FOI 190207
Document 1

DEPARTMENT OF THE ENVIRONMENT AND ENERGY

To: James Barker, Assistant Secretary, Assessments and Governance Branch (for decision)

Proposed Approval Decision Brief (recommendation report) – Shoreline urban village development, Redlands Bay, Qld (EPBC 2016/7776)

Timing: As soon as practicable. A final decision was due 6 November 2017.

Recommendation/s:

1. Consider the information in this brief, the recommendation report at **Attachment A**, the finalised preliminary documentation at **Attachment B** and other attachments to this brief.

[✓ Considered] / please discuss

2. Agree that the recommended decision on page 19 of the recommendation report (**Attachment A**), and summarised in the table below, reflects your proposed decision.

[✓ Agreed] / Not agreed

3. Sign the letter at **Attachment C** to consult the proponent, who is also the person proposing to take the action, on your proposed decision.

[✓ Signed] / Not signed

4. Agree to not publish the proposed decision at **Attachment D** on the internet for public comment.

[✓ Agreed] / Not agreed

Summary of recommendations on each controlling provision:

Controlling Provisions for the action	**Recommendation**	
	Approve	**Refuse to Approve**
Wetlands of international importance (s 16, 17B)	Approve	
Listed threatened species and communities (s 18, 18A)	Approve	
Listed migratory species (s 20, 20A)	Approve	

James Barker, Assistant Secretary, Assessments and Governance Branch:

Date: 3/4/18

Comments:

Background:

1. This brief seeks your proposed approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) of Shoreline Redlands Pty Ltd's (the proponent) proposal to develop an urban village within a footprint of 279.5 hectares in Redland Bay, Queensland.

2. The proposed action is an urban village development consisting of approximately 3,800 homes, a town centre, a school, recreational and sporting facilities, restaurants and foreshore park (See map at **Attachment B1**). No development will occur within the boundary of the Moreton Bay Ramsar wetland and an open space precinct will ensure that there is a buffer between residential and commercial buildings and the Moreton Bay Ramsar wetland.

3. The referral site is mostly cleared for agricultural land uses, with scattered individual trees and vegetated patches associated with drainage lines. The east boundary of the subject site abuts the Moreton Bay Ramsar wetland. Land to the west of the subject site is heavily vegetated and forms part of a larger tract of bushland supporting both remnant and non-remnant vegetation.

4. On 19 December 2016, the proposed action was determined a controlled action due to likely significant impacts on a wetland of international importance (Moreton Bay Ramsar wetland), migratory species and listed threatened species and communities. On the same day it was determined the proposed action would be assessed by preliminary documentation.

5. On 5 January 2017, the Department requested the proponent provide further information to:

   - quantify impacts to Moreton Bay Ramsar Wetland and evaluate the effectiveness of measures proposed to mitigate these impacts;

   - quantify impacts to the koala through degradation of habitat as a result of edge effects and ongoing mortality due to dog attack and vehicle strike;

   - evaluate the effectiveness of measures proposed to mitigate impacts to koalas;

   - quantify impacts to the eastern curlew and evaluate the effectiveness of measures proposed to mitigate these impacts; and

   - determine residual significant impacts and offset requirements in accordance with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*.

6. The proponent submitted the finalised preliminary documentation on 11 September 2017.

Issues/ Sensitivities:

- The eastern boundary of the proposed action abuts the boundary of the Moreton Bay Ramsar Wetland. Key potential impacts from the proposed action are changes to water quality, increased anthropogenic noise and light, and direct impacts from people or dogs disturbing foraging birds. This is likely to impact on adjacent migratory species habitat, including foraging habitat for the critically endangered eastern curlew (*Numenius madagascariensis*).

7. The project design and management measures required by the local council and committed to by the proponent, will reduce the impacts of the project. The management measures include:

    a. A water management plan, in accordance with Queensland Government requirements.

    b. An open space strategy, which includes fauna sensitive road design as well as provisions to retain, protect, restore and manage koala habitat.

    c. An *Eastern Curlew Impact Management Plan,* to ensure the density of eastern curlews post development are reflective of pre-development baseline densities.

