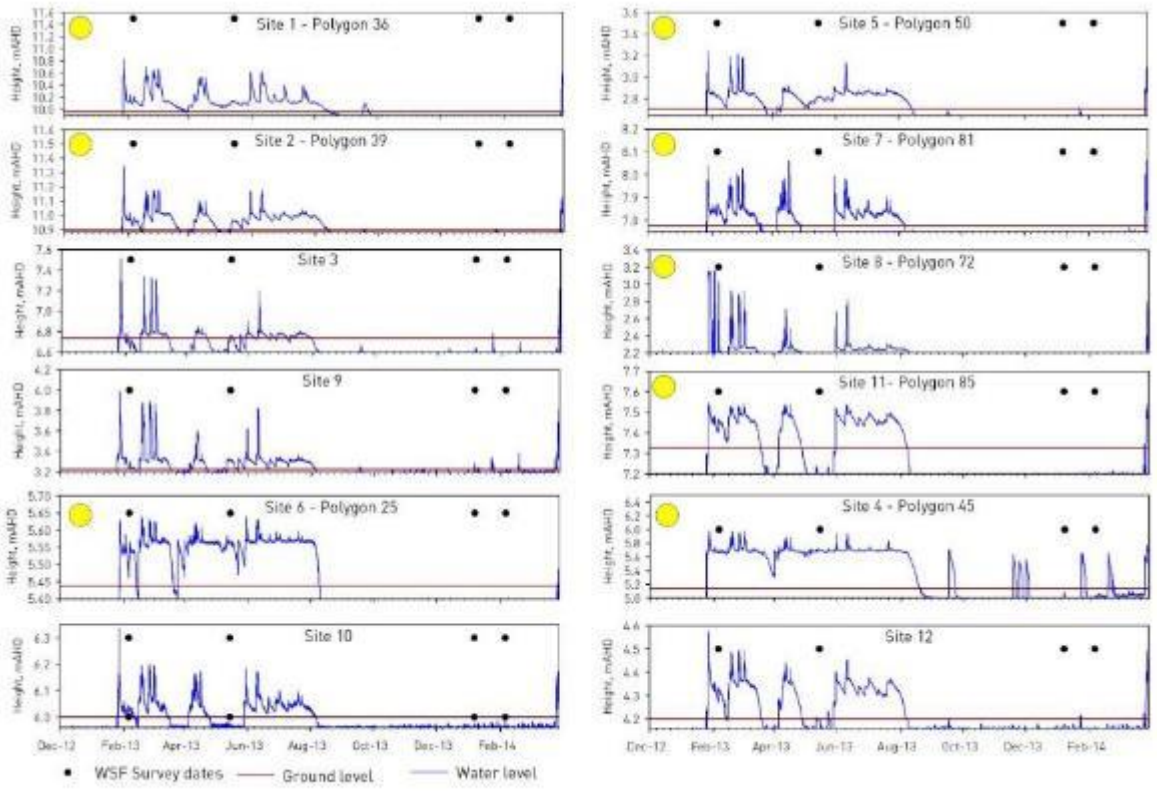


Figure A.2d: Water level over time at South Caloundra site (12 sites). Yellow dot indicates current Wallum Sedgefrog habitat Data set between December 2012 and April 2014.

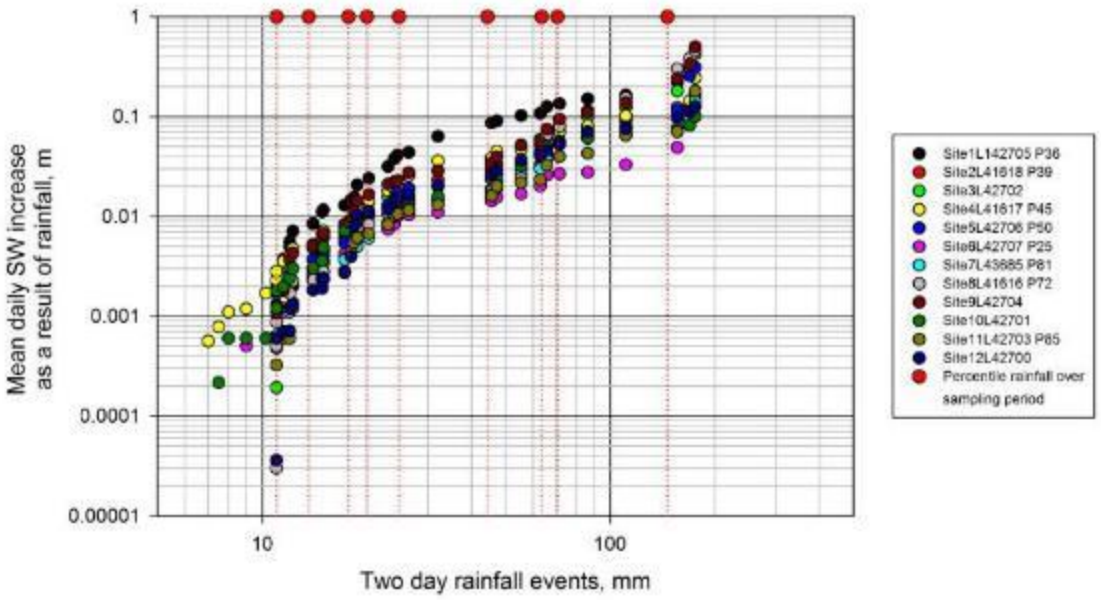


Figure A.2e: Surface water level increase as a result of two day accumulated rainfall

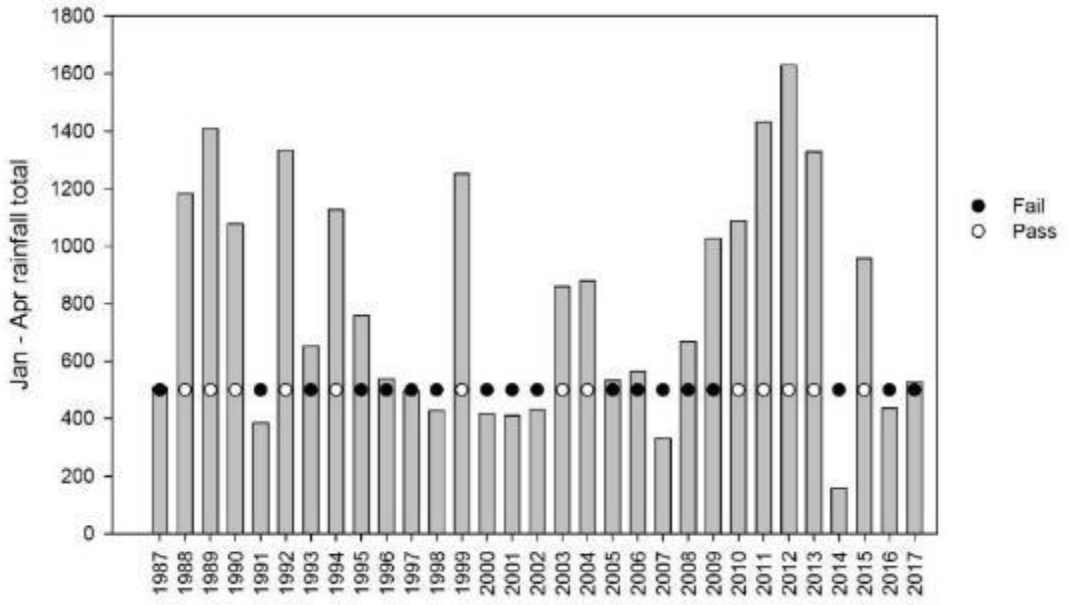


Figure A.2f: Historical assessment of surface ponding frequency sufficient to facilitate WSF breeding, with hypothisised 'fail' or 'pass' of breeding pond success (ponded water in habitat areas for >6 weeks).

Table A.2: Historical assessment of surface ponding frequency sufficient to facilitate WSF breeding

YEAR	Sum of Jan-Apr rain	%ile	Breeding pond success	Sum of Dec –Apr rain	%ile	Comment
1987	509.00	**38**	fail	674.00	**41**	
1988	1183.60	**78**	pass?	1405.6	**78**	Late season rain – into May
1989	1409.60	**86**	pass	1725.6	**86**	Late season rain – into May
1990	1077.60	**76**	pass	1185.2	**70**	
1991	384.60	**26**	fail	523.8	**28**	
1992	1332.80	**84**	pass	1627.8	**84**	
1993	651.60	**46**	fail	697.2	**42**	
1994	1127.20	**78**	pass	1261.2	**74**	
1995	758.80	**56**	fail	955.4	**59**	
1996	537.80	**40**	fail	673.8	**41**	
1997	496.40	**37**	fail	614.9	**37**	
1998	427.50	**29**	fail	554.5	**32**	
1999	1252.00	**81**	pass	1315.0	**76**	
2000	417.50	**28**	fail	625.5	**38**	
2001	410.50	**28**	fail	518.5	**28**	
2002	432.00	**31**	fail	582.0	**35**	
2003	859.00	**66**	pass	1113.5	**68**	
2004	879.00	**67**	pass?	1141.0	**79**	Lots of little 20,30 and 50mm events. Nothing over 150mm)
2005	**533.00**	**40**	**fail**	**836.0**	**50**	
2006	564.00	**41**	fail	564.0	**33**	
2007	331.00	**22**	fail	423.5	**23**	
2008	669.00	**47**	Fail?	852.0	**52**	Lots of little 20,30 and 50mm events. Nothing over 150mm)
2009	1027.00	**75**	Fail?	1089.0	**67**	All the rain came at start April
2010	1088.50	**76**	pass	1135.5	**68**	
2011	1431.00	**86**	pass	2120.5	**89**	
2012	1629.40	**88**	pass	1906.9	**88**	
2013	1329.00	**83**	pass	1361.5	**77**	
2014	159.4	**12**	fail	335.6	**14**	
2015	957.00	**70**	pass	1068	**63**	
2016	435.40	**31**	fail	507	**27**	
2017	529.00	**39**	fail	592	**35**	Majority of rain fell in mid to late March (375mm) with little follow up rain
Criteria	200+mm over 1-3 days to charge the shallow GW and express into furrows and ponds min of 60mm every 2 weeks, falling in 2-3 events to maintain depth					
Noting	Rainfall less than 10mm results in a general decrease in pond water level at approximately 1-2cm/day Rainfall between 10-15mm maintains pond levels High water levels associated with rainfall events >150mm only lasts 1-3 days					

A3 Water quality data

Water quality data from Wallum Sedgefrog habitat patches across the Caloundra South site were collected and reported between Dec 2012 and Feb 2013. Analysis of this data indicates that Wallum Sedgefrog habitat can be generally classified as having a:

- pH range between 4 – 5, with median value of 4.36;
- Tannic acid equivalent concentration range between 1.23 – 39.20 mg/L, with median value of 9.99 mg/L; and
- Salinity range between 8-77 µS/cm, median of 28.27 µS/cm.

In addition to this information, water quality data was collected at each of the 12 water level logger locations displayed in Figure A.2a on 12th February 2013 using a HYDROLAB MS5 portable, handheld multiprobe. Three readings were taken at each site with the mean value provided in Table A.3a.

Table A.3a: Water quality results at Caloundra South (Sampling date 12/2/2013)

Site	Temp (°C)	pH
Site 6	25.14	4.16
Site 7	24.21	3.74
Site 11	26.02	4.01
Site 12	29.07	4.38
Site 10	24.89	3.71
Site 8	28.6	4.15
Site 2	28.64	4.44
Site 1	27.49	4.44
Site 3	28.45	4.72
Site 5	25.58	5.07
Site 9	28.28	3.45

A.4 Soil and groundwater

Two soil and groundwater test pits were dug in the far north of the site (Precinct 2, Figure A.4a) to determine the soil type, groundwater level and general suitability for Wallum Sedgefrog habitat pond construction. The pits were located in the bottom of the farrowed swales and were dug to a depth of approximately 600mm. Groundwater was allowed to stabilise for approximately 30 minutes to an hour, before the water table level was determined. Figure A.4a shows a broad locality and each of the test pits dug.

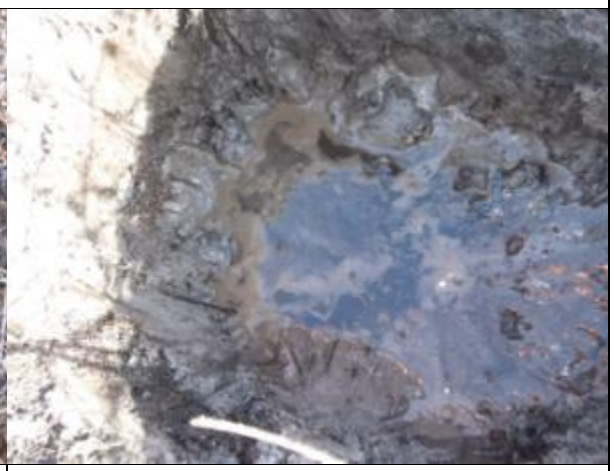
The soil in both test pits was similar, showing a topsoil layer of 50mm depth dark grey coarse sand with a high proportion of organic matter. The soil decreased in organic matter and colour with depth, moving to a light grey coarse sand. The water pooled to a depth of approximately 100mm in both test pits, with water horizontally draining into the pit from the walls.

Water pooling into the pit was tested as per the methods detailed in Section A.2. The results of the testing are shown in Table A.3a. The groundwater quality was characterised by very low pH values (2.98 and 3.21).

Detailed further in Appendix B, test pits like that described above will inform the placement of the proposed constructed Wallum Sedgefrog Habitat ponds, confirming that groundwater depth, groundwater chemistry and soil type are consistent with that required for successful Wallum Sedgefrog habitat pond creation (discussed in further detail in Appendix B).

North west area of proposed Frog Zone

Test Pit 1



Test Pit 2

Figure A.4a Test pit location and photographs

APPENDIX B: HABITAT RESTORATION AND CONNECTIVITY: PRECINCT 2

B.1 Introduction

The purpose of this section of the WSFMP is to provide a detailed example of how the person undertaking the action proposes to apply the proposed mitigation strategy in Precinct 2 (Northern Locality, refer Figure 3.9a) at Caloundra South.