8. The proponent undertook surveys of habitat adjacent to the western boundary of the site and did not identify koalas. The Department considers that the project will not result in a significant impact to the koala, given the:

    a. limited area of koala habitat on site; 15 ha spread across approximately 280 ha;

    b. small direct impact to koala habitat of 3.72 ha; and

    c. management plans to improve koala habitat and develop fauna sensitive road design.

9. The Recommendation Report (**Attachment A**), prepared in accordance with Section 95C of the EPBC Act, concludes that the proposed action should be approved under sections 130 and 133 of the EPBC Act subject to the proposed conditions recommended by the Department (see proposed approval notice at **Attachment D**). This conclusion was reached by having regard to the likely impact of the proposed action for the purposes of each controlling provision and the relevant social and economic considerations under section 136 of the EPBC Act.

10. The Department recommends a number of conditions to define the scope of the action and to enhance management measures committed to by the proponent. These recommended conditions are summarised below:

    - a condition to limit the proposed action to within the project boundary as referred (condition 1 at **Attachment D**);

    - a condition to ensure that the open space precinct (Foreshore Subprecinct), as included in the referral design, is implemented (condition 2 at **Attachment D**);

    - conditions to enhance the *Eastern Curlew Impact Management Plan – Shoreline Redlands – 20 July 2017*, including requirements for scientifically robust monitoring, to establish a clear understanding of the baseline conditions, to detect impacts and to implement contingency measures to respond to any impacts, if necessary (conditions 3, 4, 5 and 6 at **Attachment D**); and

    - conditions to enhance the *Shorelines Redland Water Quality Management Plan – June 2017*, including requirements for scientifically robust monitoring to establish a clear understanding of the baseline conditions and to detect impacts, and to implement contingency measures to respond to any impacts, if necessary (conditions 7, 8 and 9 at **Attachment D**).

11. The proponent has been given the opportunity to review the proposed conditions. The key concerns raised were in regards to:

a. the period of approval;

b. additional requirements to collate baseline data and refine monitoring to implement the eastern curlew and water management plans; and

c. buffers proposed to avoid construction impacts on eastern curlew prior to baseline data being collated.

All the proponent's comments and summary tables of how these have been addressed are at **Attachment E**.

12. The proponent has been invited to provide further comment on the revised proposed conditions of approval in the letter for your signature at **Attachment C**.
13. The proponent has no known record of adverse environmental history and the Department has no reason not to have confidence that they will fully implement all conditions.
14. There was one comment received by the Quandamooka Yoolooburrabee Aboriginal Corporation (QYAC) (**Attachment F**) during the public comment period. This comment concerned the rights and culture of the Quandamooka People as well as raising issues of further engagement and economic opportunities.
15. The proponent has demonstrated historical efforts to engage with the QYAC and has subsequently commenced discussions with the QYAC to engage and address concerns.

Public submissions on assessment documents

Number	1	For	0	Against	0	Not specified	1

Consultation:

16. In developing this brief the Department has consulted with the Marine and Freshwater Species Conservation Section, Monitoring and Audit as well as the Intelligence Team.

s22

Director
QLD South and Sea Dumping
Assessments and Governance Branch
Ph: s22
29/3/2018

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QLD South and Sea Dumping
Ph: s22

ATTACHMENTS

A: Recommendation report

B: Finalised preliminary documentation

B1: Project overview map

C: Letter to proponent

D: Proposed approval decision

E: Consultation on the proposed conditions of approval

F: Public submission QYAC

G: Conservation advice for the eastern curlew (*Numenius madagascariensis*)

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Document 1a

RECOMMENDATION REPORT

Shoreline urban village development, Redlands Bay, Qld (EPBC 2016/7776)

Recommendation

That the proposed action, to develop an urban village within a footprint of 279.5 hectares in Redland Bay, Queensland be approved subject to the conditions specified below.