For the purposes of graphical explanation, a 'Storyboard' of the construction process describing how habitat conservation and re-creation will be sequenced is provided in Section B.6.

Principles of the strategy will be applied to all of the other precincts as the development progresses over its 30 year life ensuring that frog ponds are created in advance of construction to maintain habitat connectivity.

Within Precinct 2 (total extent 222.74ha), there is a total of 71ha of existing Wallum Sedgefrog habitat, mapped on Figure 2.2a (as mapped from the January to March surveys in 2012). This habitat is represented by polygons identified in the accompanying Storyboards (refer Section B.6), most of which form the 'northern corridor' providing Wallum Sedgefrog movement along Lamerough Creek. Habitat polygon 44 is the largest habitat polygon within Precinct 2 and provides one of the main components of the 'northern corridor'. Under the proposed development within Precinct 2, the middle and north-western parts of habitat polygon 44 would be impacted.

To facilitate continued movement of Wallum Sedgefrog along Lamerough Creek, sections of the existing northern corridor (habitat polygon 44) will be preserved, while new Wallum Sedgefrog habitat will require creation. This will provide sufficient habitat along Lamerough Creek to provide for Wallum Sedgefrog movement north and west of the site and the maintenance of a viable Wallum Sedgefrog population in this portion of the site.

B.2 Habitat restoration rationale

Factors critical to the success of both created and retained Wallum Sedgefrog habitat ponds (and hence maintenance of the northern corridor) must consider:

- Proximity to known Wallum Sedgefrog habitat areas;
- Appropriate excavation depths and bathymetry such that groundwater is intercepted and a 'window' for groundwater expression is created at depths corresponding to the depths of habitat ponds surveyed;
- Delivery of water to ponds via groundwater to ensure appropriate water chemistry;
- The exclusion of surface water flows which have potential to carry contaminants which may negatively affect water chemistry and quality within Wallum Sedgefrog habitat ponds. This includes both the temporary sediment basins shown in the accompanying Storyboard and permanent drainage infrastructure within Precinct 2;
- Provision with suitable vegetation;
- Buffers of a minimum 50 metres from areas of intensive land use (roads, urban areas etc.);
- Achieving the appropriate hydroperiod, as detailed in Chapter 4; and
- Location relative to the Q5 year ARI post development flood levels plus climate change where possible.

The design for habitat ponds for the Wallum Sedgefrog must consider a number of broad design attributes including:

- A shallow mean water depth (<0.5m);
- A variety of depths (benches) and non-uniform bathymetry;
- Water sourced within ponds via groundwater, rather than surface water (i.e. drains and creeks);
- Vegetation community of rigid native and non-native grasses;

- A pH range (if groundwater is intercepted) similar to or lower than pH levels recorded during 2012 surveys, see table 5.4a (i.e., <4.9 [mean = 4.41, std dev = 0.34]), generally a pH range of between 3-5;
- Conductivity range between 8-77 µS/cm and tannin range between 1.23-39.2 mg/L; and
- An ephemeral ponding regime, ponds become dry in low rainfall conditions (winter and spring) and fill via groundwater recharge under rainfall events (generally occurring in summer and autumn).

In Precinct 2, existing Wallum Sedgefrog habitat patches are large and spaced regularly enough to facilitate movement from the south-east to the north-west of the Caloundra South site forming the 'northern corridor' for Wallum Sedgefrog movement. The Frog Conservation and Buffer Zone within Precinct 2 will be used to conserve this northern corridor, using a combination of:

- Existing retained Wallum Sedgefrog habitat (habitat polygon 45 and the south east section of habitat polygon 44 – refer Figure B.6a);
- Strategically placed created Wallum Sedgefrog habitat ponds; and
- Rehabilitation of the area between created and retained Wallum Sedgefrog habitat ponds to ensure ease of Wallum Sedgefrog movement.

5.3 Habitat Design Attributes

The above habitat attributes along with other published sources (Meyer *et al*. 2006; SEWPaC 2011; Lewis and Goldingay 2005) can be used to develop the design and rehabilitation criteria for the Frog Conservation and Buffer Zone for the northern corridor in Precinct 2. Specific design attributes for constructed Wallum Sedgefrog ponds include:

- A size range between 60 and 200m^2;
- Individual pond spacing at a desired maximum distance of 100m. The maximum viable distance for ponds aiding Wallum Sedgefrog movement and refugia is 500m (Lewis and Goldingay 2005). By applying a maximum distance of 100m between created Wallum Sedgefrog habitat ponds there is less risk of an unsuccessful restoration of the northern corridor; and
- A mean water depth of 0.5m, with a non-uniform depth and shallow (5cm) non-vegetated bench areas.

The Storyboard figures included in Section B.6 illustrate Wallum Sedgefrog pond design within the Frog Conservation and Buffer Zone demonstrating the maintenance of Wallum Sedgefrog movement corridors from the south-east of the site through the north-west of the site.

Within existing retained Wallum Sedgefrog habitat (namely Habitat polygon 45 and the south western section of Habitat polygon 44), detailed site investigations (further discussed in Section B.4) will confirm the presence of suitable existing habitat ponds. Should suitable existing ponds not occur, a series of constructed ponds will be designed to provide that the individual pond distance throughout the entire Frog Zone of Precinct 2 is sufficient to allow for Wallum Sedgefrog movement and function of the northern corridor.

The area between retained and created Wallum Sedgefrog habitat ponds within the Frog Conservation and Buffer Zone will be rehabilitated and managed to promote frog movement consistent with the species listed in Table B.3.

Table B.3: Plant species for revegtation (Frog Conservation and Buffer Zone)

Botanical name	Common name
Baloskion pallens	bog rush
Baumea articulata	jointed twig-rush
Baumea rubiginosa	twig-rush
Blechnum indicum	water fern
Cyperus haspan	sedge
Cyperus melanostachys	sedge
Gahnia sieberiana	saw-sedge

Botanical name	Common name
Juncus usitatus	common rush
Lepironia articulate	lepironia
Melaleuca pachyphylla	swamp teatree
Philydrumlanuginosum	frogsmouth
Schoenusbrevifolius	zig-zag bog rush
Xanthorrhoea fulva	wallum grasstree

B.4 Site investigations to inform design of Wallum Sedgefrog ponds

More localised site investigations will be undertaken prior to commencing habitat creation in target areas within Precinct 2. These investigations will inform the design of the Wallum Sedgefrog ponds and habitat re-creation within the Frog Zone and re-establishment of the northern corridor. As previously discussed, local site investigations will be specifically focussed on soil, ground and surface water chemistry, hydrology, vegetation, proposed drainage infrastructure and retained Wallum Sedgefrog habitat. The following sections describe the nature of the proposed investigations:

Soil pot holes

Soil pot holes will be dug at a uniform rate of 1 pot hole per 2000m^2, to a maximum depth of 0.8m. The aim of this exercise is to ensure that the created Wallum Sedgefrog habitat ponds occur in the correct soil and groundwater environment. Figure B.4a displays a draft layout of the soil pot holes within Precinct 2. Pot holes will be dug and the soil and groundwater conditions examined for compliance with:

- A pH range (if groundwater is intercepted) similar to or lower than pH levels recorded during 2012 surveys, see table 5.4a (i.e., <4.9 [mean = 4.41, std dev = 0.34]), generally a pH range of between 3-5; and
- Positioned entirely within sandy soil (loamy sand) which does not buffer water acidity to the extent more clayey soils do.

Should clay soil layers be intercepted within the soil pot holes, the specific area will be marked 'unsuitable' for the construction of Wallum Sedgefrog habitat ponds. This is, however, not likely to occur on a regular basis due to the landform and soil profile characteristics of the site.

Shallow groundwater expression zones

Where shallow groundwater is intercepted within the soil investigation pits or it is expressed at the surface (via shallow ponds or furrows etc) within the Frog Zone of Precinct 2, water quality measurements for pH, conductivity and colour will be made and compared to the known water quality attributes of Wallum Sedgefrog habitat ponds, as detailed in Table B.4a below. Sites which comply with this data will be assessed for their suitability for Wallum Sedgefrog habitat in accordance with criteria presented in Section 3.3.

Should groundwater quality (expressing at the surface) exceed the upper pH limit displayed in Table B.4a, the specific area will be marked 'unsuitable' for the construction/rehabilitation of Wallum Sedgefrog habitat ponds. This is envisaged to occur within existing and proposed deep drainage lines, as displayed in Figure B.4b, where the pH of the water was measured at 5.44 and thus non-compliant with the criteria for Wallum Sedgefrog habitat data presented inTable B.4a.

Initially, three hydroperiod loggers will be installed throughout Precinct 2 (see Figure B.4a) in retained Wallum Sedgefrog habitat polygons 44 and 45, to the north and east of the development. Upon completion of created Wallum Sedgefrog habitat ponds, an additional three hydroperiod loggers will be deployed and used to monitor the hydroperiod of the created Wallum Sedgefrog habitat ponds until areas are accepted off maintenance.

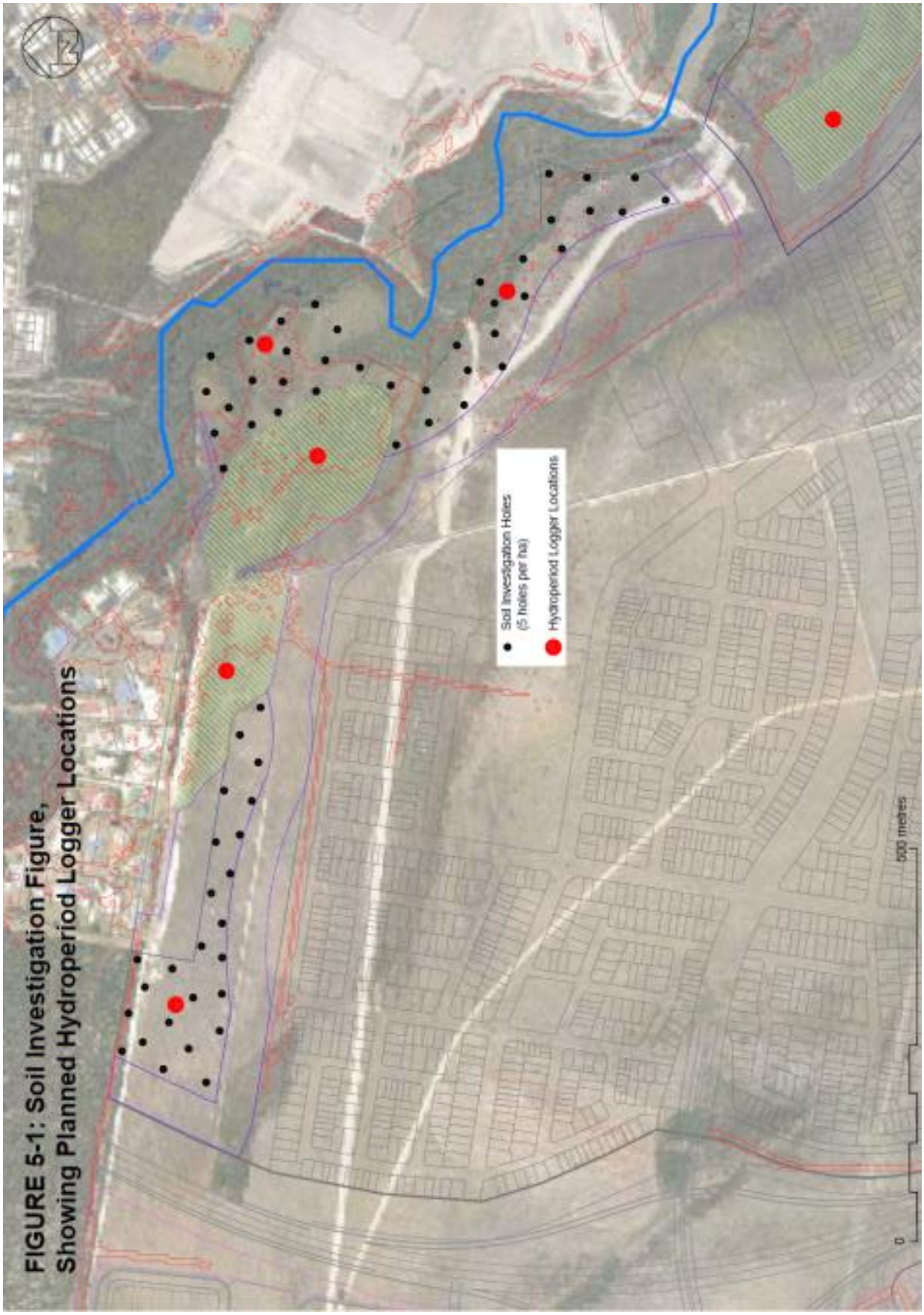


Figure B.4a: Planned hydroperiod logger locations

Table B.4a: Known Water Quality Attributes of Wallum Sedgefrog habitat ponds (AWC, 2012)

		pH	Tannin Colour [mg/L])
Mean		4.41	10.80
Median		4.36	9.99
Minimum		4.00	1.23
Maximum		5.00	39.20
Percentiles	25	4.13	6.63
	50	4.36	9.99
	75	4.56	13.79

Figure B.4b: Existing deep drainage line that has unsuitable water quality for the creation of Wallum Sedgefrog habitat ponds. Note: Drainage line is not within Release Area

Vegetation and Wallum Sedgefrog Habitat survey

Condition No. 8g of the EPBC Act approval requires a pre-construction survey to be undertaken by an appropriately qualified ecologist immediately prior to removal of any identified areas of Wallum Sedgefrog habitat to record the size of the area to be removed by the proposed action. Box 1 below outlines the proposed scope, methodology and timing of the pre-construction survey to be undertaken in each precinct.

BOX 1: OUTLINE OF WSF SURVEY'S ACCROS THE UNDEVELPOED AND DEVELPOED PORTIONS OF THE AURA DEVELOPMENT.

Condition (8) (g) notes the requirement for pre-construction surveying on the subject site by an appropriately qualified ecologist immediately prior to the removal of any identified areas of WSF habitat to record the size of the area to be removed by the proposed action. Furthermore, surveying of created compensatory and retained WSF habitat post

develpoment is required to demonstrate that habitat created as conditioned within the approval meets the specifications outlined within this WSFMP.

Preconstruction surveys

Pre-construction WSF surveys will be undertaken within each precinct prior to commencement of the action within that precinct (or group of precincts) to confirm the area of WSF habitat that is to be removed as a result of construction activities.

These surveys are considered to address three goals:

1. Review and refine WSF population and distribution known from surveys carried out for the PER on a precinct by precinct basis (or in a group of precincts) in line with the progression of the development and known WSF movement corridors over a 30 year period;
2. Reassess and confirm the location, size and functionality of habitat polygons identified in Figure 2.2d within precincts; and
3. Confirm the area of WSF habitat that is to be removed and or retained during the construction of each precinct or precincts.

The preconstruction survey will be implemented in two phases to ensure that the impact of the develpoment on WSF habitat is adequatly quantified over the lifetime of the develpoment apporval (30 years from the commencemnt of the action).

1) Phase 1 preconstruction survey - Review existing baseline WSF population and distribution

The Phase 1 preconstruction survey is aimed to meet survey goals 1 and 2 (refer above). This survey will occur over key undevelped areas of site and be completed no longer than 5 years prior to the develpoment of a precint or group of precincts. The survey area will encapsulate known movement corridors (refer Figure 2.2b) that occur across a series of development precinct/s and follow the planned development of the site. This will ensure that the function of WSF habitat planned to be removed as a result of the development is adequatly assessed prior to its removal.

Surveying of the WSF population within the Subject Site will follow the methods outlined below, consistent with that used in Chapter 9 of the PER, from work undertaken by EcoSmart (2011, 2012, 2013), Meyer et al. (2006) and that listed in the Draft Referral Guidelines for the Vulnerable WSF [Litoria olongburensis] (2011).

All WSF mapping produced based on the below methods will also show the results from all previous mapping, clearly describing the climatic conditions leading up to the respective habitat survey periods.

The distribution and population of WSF's across the precincts of the site will be estimated using both aural and visual survey techniques for the full extent of all known and mapped WSF habitat (see Figure 2.2d). It is proposed that an aural survey be conducted initially to confirm presence/absence within a known habitat area. If the WSF is not recorded via aural surveys within a particular known habitat area, visual surveying will be used to confirm presence/absence. Surveying will be undertaken within known habitat area:

- when they are inundated with water;
- when night time air temperatures will exceed 15oC; and
- when wind strength is low and humidity levels are high.

Aural survey

Aural surveying will be undertaken by 2 ecologists listening from 1 location for 5 minutes, recording the number of individuals present within 30mins. Aural surveying will be undertaken from sunset into the evening between the calling months (September – April). Surveying will be timed to occur after rainfall when known habitat areas (Figure 2.2d) are inundated with water..

Visual survey

Visual surveys will be undertaken 6-8 weeks following significant rainfall causing wide spread inundation of known habitat areas. Visual surveys will be undertaken along one 50m x 2m transect per 2ha of suitable habitat at a minimum of one hour of survey effort per transect (SEWPaC, 2011).

Confirmation of WSF habitat area

At each location where WSF have been identified (from above investigations), habitat extents will be established based on water quality and vegetation attributes, as specified in the table below. This includes presence of a water depth of > 5cm and a specific vegetation community. Water quality and depth measurements within each identified WSF habitat area will be obtained at a rate of 5 samples per ha. Notwithstanding that the extent of surface water inundation within WSF habitat changes on a daily basis, the extent of surface water inundation should be noted to gain a better understanding into the dynamic relationship between rainfall, habitat ponding and water quality. This information will be included into the WSF Research Program (refer to Section 3.8).

As shown in Fig A.2d, the water level (and hence extent of inundation) within WSF habitat increases and decreases rapidly over 1-2 days following large rainfall events. As such, the water depth and extend to inundation within WSF habitat measured following large rainfall events is not a true reflection of the attributes of WSF breeding habitat. As such, WSF habitat mapping should not immediately follow large rainfall events of >150mm/24hours.

Habitat attribute	Measurable component
Water chemistry and water depth	• pH range (if groundwater is intercepted) similar to or lower than pH levels recorded during 2012 surveys, see table 5.4a (i.e., <4.9 [mean = 4.41, std dev = 0.34]. Generally a pH range of between 3-5. • Tannic Acid equivalent concentration range between 1.23-39.2mg/L • Conductivity range between 8-77µS/cm • Average depth of WSF ponds between 5-67cm
Vegetation	Vegetation within WSF habitat can include: • native rigid rushes/reeds/sedges comprising (but not limited to) *Baumea articulata*, *Baumea juncea*, *Baumea rubiginosa*, *Juncus usitatus*, *Lepironia articulata* • open water • non native grasses including (but not limited to) *Setaria sphacelata*, *Axonopus fissifolius*, *Paspalum scrobiculatum* • combined litter, bare ground, ferns, forbs, shrubs jointed rushes/reeds/sedges, limp rushes/reeds/sedges.

If weather conditions are not suitable for the monitoirng of WSF's (as defined above) on the 5th year folloiwng the last Phase 1 survey, the most recent Phase 1 survey will be used to meet survey goals 1 and 2 (refer above). Phase 1 WSF surveys will be subsequently undertaken at the next suitable opportunity, as defined above and in the Draft Referral Guidelines for the Vulnerable WSF [Litoria olongburensis] (2011).

2) Phase 2 preconstruction survey – Confirming area of WSF habitat to be removed/destroyed as a result of the develpoment.

The Phase 2 preconstruction survey is aimed to meet survey goal 3 (refer above). Using the results of the WSF habitat mapping from Phase 1, confirmation of the extent of WSF habitat to be destroyed/removed as a result of the development will be confirmed immediately prior (within 6 months) to the removal of such habitat. The confirmation of the extent of Wallum Sedgefrog habitat will be determined based on ground truthing the results of the Phase 1 investigations against the following attributes:

- Vegetation type (native rigid rushes/reeds/sedges comprising (but not limited to) *Baumea articulata*, *Baumea juncea*, *Baumea rubiginosa*, *Juncus usitatus*, *Lepironia articulata,*
- Soil type (sandy loam, with high organic matter content),
- Topography, and
- If water present, water quality and surface water extent (refer to Table above).

Vegetation associated with ephemeral wetlands inhabitated by the Wallum Sedgefrog has evolved to survive a wide variety of seasonal weather conditions, having the ability to grow and survive during low rainfall years, as well as having the ability to grow and survive under prolonged inundation. These vegetation species / communities play an important role for the Wallum Sedgefrog during these low rainfall periods, providing drought refuge areas in the cool micro climate of the subsoil surrounding the roots / little layer ephemeral wetland vegetation.

The chemistry of the water within Wallum Sedgefrog habitat is largely the result of the interaction of rainfall with the **soil** within and surrounding its habitat – sandy loam with high organic matter content. The high amount of organic matter within the soil results in water becoming laden with tannic acids, which stain the water 'brown' and lower its pH to <6.0. The presence of significant clay particles within soils removes tannic acids from water (via adsorption), thereby resulting in water that is often clear with a pH >6.0. As such, clayey soils are an indication that an ephemeral wetland will NOT support the habitation and breeding of the Wallum Sedge Frog.

The **topography** of the land influences how long water will pond within a given area, which in turn influences the type of vegetation that grows there. While not as important as the vegetation and soil in reassessing WSF habitat mapping during periods of reduced rainfall conditions (as topography changes little over time), it will still provide a means by which one can assess the extent of WSF habitat in the absence of a developed vegetation community.

Post construction survey

Post contruction WSF surveys will be undertaken (at frequencies outlined in Section 6) to ensure that both created and retained WSF habitat meets the site wide success criteria outlined within Table 4.2a of this WSFMP. Methodologies used to assess the success of the created compensatory habitat, recreated movement corridors and retained habitats is outlined below:

1) **physical presence / absence assessments** at a minimum frequecy of once / year (dependant upon weather condtions) by expereinsed ecologist from a representative number of ponds along each corridor (minimum of 1 pond every 250m) and within any retained habitat. Each pond/habitat polygon search using visual / audible techniques consistent with the Draft Referral Guidelines for the Wallum Sedge Frog.
2) **remote assessments** via the use of sound recorders within key ponds along a corridor to identify use of ponds / habiatat by WSF.
3) **Corridor function assessment** via the survey of key sections of the corridors between ponds (within wider frog zone) during wet years to assess broader corridor function. Survey technique will be either visual / audible techniques consistent with the Draft Referral Guidelines for the Wallum Sedge Frog or the use of remote sound recorders.

This survey will be undertaken in Precinct 2 within the Frog Conservation and Buffer Zone prior to the design of the Wallum Sedgefrog habitat ponds.This survey will also confirm the location of existing retained Wallum Sedgefrog habitat within the Frog Conservation and Buffer Zone, the vegetation assemblages within these habitat areas and ensure any flora species listed under the *Nature Conservation Act 1992* and EPBC Act 1999 are identified and mapped. A specific focus of the survey in Precinct 2 will be on mapping existing Wallum Sedgefrog habitat ponds within habitat polygons 44/45 so as to confirm the presence of suitable Wallum Sedgefrog ponding areas and inform the design of Wallum Sedgefrog habitat ponds within the Frog Zone of Precinct 2 for the maintenance of the northern movement corridor. This is further discussed in Section B.4. Habitat ponds within the retained areas of polygons 44/45 will be determined based on the known habitat characteristics of the Wallum Sedgefrog which include:

- Water pH of generally between 3 and 5;
- Tannic Acid equivalent concentration for individual ponds range between 5-39.2mg/L;
- Conductivity range between 8-77µS/cm, with a median level of 20-30 across all constructed ponds; and
- Water depth range in accordance with:
    - Average water depth of created Wallum Sedgefrog ponds between 5-67cm;
    - Minimum water depth of constructed Wallum Sedgefrog ponds when full between 5cm; and
    - Maximum water depth of constructed Wallum Sedgefrog ponds when full between 30-100cm.

Coordination with Drainage Infrastructure

The location of the proposed drainage infrastructure will be reviewed onsite to not coincide with the proposed locations of created Wallum Sedgefrog habitat ponds. This is especially important to the south-east of Habitat polygon 44 where proposed drainage corridors will bisect the Frog Zone to link the development to Lamerough Creek. Planned drains bisecting the Frog Zone (including existing Wallum Sedgefrog habitat), will either be temporary (ie only in place during construction) or permanent drainage corridors.

B.5 Detailed Design Process of Ensuring Wallum Sedgefrog Habitat Corridor Connectivity

The re-creation of the northern Wallum Sedgefrog habitat corridor will involve conserving existing Wallum Sedgefrog habitat, small scale earthworks to create breeding and habitat refuge ponds and vegetation management via supplementary planting and weed control.

As a result of the proposed site investigation within Precinct 2, the Frog Zone will be split into 4 categorises:

1. Existing retained Wallum Sedgefrog habitat;
2. Area outside the Q5 ARI flood level;
3. Area inside the Q5 ARI flood level; and
4. Area occupied by existing and proposed drainage infrastructure.

Two broad types of rehabilitation actions will be detailed across Precinct 2:

1. Maintain and enhance existing Wallum Sedgefrog habitat ponds: via weed control and supplementary planting; or
2. Recreation of Wallum Sedgefrog habitat ponds.

Areas within the Frog Zone outside the Q5 ARI (plus climate change) flood level will be subject to the re-creation of Wallum Sedgefrog habitat ponds. Figure B.6c displays an example plan layout of created Wallum

Sedgefrog habitat ponds within the Frog Zone of Precinct 2, also showing existing retained Wallum Sedgefrog habitat, drainage corridors and the Q5 year ARI.

Detailed site investigations of retained Wallum Sedgefrog habitat polygons (namely 44 and 45) will confirm the size and density of Wallum Sedgefrog habitat ponds that will be retained within the Frog Zone. Using this information, the density of actual retained Wallum Sedgefrog habitat ponds within the retained proportions of habitat polygons 44 and 45 will be assessed for the maintenance of the northern corridor. Suitable 'density' of ponds will be assumed to be 150m^2 of ponds every 250m. Should the density of existing ponds fall below this benchmark, recreation of Wallum Sedgefrog habitat ponds within the habitat polygons 44 and 45 will be considered.

Areas between the created Wallum Sedgefrog habitat ponds within the Frog Zone, areas of the Frog Zone inside the modelled Q5 ARI flood level, within drainage corridors and existing Wallum Sedgefrog habitat will be subject to maintain and enhance rehabilitation actions.

The recreation and preservation of the northern Wallum Sedgefrog corridor requires the retainment of existing Wallum Sedgefrog habitat within Precinct 2, the creation of Wallum Sedgefrog habitat ponds and the management of vegetation within the broader Frog Zone and Buffer Zone. It is proposed to monitor performance by implementation of a monitoring plan linked to success criteria, which is detailed in Section 4.2.

Drawings to Direct Wallum Sedgefrog Pond Cconstruction and Protect Existing Habitat

Wallum Sedgefrog ponds will be designed and located based on the attributes and criteria listed in Section 3.3 and results from the site investigations. Full design drawings of the created Wallum Sedgefrog ponds will be competed to guide civil construction, of which will also highlight areas of retained existing habitat. Plans and long/cross sections of created Wallum Sedgefrog ponds will be developed on a full topographical basis for the entire Frog Conservation and Buffer Zone of Precinct 2.

The type, extent and management of vegetation within both the created and retained ponds and Frog Zone and Buffer Zone is important to the success of the created breeding and habitat refuge ponds and establishment of corridor connectivity. Full vegetation management plans will be prepared the Frog Zone and Buffer Zone highlighting areas that require intensive supplementary planting, full habitat recreation and weed control.

Construction and Technical Specifications to Ensure Correct Construction Process

The practical completion of created Wallum Sedgefrog habitat ponds and the rehabilitation of the Frog Zone and Buffer Zone is intended to preserve the northern Wallum Sedgefrog habitat corridor. This requires careful planning and direction to not compromise the existing Wallum Sedgefrog habitat (namely all of habitat polygon 45 and the south-eastern portion of habitat polygon 44) during construction activities. Additionally, construction methodologies and activities within the Frog Zone and Buffer Zones will be regulated and monitored to ensure the best chance of the successful establishment of constructed Wallum Sedgefrog habitat and corridor connectivity.

Specific construction techniques and methods to be used within the Frog Zone and Buffer Zone will reported within the Construction Environmental Management Plan (CEMP) for the specific release area.Additionally a detailed Construction Technical Specification will accompany each set of Wallum Sedgefrog habitat construction plans to ensure the contractor understands the rehabilitation activities required . This Construction Technical Specification document will:

- Highlight the existing habitat that is to be retained;
- Detail the level of protection to be applied to existing habitat prior to activity within the Frog Zone and Buffer Zone (i.e. fencing around habitat boundary to prevent access);

- Identify potentially threatening actions to the existing habitat and suggest ways to eliminate or mitigate against the actions;
- Specify civil engineering, planting and weed control techniques to be used;
- Highlight temporary soil storage areas, access points and transport routes within the Frog Zone and Buffer Zone;
- Provide a timetable for construction; and
- Identify construction 'hold points' to ensure existing habitat is being adequately protected, created Wallum Sedgefrog habitat ponds are meeting the design criteria (refer to Section 5.3) and the weeding and planting regime is appropriate;
- Include a Commissioning Plan, specifying in the steps required for the effective establishment of Wallum Sedgefrog habitat ponds. This would include planting and water level information, highlighting areas of risk to successful Wallum Sedgefrog habitat creation and actions required to mitigate or prevent the identified risks; and
- Include an Operation, Monitoring and Maintenance Plan, specifying the routine monitoring and maintenance frequencies/requirements of the Frog Zone and Buffer Zone. This document sets out detailed methodologies and reporting criteria to report on the success criteria (further discussed in Section 6.2).

5.6 Construction and Rehabilitation Sequencing of Frog Zone

Created Wallum Sedgefrog Habitat Ponds and Sequencing

Due to the scale and extent of the Frog Zone and Buffer Zones throughout the project, rehabilitation will occur in several phases. Figures 4.6 a - j depict the proposed staged rehabilitation methodology for Precinct 2, which will be adopted and applied throughout the balance of the project. The methodology focuses on providing suitable breeding habitat and facilitating habitat connectivity. In relation to Condition No. 7, habitat ponds will be created in advance of construction works and rehabilitation of Frog Zone, Frog Buffer and Lifestyle Buffer will occur at the time contiguous development stages achieve plan sealing. Whilst habitat lost in a precinct (or precincts) may not be compensated for directly within that precinct (or precincts), over the full life of the development, the 152ha of habitat removed by the development will be progressively recreated and compensated for. The following story boards (updated 02/2015) depict the proposed methodology for Precint 2 as follows:

- Storyboard 1 (Figure B.6a) shows extent of developable area and existing habitat polygons both in the 2012 and 2013 surveys;
- Storyboard 2 (Figure B.6b) shows the total area to be rehabilitated including corridor connectivity;
- Storyboard 3 (Figure B.6c) shows the typical bulk earthworks phases and indicative locations for establishment of frog ponds to facilitate habitat connectivity prior to earthworks commencement;
- Storyboard 4 (Figure B.6d) shows extent of indicative phase 1 bulk earthworks, locations of sediment basins, frog ponds and drainage corridors;
- Storyboard 5 (Figure B.6e) shows the completed rehabilitation of contiguous areas to stage 1 construction; and
- Storyboards 6 -10 (Figure B.6f -j) show how staged rehabilitation will occur relative to typical construction phases.

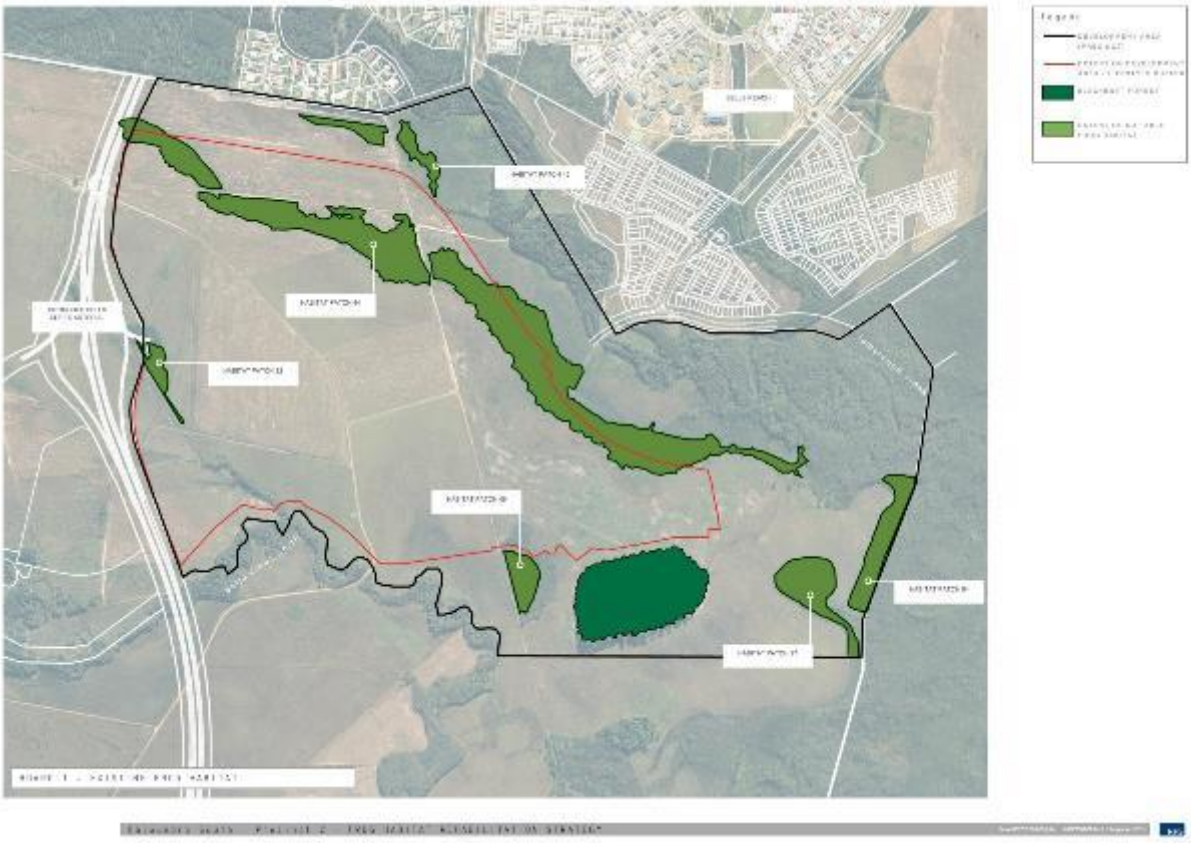


Figure B.6a : Board 1 (updated 02/2015) - Existing Frog Habitat

Figure B.6b : Board 2 (updated 02/2015) - Impact and Broad Mitigation Strategy

Figure B.6c: Board 3 (updated 02/2015) - Ultimate Habitat Creation and Buffering Strategy

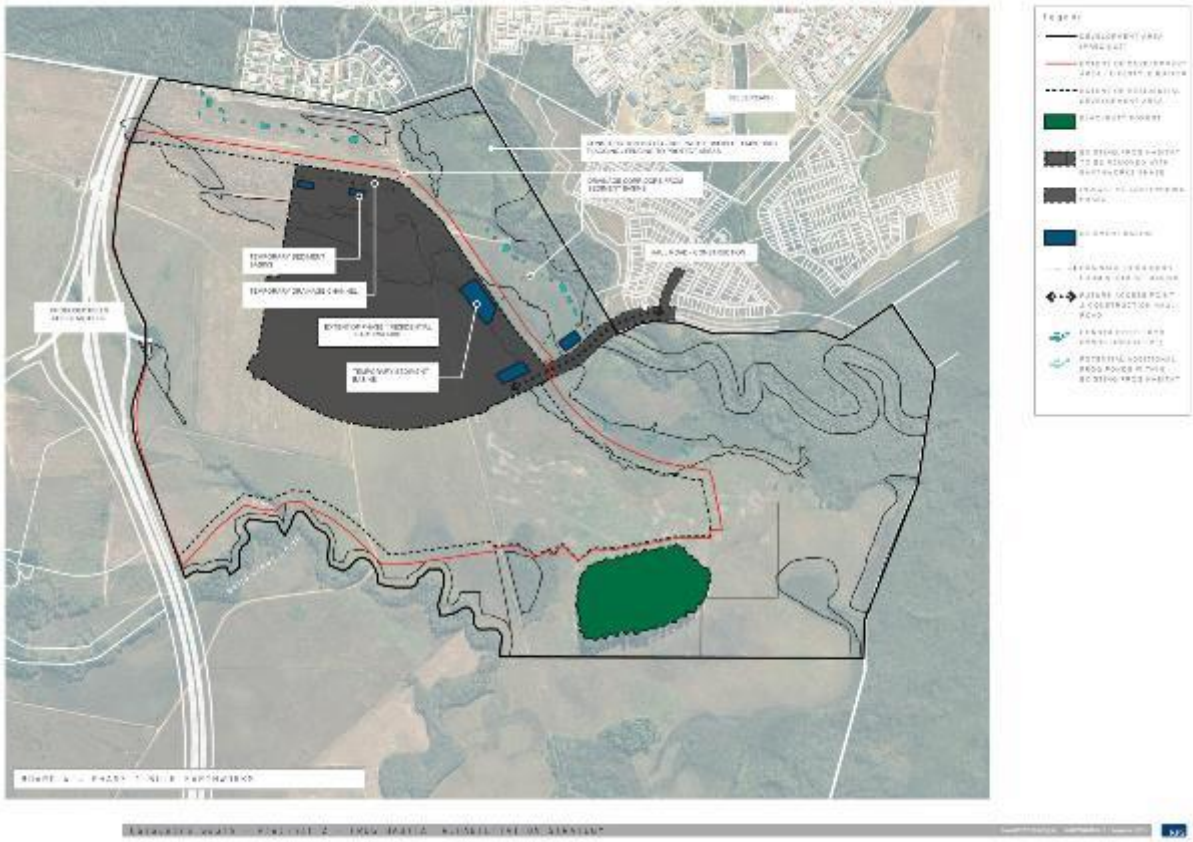


Figure B.6d: Board 4 (updated 02/2015) - Phase 1 Bulk Earthworks

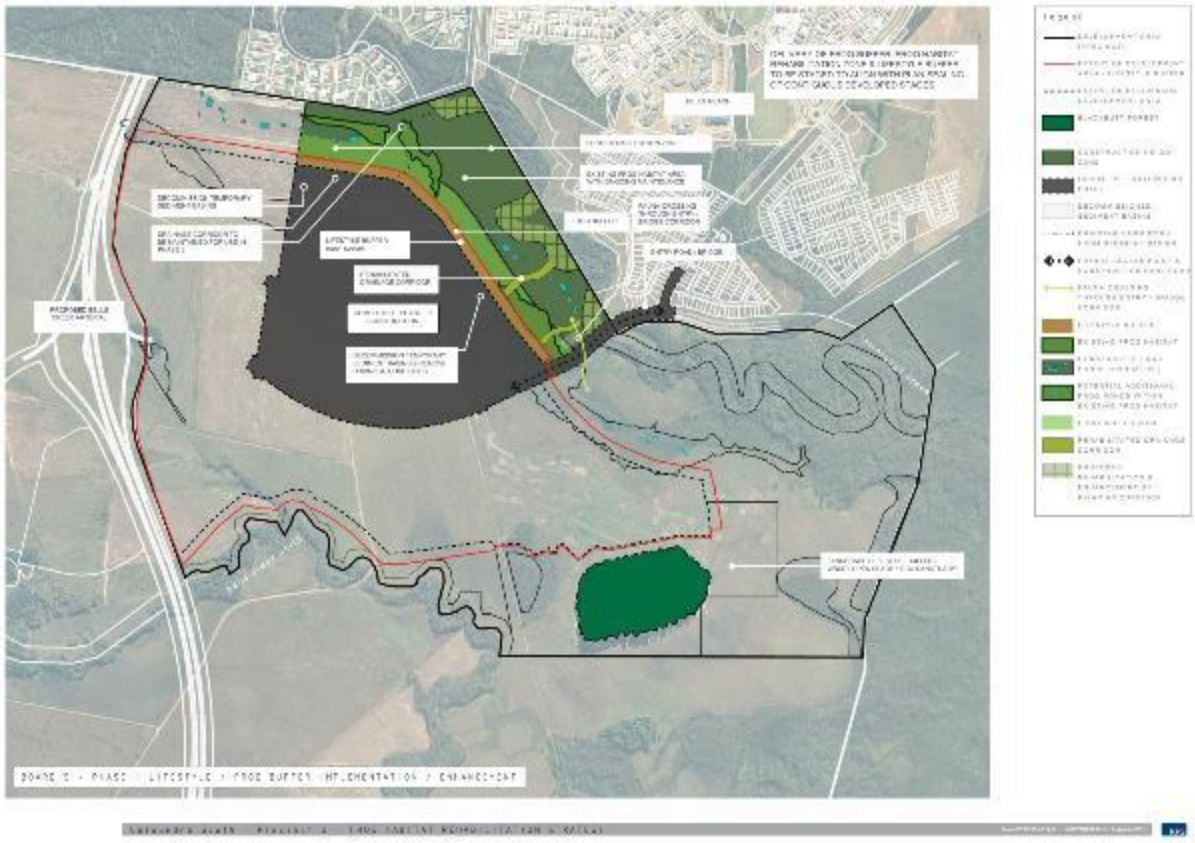


Figure B.6e: Board 5 (updated 02/2015) - Phase 1 Lifestyle / Frog Buffer Implementation/ Enhancement

Figure B.6f: Board 6 (updated 02/2015) – Phase 2 Bulk Earthworks

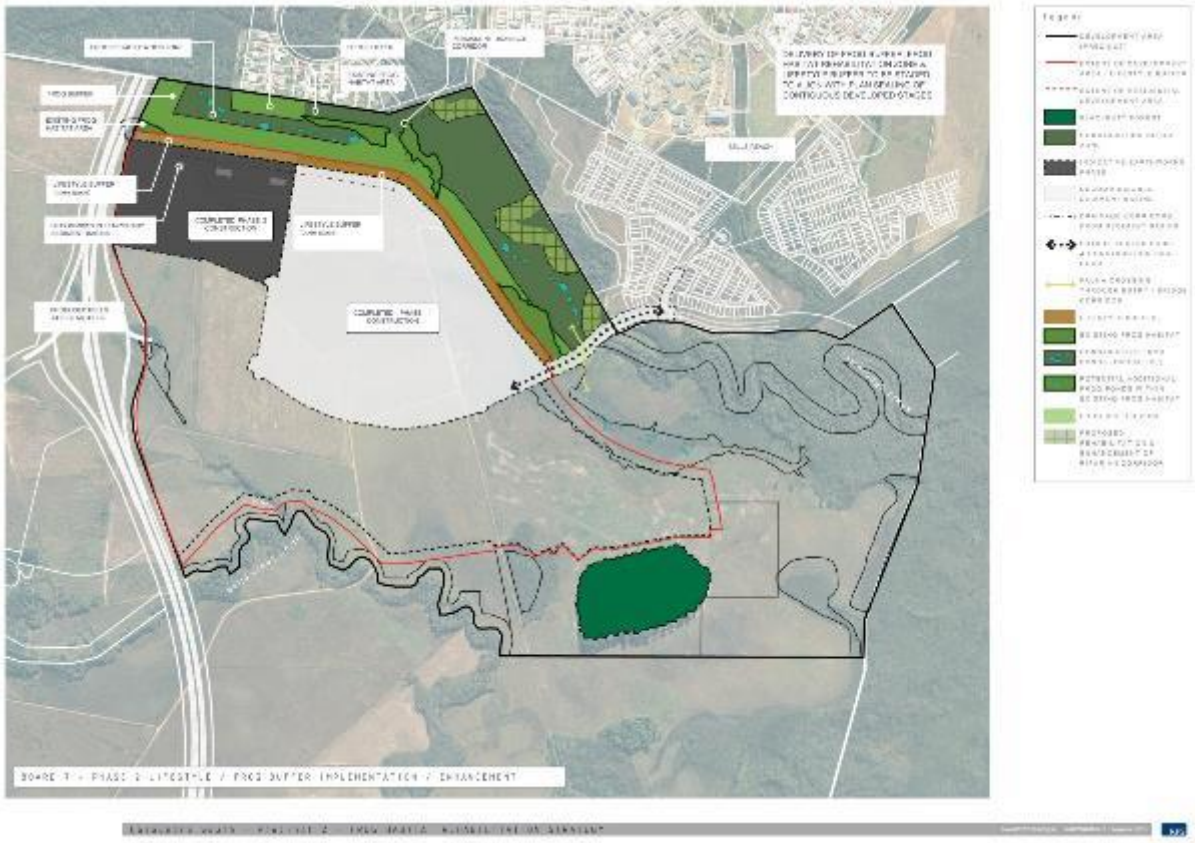


Figure B.6g: Board 7 (updated 02/2015) – Lifestyle / Frog Buffer Implementation/ Enhancement

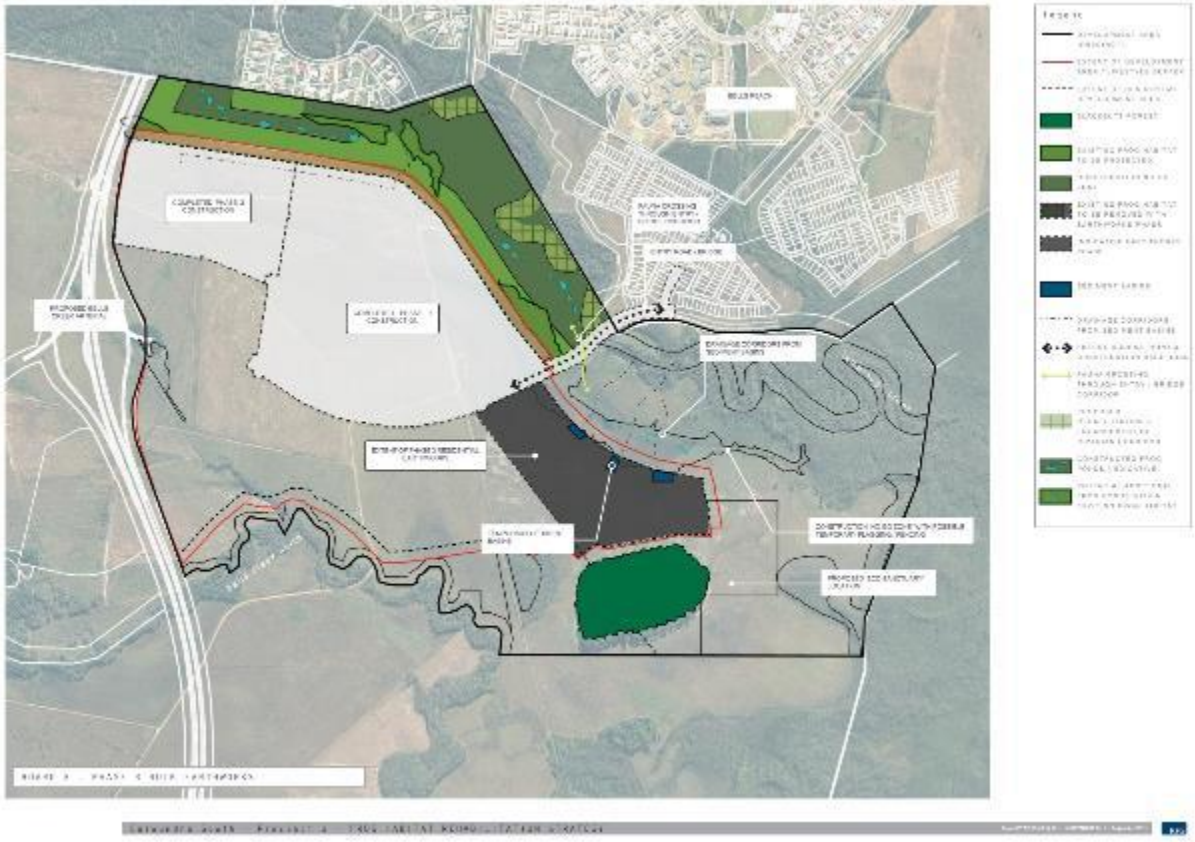


Figure B.6h: Board 8 (updated 02/2015) – Phase 3 Bulk Earthworks

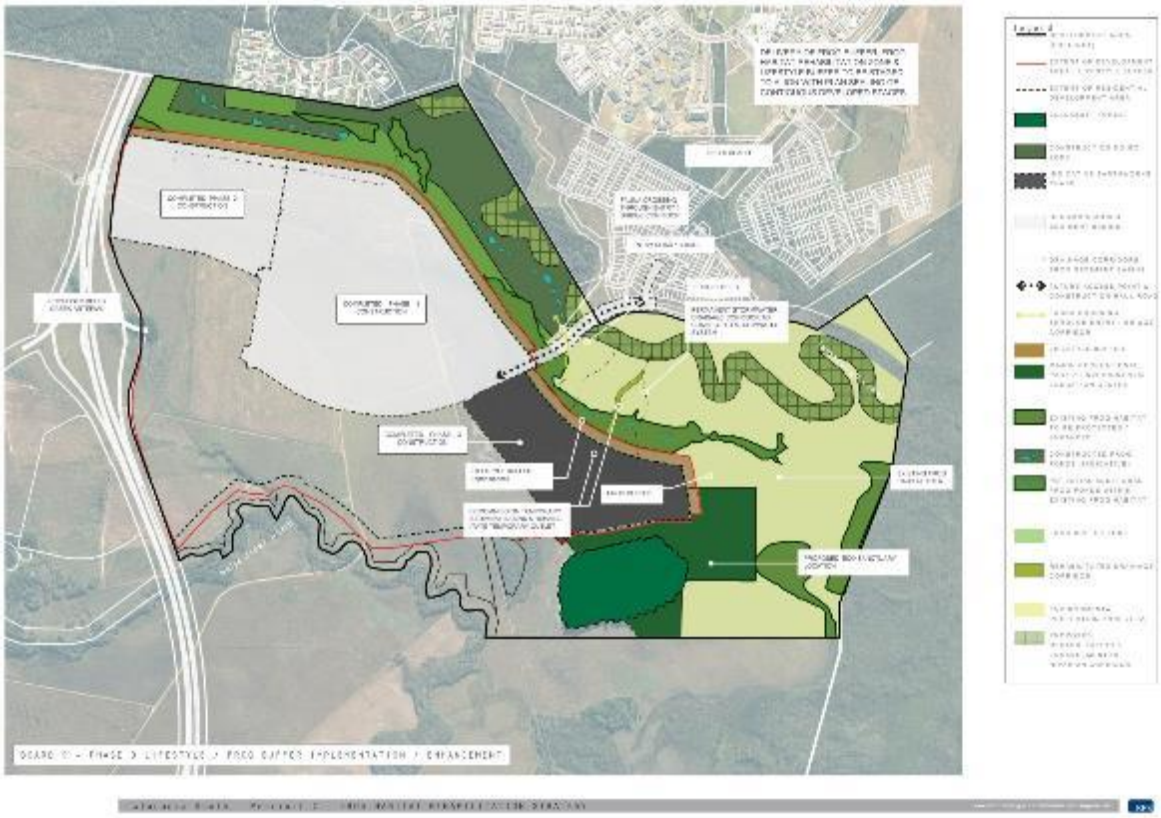


Figure B.6i: Board 9 (updated 02/2015) - Lifestyle / Frog Buffer Implementation/ Enhancement

Figure B.6j: Board 10 (updated 02/2015) – Phase 4 Bulk Earthworks/ Lifestyle/ Frog Buffer Implementation/ Enhancement

Table B.6a outlines the key steps during each construction phase as identified Figures 5.6a-j, in maintaining Wallum Sedgefrog corridor connectivity within the Frog Zone and Buffer Zone of Precinct 2. As shown in this Table, the construction of Wallum Sedgefrog habitat ponds within the Frog Zone and Buffer Zone are staggered so as to avoid wide scale disturbance of the northern corridor.

Planting within the created Wallum Sedgefrog habitat ponds should occur when suitable water levels and climatic conditions are present. This can be defined as at least 5cm water depth within the ponds and a climatic outlook favouring wet conditions.

Every created and retained habitat pond within Precinct 2 will be assigned a specific identification number and their boundaries mapped. The success criteria discussed in Section 4.2 will refer directly to these pond identification numbers.

Frog Zone and Frog Buffer

Upon completion and planting of the created habitat ponds, remaining areas within the Frog Zone and Buffer Zone are proposed to be managed in two stages:

- Stage 1 – Slashing/chopper rolling area in between created and retained habitat ponds to a minimum height of 400mm.
- Stage 2 – Supplementary planting and weed control.

Stage 1 is designed to maintain existing vegetation within the Frog Conservation and Buffer Zone to allow movement between created and retained habitat ponds. While this management technique is sufficient to maintain corridor connectivity, it would not be effective in establishing a low maintenance Frog Conservation and Buffer Zone.

Stage 2 consists of the rehabilitation of the Frog Zone and Buffer Zone within Precinct 2 and its focus is weed control and supplementary planting. This is intended to deliver minimal weed presence and the correct assemblage of plants within the area of the habitat corridor.

Biannual vegetation monitoring throughout the Frog Conservation and Buffer Zone will be undertaken to guide maintenance activities. Section 6 presents detail on monitoring tasks, time and reporting commitments.

Table B.6a: Maintenance of corridors within the Frog Conservation and Buffer Zone.

Construction phase	Frog movement →	→	→	→	→
Pre-construction (current)	Habitat polygon 44		Habitat polygon 45	Northwest of site	Off site
Phase 1	Southeast of habitat polygon 44 (Environmental No Go Zone)	Phase 1 Frog Zone works including Wallum Sedgefrog pond creation and temporary drainage corridor construction	Habitat polygon 45 (Environnemental No Go Zone)	Northwest of site (Environmental No Go Zone)	Off site
Phase 2	Southeast of habitat polygon 44, temporary drainage corridor construction	Phase 1 Frog Zone including Wallum Sedgefrog pond creation (Environmental No Go Zone)	Habitat polygon 45 (Environnemental No Go Zone)	Northwest of site (Environmental No Go Zone)	Off site

Phase 3	Southeast of habitat polygon 44 (Environmental No Go Zone)	Phase 1 Frog Zone including Wallum Sedgefrog pond creation (Environmental No Go Zone)	Habitat polygon 45 (Environnemental No Go Zone)	Phase 3 Frog Zone works including Wallum Sedgefrog pond creation	Off site

Note: grey shading indicates where Wallum Sedgefrog habitat construction activity will be undertaken.

B.7 Wallum Sedgefrog Pond Construction

Construction methodologies for the creation of Wallum Sedgefrog habitat ponds will be outlined in a Construction Environmental Management Plan, encompassing a comprehensive Construction Technical Specification, commissioning and operational/maintenance plan prepared at the detailed design phase of the project. The construction of the Wallum Sedgefrog habitat ponds will follow four stages:

1. Construction mark out;
2. Topsoil stripping and bulk earthworks;
3. Topsoil spreading and fencing; and
4. Pond planting.

Each stage will subject to an operational policy, performance criteria, implementation strategy, monitoring, corrective action strategy and reporting.

Stage 1: Pond mark out and confirmation of transport routes, soil management and drainage

Following the mark out of the proposed Wallum Sedgefrog habitat ponds to be created, their location and suitability will be confirmed by a qualified Environmental Consultant familiar with the Wallum Sedgefrog habitat requirements and recreation of the northern corridor within Precinct 2.

Additionally, the access route for earthmoving equipment into and through the Frog Zone and Buffer Zone will be discussed with the contractor and confirmed appropriate. Topsoil excavated from the frog ponds is permitted to be placed within Frog Zone and Buffer Zone, however subsoil excavated from the frog ponds must be transported and stored outside of the Frog Conservation and Buffer Zone.

Existing and proposed drainage infrastructure from the broader construction site will be reviewed and discussed with the Contractors Site Manager / Superintendent during Construction Hold Point 1 (Table 5.7a). Specific focus will be placed on the drainage to and from the temporary sediment basins so as to ensure that stormwater runoff from the temporary sediment basins passing through the Frog Zone and Buffer Zone does so in such a way that it does not directly connect with either created or existing retained Wallum Sedgefrog habitat ponds.

The operational policy, performance criteria, implementation strategy, monitoring and reporting for this stage of the Wallum Sedgefrog Pond construction is detailed in Table B.7a.

Table B.7a: Construction Stage 1 Hold Point

Construction Stage 1 Hold Point	
Person responsible	Contracted Site Manager, Environmental Consultant
Issue	Location of proposed Wallum Sedgefrog habitat ponds, soil management and drainage from area of construction activities.
Operational policy	To ensure the correct location of the Wallum Sedgefrog habitat, drainage from the development and management of soils.
Performance criteria	• All ponds are located as per detailed design drawings. • No ponds are placed within existing deep drainage channels. • Drainage from the temporary sediment basins must be isolated from created and existing retained Wallum Sedgefrog ponds. • Sediment storage areas located outside Frog Zone and Buffer Zone, away from drainage lines that may enter created or existing retained Wallum Sedgefrog ponds.
Implementation strategy	Contractor will mark out the location of created and existing retained Wallum Sedgefrog ponds, development drainage channels and soil stockpile sites. This will be reviewed on site by the person responsible prior to any earthmoving beginning within Precinct 2.
Reporting	A Stage 1 hold point form will be completed and signed by person responsible, identify the performance criteria, confirming compliance and where relevant making recommendations to address any identified failures. This form will be prepared within the Construction Environmental Management Plan encompassing a detailed Construction Technical Specification prepared during the detailed design phase of the project. The Stage 1 hold point form will identify areas suitable within the Frog Zone and Buffer Zone suitable to accept drainage water from the temporary sediment basins.
Identification of failure	• Location of Wallum Sedgefrog ponds located within 30m of permanent drainage corridors. • Location of Wallum Sedgefrog ponds not consistent with detailed design drawings. • Drainage from temporary sediment basins would likely enter either created or existing retained Wallum Sedgefrog habitat ponds.
Corrective actions	• Re-locate Wallum Sedgefrog ponds • Re-locate drainage infrastructure • Re-locate sediment storage areas

Stage 2: Topsoil Stripping and Bulk Earthworks of Created Wallum Sedgefrog Ponds

Bulk earthworks can commence following the installation of Wallum Sedgefrog ponds including having appropriate set back distances to maintain corridor connectivity.

Following the sequencing plan outlined in Section B.6, the topsoil and bulk earthworks for each pond within a particular construction phase area would be undertaken. Construction activities within the Frog Conservation and Buffer Zone must be completed using tracked earthmoving machinery. Equipment proposed to be used to construct the Wallum Sedgefrog habitat ponds within Precinct 2 includes (Figure B.7a):

- Small tracked excavator (10t limit);
- Tracked skid steer loaders (50-80kw); and
- Tracked dump truck (<6t).

As discussed above, topsoil excavated from the frog ponds will be allowed to be placed within the Frog Zone and Buffer Zone, however subsoil excavated from the frog ponds must be transported and stored outside of the Frog Zone and Buffer Zone. Top soil stripping and bulk earthworks will be assessed and confirmed as appropriate during Construction Hold Point 2 (Table B.7b).

Specific focus will be put on the soil and groundwater conditions within the excavated ponds, ensuring they meet the proposed criteria detailed in Section B.4, i.e.:

- A pH range of generally between 3-5 (if groundwater is intercepted); and
- A soil texture of 'loamy sand'.

Excavator	Skid steer loader	Dump truck

Figure B.7a: Example of earthmoving equipment to be used

Table B.7b: Construction Stage 2 Hold Point

Construction Stage 2 Hold Point	
Person responsible	Contracted Site Manager, Environmental Consultant
Issue	Location of proposed Wallum Sedgefrog habitat ponds, soil management and drainage from area of construction activities.
Operational policy	To ensure the correct soil and groundwater conditions of proposed Wallum Sedgefrog habitat ponds.
Performance criteria	All excavated ponds have a soil texture consistent with a loamy sand. If groundwater is intercepted, pH must be between 3-5. No ponds are placed within existing deep drainage channels.

Construction Stage 2 Hold Point	
	No indication that material from top soil or sediment storage area entering existing retained Wallum Sedgefrog habitat ponds. No indication that surface water from the temporary sediment ponds are entering the Frog Zone and Buffer Zone in areas other than that which have been identified and approved in Stage 1 hold point documentation. Bulk out pond basins so as to achieve final pond depths (as measured from top of topsoil to top of batter, taking into account topsoil requirements consisted with: • Average depth between 5-67cm. • Minimum depth of 5cm. • Maximum depth of 100cm.
Implementation strategy	Review of detailed design plans and site assessment for the persons responsible.
Reporting	A Stage 2 hold point form will be completed and signed by person responsible, identify the performance criteria, confirming compliance and where relevant making recommendations to address any identified failures This form will be prepared within the Construction Environmental Management Plan encompassing a detailed Construction Technical Specification prepared during the detailed design phase of the project.
Identification of failure	• High content of clay soils in excavated holes, resulting in high pH water. • Evidence of surface water entering excavated holes or existing retained Wallum Sedgefrog habitat. • Movement of stored sediment. • Ponds excavated to shallow or too deep.
Corrective actions	• Re-locate Wallum Sedgefrog ponds to non-clay subsoil areas. • Manage drainage infrastructure to ensure effective flow away from Wallum Sedgefrog habitat. • Insure effective sediment and erosion controls. • Add or remove soil to ensure correct pond depths.

Stage 3: Topsoil Spreading and Fencing

Upon confirmation of successful Stage 2 works, the stored topsoil can be positioned back into the excavated ponds and fencing erected around each Wallum Sedgefrog habitat pond or group of ponds. The placement of topsoil is envisaged to be 20cm deep and extend across the entire base of each pond. This topsoil layer will deliver good plant establishment and correct water chemistry within the pond. Topsoil spreading will be completed with earthmoving equipment detailed in Stage 2 works above, with planting completed by hand. Topsoil spreading and fencing will be assessed and confirmed as appropriate during Construction Hold Point 3 (Refer Table B.7c)

Table B.7c: Construction Stage 3 Hold Point

Construction Stage 3 Hold Point	
Person responsible	Contracted Site Manager, Environmental Consultant
Issue	Topsoil spreading and fencing

Operational policy	To ensure the correct soil conditions of proposed Wallum Sedgefrog habitat ponds, correct topsoils depths so as to ensure correct pond water depths and appropriate fencing to protect against person or machinery intrusion/damage.
Performance criteria	• Topsoil depth of 10-30mm. • Final pond depths (as measured from top of topsoil to top of batter) consistent with: - Average depth between 5-67cm. - Minimum depth of 5cm. - Maximum depth of 100cm. • All excavated ponds and existing retained ponds to be contained within a highly visible fence.
Implementation strategy	Site assessment by the persons responsible following completion of fencing in accordance within the construction phase sequencing.
Reporting	A Stage 3 hold point form will be completed and signed by persons responsible, identify the performance criteria, confirming compliance and where relevant making recommendations to address any identified failures. This form will be prepared within the Construction Environmental Management Plan encompassing a detailed Construction Technical Specification prepared during the detailed design phase of the project.
Identification of failure	• Incorrect depths of topsoil. • Incorrect final depths of ponds. • Poorly visible fencing and/or ponds not fenced.
Corrective actions	• Re-lay topsoil. • Re-fence.

Stage 4: Planting

The final stage of the construction of the Wallum Sedgefrog habitat ponds involves the planting of each pond (Table B.7d). This stage may not happen directly following the completion of topsoil placement and fencing as groundwater and climatic conditions may not be appropriate. As mentioned earlier, an appropriated planting time can be defined as at least 5cm water depth within the ponds and a climatic outlook favouring wet conditions.

Table B.7d: Construction Stage 4 Hold Point

Construction Stage 4 Hold Point	
Person responsible	Contracted Site Manager, Environmental Consultant
Issue	Planting
Operational policy	To ensure the correct choice of plants, planting locations and planting methodology and timing.
Performance criteria	Adherence to the detailed planting plan, which will be completed during the detailed design phase of the project.
Implementation strategy	• Confirmation of planting list prior to planting by persons responsible. • Confirmation of the quality of plants prior to planting by persons responsible. • Site assessment by the persons responsible following completion of planting in accordance within the construction phase sequencing.

Construction Stage 4 Hold Point	
Reporting	A Stage 4 hold point form will be completed and signed by persons responsible, identify the performance criteria, confirming compliance and where relevant making recommendations to address any identified failures. This form will be prepared within the Construction Environmental Management Plan encompassing a detailed Construction Technical Specification prepared during the detailed design phase of the project.
Identification of failure	• Incorrect plant type. • Incorrect planting location of specific plant species. • Poor planting and establishment conditions.
Corrective actions	• Re-plant. • Irrigate if dry conditions likely.

B.8 Drainage Infrastructure

Temporary drainage corridors from sediment basins are proposed to be in place during the construction phase only, and be rehabilitated following the decommissioning of the temporary sediment basins. Temporary drainage corridors would bisect habitat polygons 45 and 44 at six locations within the Frog Zone and Buffer Zone of Precinct 2. These drainage corridors will provide a pathway to transport runoff from the temporary sediment basins located within the construction foot print of the Precinct 2 and shown on Figures B.6e, B.6g & B.6i.

Earthworks construction within Precinct 2 is to be undertaken in three phases:

- Phase 1 (Storyboard 5 - Figure B.6e), located centrally within the proposed development area, encapsulates 5 temporary sediment basins, 2 drainage corridors through the Frog Conservation and Buffer Zone and 1 drainage corridor through habitat polygon 45 to the north of the site.
- Phase 2 (Storyboard 7 - Figure B.6g), located in the southeast area of the proposed development area, includes 3 temporary sediment basins and 3 drainage corridors through habitat polygon 44.
- Phase 3 (Storyboard 9 - Figure B.6i), located in the far northwest of the site, incorporates 2 sediment basins which drain to the drainage corridor created in habitat polygon 45 in Phase 1 earthworks.

As shown in the accompanying storyboard figures (Figures 5.6a-j), temporary drainage corridors and temporary sediment basins are to be rehabilitated in accordance with the methods and sequencing outlined in Section B.6 and be subject to success criteria for the Frog Zone and Buffer Zone outlined in Section 4.2.

APPENDIX C: L. OLONGBURENSIS POPULATION AND DISTRIBUTION INFORMATION: TAKEN FROM THE 2012 PER STUDY OF THE SUBJECT SITE.

The below sections are taken from Chapter 9 of the 2012 Calundra South Public Environmental Report (PER), which documented the baseline population of the Wallum Sedgefrog across the subject site. In this extract of the PER (as well as Chapter 9 of the PER) you will read reference to the "atypical" or "abnormal" survey conditions. These "atypical" or "abnormal" survey conditions were cuased by two main factors:

1. The 2012 survey of the Wallum Sedgefrog population occurred during abnormally wet climatic conditoins (refer to Appendix A) with rainfall over the survey period being greater than the historical 85th%ile (refer Table A.2). and
2. The vegetation across much of the site was dominated by grasses due to pine plantation removal, cattle grazing and active woody tree removal (via dozer/chopper rolling).

These two factors resulted in the wide spread inundation of the site (due to high rainfall), and the increased and prolonged water table across the height due to reduce groundwater usage by trees. The relatively large amount of low quality Wallum Sedgefrog habitat (detailed below and in Chapter 9 of the PER) recorded during the 2012 survey reflects the impact of the above two factors on the survey results.

Methods and survey conditions

A preliminary desktop and field-based assessment of habitat values undertaken early in the Project (including a review of previous studies carried out on site), suggested that Wallum Sedgefrog populations were restricted to habitats in the north-eastern portion of the Study Site (see Section C9.1.3.3, PER 2012). Field methods, which included visual (transect) and aural counts, were initially developed to rigorously sample the abundance of Wallum Sedgefrogs in these locations. At the start of the second week of survey, it was discovered that Wallum Sedgefrogs were distributed more broadly, inhabiting atypical non-remnant habitats including areas dominated by exotic grasses (e.g., central and southern portions of the Study Site). In order to characterise frog distribution, field methodology was modified to enable the approximately 2400ha site to be covered within the time period. Transect counts were replaced with timed search counts and aural census. Table C9.2.7 within the 2012 PER details the extensive survey effort undertaken.

Habitat and subpopulation Recognition

Throughout the study, survey teams broadly traversed the Study Site recording the presence of Wallum Sedgefrogs using either visual encounter methods or aural census (further detailed below). In addition surrounding habitats were also searched, particularly within the Stockland land holding to the south (i.e., the Halls Creek land). Permission was gained for access to all land prior to entry.

All records of Wallum Sedgefrogs within the Study Site, irrespective of abundance, were plotted over satellite photography. Using three separate aerial satellite images, habitat polygons were defined around records according to aerial signatures consistent with surface water and/or sedges. Habitat polygons were continually modified during the field investigations as teams inspected and verified suitable conditions and locations. Despite these efforts, it is acknowledge that in some locations the extent of suitable habitat may vary slightly

from mapped polygons. Habitat attributes (e.g., abundance and recruitment potential), which are later assigned to these polygons, are conservative and based on the highest recorded.

It is recognised that some Wallum Sedgefrog records fall outside mapped habitat patches. These may reflect either transient individuals which do not appear to be associated with any suitable habitat (e.g. the lack of surface water), or small pockets of habitat too minor in extent to warrant mapping. It is recognised that some potential habitats do not have a discernible aerial signature. While it is possible that some habitats may have been overlooked, extensive traversing of the site (Figure C9.2.1, refer to PER 2012) during suitable conditions suggests this is unlikely.

While surveys focused on quantifying the extent of frogs within the Study Site, some effort was undertaken within surrounding properties (e.g. Lot 504, Halls Creek etc), with permission from the land owners, to establish the presence of Wallum Sedgefrogs. Mapping of habitat and subpopulation extent was not undertaken in surrounding properties.

Frog Abundance/Presence/ Absence Data

Commonwealth survey guidelines for referral under the EPBC Act (DEWHA2010), and discussion with relevant QPWS staff, indicated that field surveys for Wallum Sedgefrogs should include both call detection and visual encounter (search) components.

Visual counts

Transect counts utilise two ecologists searching vegetation within one metre of a 50m long transect established in suitable vegetation. Transects are surveyed at night using head torches, and dense vegetation is parted or moved following an initial scan. The time that the search started and ended was recorded for each individual transect.

This technique allows the number of observed frogs to be counted, but is time consuming (approximately one hour per transect, depending on vegetation and frog density).

Following the discovery that Wallum Sedgefrogs were more widely distributed, the methodology was modified. Teams searched an area of suitable habitat in a grid pattern for approximately 20 minutes, although more or less time was allocated depending on the extent of habitat. In all cases, the search duration (minutes) was recorded in order to allow relative abundance estimates per unit time.

Counts of calling animals Counts of calling animals were used to supplement visual counts. This method consisted of two ecologists listening from a single location for a duration of five minutes for the distinctive call of the Wallum Sedgefrog. The number of individuals heard calling within approximately 30m1 of the observers was noted.

Opportunistic presence/absence data

Throughout the survey, teams collected opportunistic records (visual encounters or calling individuals) of Wallum Sedgefrogs. This provided spatial data and assisted in mapping the extent of the species, but does not contribute to abundance estimates.

Relative abundance

In order to assess habitats not previously surveyed, some locations that were sampled early in the study using transect counts were not re-surveyed using timed area counts. Furthermore, frog numbers in smaller habitat patches may have only been estimated using call census. Accordingly the study does not use a uniform methodology to compare abundance.

In order to evaluate and compare different populations, abundance criteria were developed using quartiles within the different data streams. To facilitate the ranking, visual encounter records (i.e. transect or search area) were standardised to reflect the number of observed frogs per five minute unit. Using these criteria, relative abundance can be ranked according to four categories; high, moderate, low and very low (Table C9.2.2.).

Once identified a habitat patch (which represent subpopulations) may be attributed according to the highest abundance category recorded in that polygon. It is recognised that this may overestimate abundance in some patches and frog density is unlikely to be uniform in all areas of sedge vegetation. As such, the estimate is conservative in nature.

Table C9.2.2: Criteria for assessing relative abundance

Relative abundance	Criteria
High	Standardised aural census count >third quartile for all aural census counts (i.e., >5 frogs/ 5 min census). OR Standardised transect count > third quartile for all transect counts (i.e., >0.39 frogs/5 minutes survey). OR Standardised visual search count > third quartile for all visual search counts (i.e., >1.73 frogs/5 minutes survey).
Moderate	Standardised aural census count > second quartile and ≤ third quartile for all aural census counts (i.e., 3-5 frogs). OR Standardised transect count > second quartile and ≤ third quartile for all transect counts (i.e., 0.30-0.39 frogs/5 minutes survey). OR Standardised visual search count > second quartile and ≤ third quartile for all visual search counts (i.e., 0.76-1.73 frogs/5 minutes survey).
Low	Standardised aural census count > than first quartile and ≤ second quartile for all aural census counts (i.e., 2 frogs). OR Standardised transect count > first quartile and ≤ second quartile for all transect counts (i.e., 0.23-0.29 frogs/5 minutes survey). OR Standardised visual search count > first quartile and ≤ second quartile for all visual search counts (i.e., 0.3-0.75 frogs/5 minutes survey).
Very Low	Standardised aural census count ≤ first quartile for all aural census counts (i.e., <1 frog). OR Standardised transect count below first quartile for all transect counts (i.e., ≤ 0.22 frogs/5 minutes survey). OR Standardised visual search count below first quartile for all visual search counts (i.e., ≤ 0.34 frogs/5 minutes survey).
Unknown	Non standardised count data available for comparison.

Patch evaluation

Wallum Sedgefrogs are distributed across the Study Site in distinct habitat patches, however these patches may not contribute equally to the overall long-term viability of the local population. To evaluate their relative

importance, habitat patches are ranked using a variety of criteria. These criteria have been divided into two groups according to their ecological importance; *Diagnostic* criteria and *Essential* criteria (Table C9.2.7). The *Diagnostic* criteria are initially applied according to a consistent set of rules to evaluate the patch:

1. *Low*: Breeding 2011/12 = Unlikely AND Abundance = No records;
2. *Very High:* All remaining records AND *both* Corridor and Refugia = Likely;
3. *High*: All remaining records AND *either* Corridor or Refugia = Likely; and
4. *Moderate*: All remaining records.

If further clarification is required, then the results may be refined by Essential criteria as necessary. These criteria were then attributed into a GIS database to allow individual inspection and greater transparency

Table C9.2.7: Patch evaluation criteria

DIAGNOSTIC CRITERIA		
Criteria	Scores	Description
Frog Abundance	High Moderate Low Very Low	Habitat patches assigned appropriate score based on standardised abundance (see 2.1.2). Polygons were tagged with the highest estimate when multiple estimates were undertaken within an individual polygon.
Breeding 2011/12	Confirmed Highly Likely Likely Possible Unlikely Unknown	A representation of breeding success during the extremely wet summer of 2011/12. Habitat patches were assigned with the highest breeding score (see 2.1.3).
Refugia	Likely Possible Unlikely	Each habitat patch was ranked according to perceived likelihood of breeding during drought/dry years. Results were based on surface water modelling (i.e., % flood frequency) and polygons ranked *in their entirety* based on their wettest area(s).
Corridor	Likely Possible Unlikely	A reflection of the likely contribution of the habitat patch to local area movement and genetic flow (i.e. movements/flow through the Study Site to/ from populations outside the Study Site).
ESSENTIAL CRITERIA		
Patch size	Large Moderate Small Very Small	Patch/polygon size (ha) ranked according to quartiles. Large = >3.26; Moderate = >1.71-3.26; Small = >0.59-1.71; Very Small = 0-0.59.

Survey Conditions and Limitations

Surveys for Wallum Sedgefrogs have occurred at several stages throughout the project, resulting in an accumulation of data. Early studies were conducted in October and November 2010 and contributed to the initial referral of the Project (see EcoSmart Ecology 2011). Recent studies were initiated in response to the PER requirements in early 2012. In total, eight surveys of varying length have been conducted during a variety of conditions. The purpose of each survey, its duration and number of ecologists collecting data is provided in Table C9.2.8 of the PER 2012.

The bulk of survey effort was conducted between January and March 2012, particularly March when three teams of two ecologists undertook abundance/presence surveys and sampled for Wallum Sedgefrog tadpoles. For the most part, surveys were undertaken under warm, wet conditions with significant rainfall during and/or preceding survey events (see Figure C9.2.8a of the PER 2012.). As such, survey conditions were excellent. Little

rainfall occurred prior to, or during, surveys on the 14th and 15th of February and a light breeze was experienced during the evening of the 6th March. These conditions may have reduced frog activity on this date, but most areas were re-surveyed during more suitable conditions.

Rainfall during summer 2011/2012 was well above average, with 630.5mm of rain recorded in January alone (the highest total for January in 26 years of data). Rainfall for March 2012 was also well above average, exceeding the 90th percentile for March. Rainfall in the 12 months preceding surveys (i.e., for the 2011 calendar year) was also well above average (2221 vs. 1688mm). The year before (i.e., 2010) was the wettest on record at Corbould Park Racecourse with rainfall totalling 2664.5mm over 12 months. Above average summer rainfall has been the predominant pattern since the summer of 2008/09 (FigureC9.2.8b of the PER 2012).

Existing Conditions

Extent of occurrence Wallum Sedgefrogs

During surveys, Wallum Sedgefrogs were recorded at numerous locations across the Study Site (Figure C9.3.1). Of the 400 or so Wallum Sedgefrog records amassed during surveys, the majority (> 90%) were from low-lying areas with standing water, sedges and grass cover. In Google Earth™ satellite imagery (dated 06/05/2011), these areas appear as discrete, darker patches of habitat readily distinguishable from surrounding, drier habitat on slightly higher ground.

Using this imagery , along with extensive field-based observations, 94 discrete patches of potential Wallum Sedgefrog habitat were identified on site (encompassing an area of approximately 263.94ha, or 11.15% of the Study Site) (see Figure C9.3.1). Almost all of these (i.e., 90 habitat patches; 96% of the total number identified) were surveyed for frogs. Those areas of potential habitat which were not surveyed for frogs are small in size (i.e. < 0.38ha) except for habitat patch 84 (2.3ha) (see Figure C9.3.1). Surveys were not undertaken at this larger site due to chopper-rolling undertaken during the survey period. Given its connection to other subpopulations through remnant vegetation, and the presence of suitable habitat prior to chopper rolling, this area is likely to be inhabited by Wallum Sedgefrogs.

Wallum Sedgefrogs were recorded from 82 of 94 (~89%) habitat patches surveyed. Areas of occupied habitat were identified within all three catchments of the Study Site: Bells Creek North, Bells Creek South and Lamerough Creek.

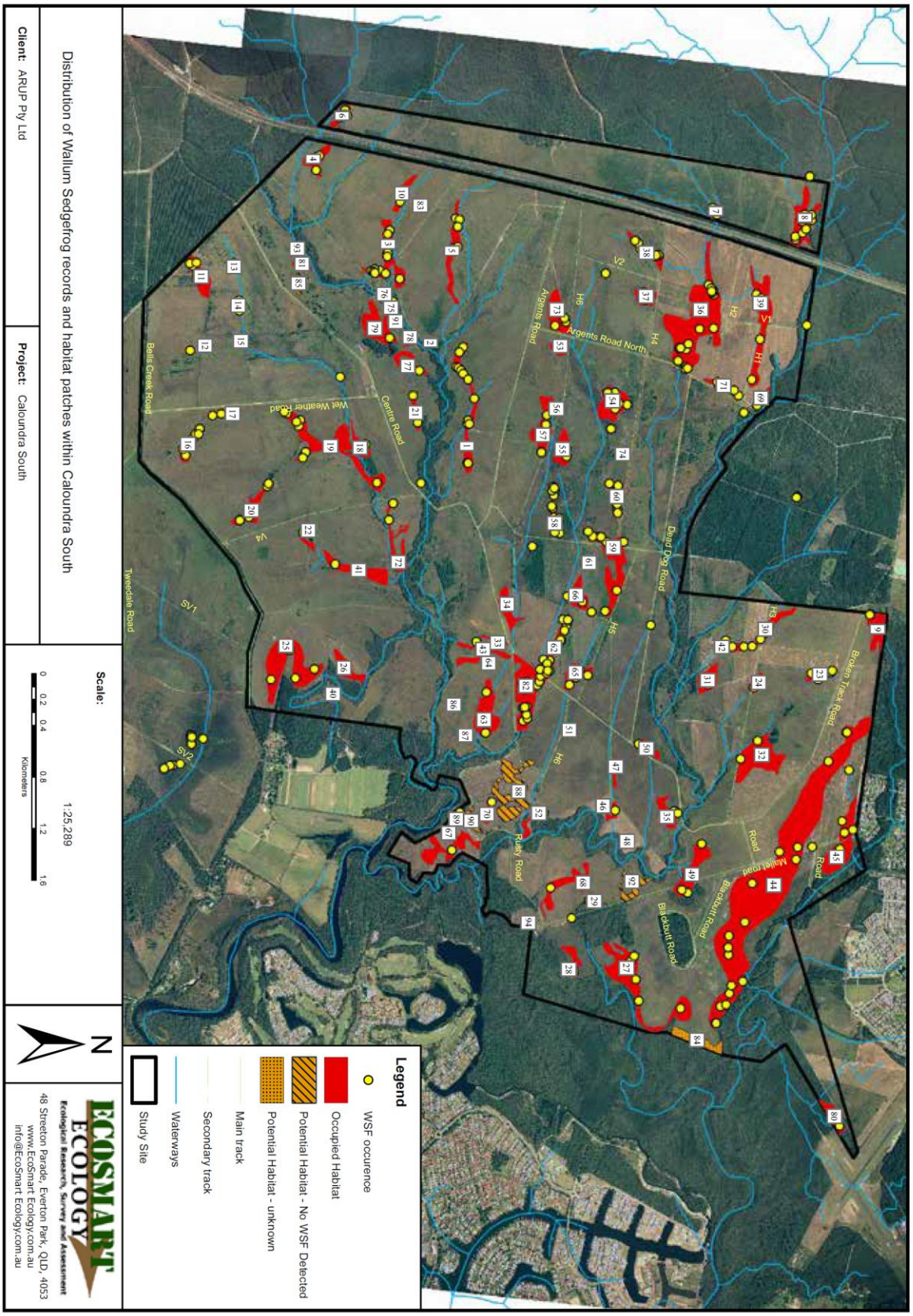
Occupied habitat patches were mostly located in low-lying areas with free-standing water in proximity to, but set back from, creek and/or drainage lines. A number of sedgefrog records were associated with habitat situated in areas of slightly higher elevation (e.g., habitat patch 1, 16, 11 and 23).

Occupied habitat patches were generally small (i.e., <10ha in size), with larger areas of habitat restricted to the north-east (e.g., habitat patch 44: 46.6 ha) and west of the site (habitat patch 36: 16.4 ha) (see Figure C9.3.1). Distances between most habitat patches are short (at most 500m) and many lie immediately adjacent one another, separated only by minor tracks (e.g. habitat patches 62, 82, 22, 43 and 64) or artificial drains (e.g. habitat patches 18 and 19). Some habitat patches, such as 8, 9, 27, 28 and 29, directly adjoin remnant habitat and populations within these areas are likely to be larger in extent than indicated in Figure C9.3.1, or possibly even contiguous with one another (e.g., habitat patch 44, 84, 27, 28 and 29). With most areas of habitat separated only by furrowed grass/sedgeland, movement of Wallum Sedgefrogs between occupied habitat patches appears likely. Thus, rather than representing discrete, isolated populations, occupied habitat patches appear to form part of a larger metapopulation (i.e., a network comprising of numerous interconnected subpopulations) incorporating lands within and immediately adjacent the Study Site..

While mostly unsuitable for Wallum Sedgefrog, land west of the Bruce Highway (included within the Study Site) does support small areas of occupied habitat, the largest lies adjacent to Bells Creek North. Aggregations of Wallum Sedgefrog were also recorded in the adjacent State Forest in remnant vegetation associated with Bells Creek North.

Elsewhere outside the Study Site, Wallum Sedgefrogs were recorded from land within the Hall's Creek area (to the near south of the Study Site); and Council-owned land to the immediate north (Lot 504). On the basis of satellite imagery, it appears suitable habitat is also present to the immediate west of the south-western corner of the Study Site and to the east in Lot 480. Remnant wet heath and sedgeland within Lot 800 and the Caloundra Aerodrome, to the north and east of the Study Site, also appears highly suitable for Wallum Sedgefrogs.

Figure C9.3.1: Distribution of Wallum Sedgefrog records and habitat patches within Caloundra South



Recruitment (2011/12)

Metamorph and/or juvenile frogs (snout-vent length <20mm) were recorded on 28 separate occasions from January-March 2012, confirming successful breeding on site. Metamorph and/or juvenile Wallum Sedgefrogs were found at 19 out of 90 habitat patches surveyed during 2011/2012. These patches are shown as 'Confirmed' breeding habitat in Figure C9.3.2a.

As shown in Figure C9.3.2a, successful breeding was documented within Bell's Creek North, Bell's Creek South and Lamerough Creek catchments. The number of sites with successful breeding was lowest in the Bells Creek South catchment, where successful breeding was confirmed within 5 discrete habitat patchers. Three of these are extremely small habitat patches, less than 0.4ha while the remaining two were much larger (habitat patch 25: 4.3ha and 79:9.3 ha). Larger areas of confirmed breeding habitat occurthrough the centre of the site north of Bell's Creek South. This includes one of the larger habitat patches on site, polygon 36 (see Figure C9.3.2a).

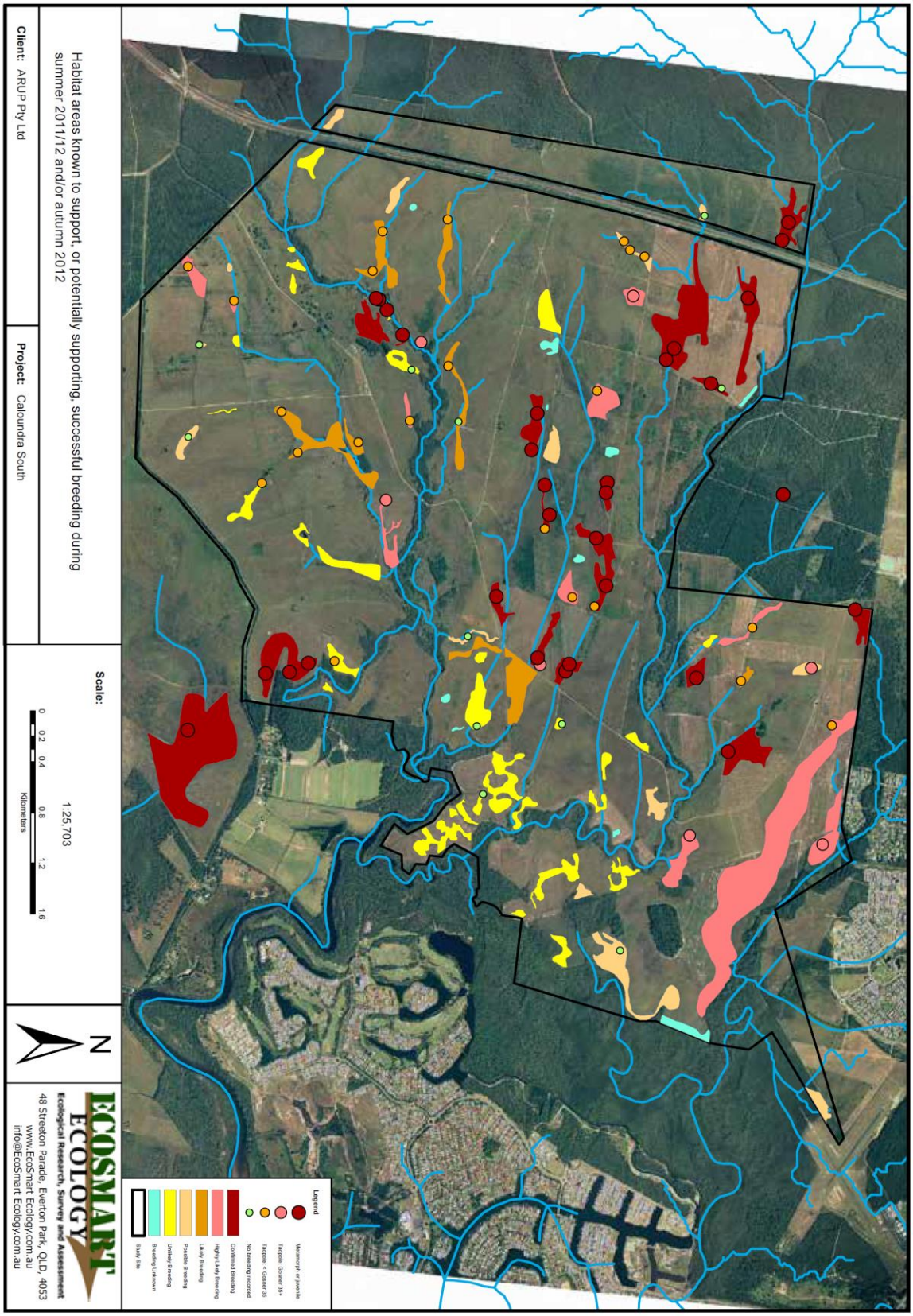
Wallum Sedgefrog tadpoles were found at another 28 sites within the Study Site, indicating widespread breeding during January-March 2012. Tadpole records were mostly of early stage (i.e., pre-Gosner stage 26) animals with late stage tadpoles (Gosner stage 35 or greater) detected at relatively few (6) survey sites. No evidence of breeding was located at eleven survey locations, despite the presence of adult frogs and apparently suitable breeding habitat (including habitat patch 7, 16 and 27, where sedgefrogs were recorded in good numbers [i.e., >10 frogs/20 minute search]). Some of these sites were surveyed for tadpoles under very wet conditions (i.e., following very heavy rainfall) with rising water levels.

Under such conditions, detection of Wallum Sedgefrog tadpoles may have been significantly reduced (especially in areas of deeper water with more open vegetation, wheredensities of tadpoles are likely to be low). Breeding at these sites therefore cannot be discounted and, as such, areas in this category have been labelled as 'Possible' breeding habitat (see Figure C9.3.2a).

It should be noted that the current assessment of breeding success is based on unusually wet conditions during summer 2011/2012 and autumn, 2012. Regular and heavy falls were experienced during this period, with over 600 mm of rain recorded in both January and February (see Figure C9.2.8a and C9.2.8b of the 2012 PER). The extent of surface water during surveys is likely to have been far greater than would be expected in an average (and drier) year. In many areas, surface water is also likely to have persisted longer than might normally be the case. Thus, under drier conditions, the extent of habitat known or likely to support successful breeding would be likely significantly less than shown in Figure C9.3.2a.

It should also be recognised that breeding success has been assigned to individual polygons based on the highest reproductive rank identified during field surveys. These surveys did not sample polygons in a systematic grid, and. as such, it is not known if reproductive potential is uniform throughout the polygon.

Figure C9.3.2a: Habitat areas known to support, or potentially supporting, successful breeding during summer 2011/2012 and/or autumn 2012



Habitat Patch size

Habitat patches identified during surveys over Summer 2011/12 ranged in size from 46.6ha to 0.08ha (average 2.8ha). The larger patches (ranging in size from 3.3 to 46.6ha) are relatively evenly spaced across the Study Site, occurring in all three catchment areas (see Figure C9.3.4). Smaller patches are slightly more common within the Bells Creek South catchment, but can be found scattered throughout the Study Site.

Relative Abundance

Standardised call census data and visual count data (standardised for timed survey effort) were used to compare abundance estimates across habitat patches (as explained in previous sections). On the basis of this comparison, habitat patches were assessed as having either a high, moderate, low or very low relative abundance of Wallum Sedgefrogs (see Figure C9.3.5a).

As shown in Figure C9.3.5, areas of habitat with higher abundances of Wallum Sedgefrog occur in the south, north- west, north-east and centre of the Study Site. These areas include both remnant and (mostly) non-remnant habitat in the form of furrowed grass/sedgeland (in what was formerly pine plantation). Areas of non-remnant habitat with very low abundance or no Wallum Sedgefrogs occur mainly in the centre-east of the site (mostly in the vicinity of Rusty and Mallet Roads). Despite similarities with areas supporting higher abundances of sedgefrogs elsewhere on site, surveys of suitable habitat in this part of the site have turned up only a handful of frogs.

Outside of the Study Site, Wallum Sedgefrogs were recorded in relatively high abundances within Lot 504 (at GM0803). The number of Wallum Sedgefrogs encountered within the Halls Creek property was notably lower than encountered elsewhere. Numbers of Wallum Sedgefrog were especially low (e.g., three frogs in >3 search hours) in the area of sedgeland swamp located between Tweedale Road, Orchid Road and east of SV3 where frogs were rarely encountered (Figure C9.2.5c). Counts increased to 'Low' and 'Moderate' abundance levels in habitat further upstream (near and west of SV2). Numbers of frogs in this part of the Hall's Creek catchment may, however, have been reduced following fire in August 2011.

The assessment of relative abundance presented in Figure C9.3.5a, assumes that abundance estimates are representative of patches as a whole. In reality this is unlikely to be the case, with sedgefrogs tending to aggregate in certain areas within most habitat patches. As such, the assessment of relative abundance provided in this figure may not be entirely accurate.

Notwithstanding the aforementioned limitations, abundance data from surveys carried out over summer 2011/2012 suggest that the Study Site supports a Wallum Sedgefrog population numbering in the hundreds. Based on raw count data, the minimum number of adult animals on site is estimated at around 700 animals across the approximately 2,400 hectare site. Given that habitat patches weren't surveyed in their entirety, the actual number of Wallum Sedgefrogs present during the survey could have been higher.

Figure C9.3.4: Ranked habitat patch size

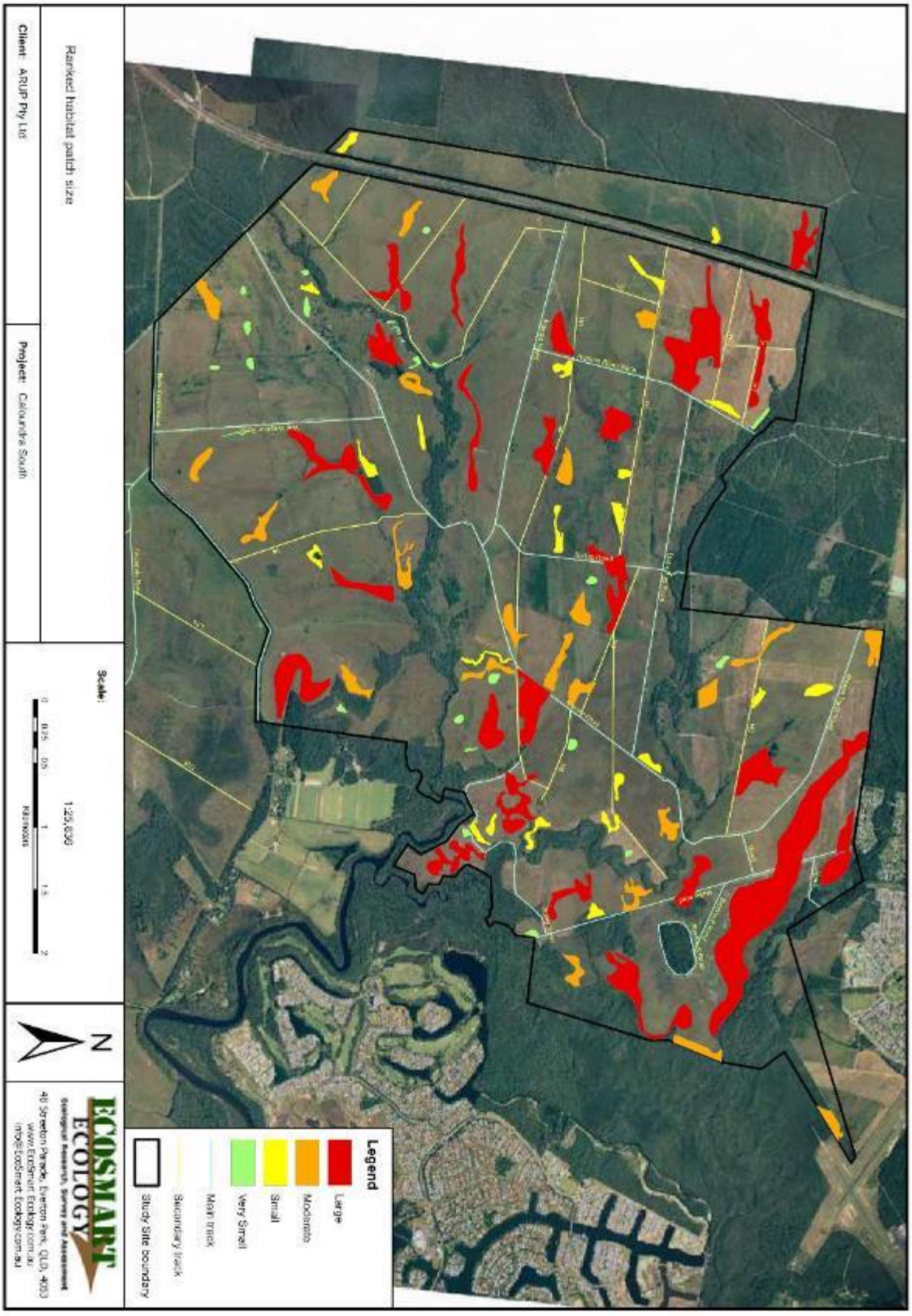


Figure C9.3.5a: Standardised relative abundance of Wallum Sedgefrogs within the Study Site