Conditions	Relevant paragraph in report
1. The **approval holder** must ensure that development associated with the action occurs within the **site** identified in **Attachment A1** as the Application Area.	36
2. The **approval holder** must ensure that no buildings are constructed within the Foreshore Subprecinct as identified at **Attachment A2** except barbeque shelters, picnic shelters, playgrounds and toilet amenities.	36
3. For the period for which this approval has effect, the **approval holder** must ensure there is no decline in eastern curlew (*Numenius madagascariensis*) density, foraging habitat quality, or foraging habitat extent in the site identified as 'shorebird foraging habitats' at **Attachment A3**, compared to pre-**commencement,** as a result of the approved action. 4. The **approval holder** must prepare and submit an Eastern Curlew Management Plan (ECIMP) to the **Minister** before **commencement**. In addition to the detail provided in *Eastern Curlew Impact Management Plan – Shoreline Redlands – 20 July 2017,* the ECIMP must include: a. a scientifically valid monitoring program, sufficient to: i. determine pre-**commencement** eastern curlew density, foraging habitat quality and foraging habitat extent; ii. detect impacts on the matters identified in condition 4(a)(i); and iii. delineate impacts due to the action from impacts due to natural or other anthropogenic causes; b. contingency measures to be implemented (such as fencing) in the event that monitoring identifies that the outcome described in condition 3 is not met; c. a timeframe for when contingency measures will be implemented;	36, 54 and 57

d. details of reporting to be provided to the Department in the event that the outcome described in condition 3 is not met; and e. provisions to make monitoring results publicly available on the approval holder's website for the life of the project. 5. The ECIMP, including any revised plans, must be peer reviewed by a **suitably qualified person**. The peer review must be submitted to the **Minister** together with the ECIMP and a statement from the **suitably qualified person** stating that they carried out the peer review and evaluated the adequacy of the monitoring, mitigation and management measures proposed. The approved ECIMP must be implemented by the **approval holder**. 6. The **approval holder** must not: f. undertake construction within 250m of the Moreton Bay Ramsar wetland between 1 September and 30 March; or g. facilitate public access to the Moreton Bay Ramsar wetland, until the ECIMP has been approved by the **Minister** in writing and pre-**commencement** eastern curlew density, foraging habitat quality and foraging habitat extent has been determined.	
7. The **approval holder** must prepare and submit a Water Quality Management Plan (WQMP) to the **Minister** before **commencement**. In addition to the detail provided in *Shorelines Redland Water Quality Management Plan – June 2017,* the WQMP must accord with **national water quality guidelines** and include: a. a monitoring program sufficient to determine pre-**commencement** water quality within all catchments within the **site** and at a reference/control monitoring site; b. a rationale for the sampling effort undertaken to determine pre-**commencement** water quality and justify the selection of the reference/control monitoring site with respect to the potential impacts of the action and the objectives of the WQMP; c. details of ongoing monitoring locations and the parameters to be monitored; d. proposed early warning indicators, trigger thresholds and limits for detecting impacts on surface water quality; e. contingency measures to be implemented in the event that trigger thresholds are breached; and f. provisions to make monitoring results publicly available on the approval holder's website for the life of the project.	15-25 and 36

8. The WQMP, including any revised plans, must be peer reviewed by a **suitably qualified person**. The peer review must be submitted to the **Minister** together with the WQMP and a statement from the **suitably qualified person** stating that they carried out the peer review and evaluated the adequacy of the monitoring, mitigation and management measures proposed. 9. The **approval holder** must not **commence** until the WQMP has been approved by the **Minister** in writing. The approved WQMP must be implemented by the **approval holder**	
The above conditions are those specific to the action. For readability the general conditions and definitions have been provided at **Annexure A** to this document.	

Background

Description of the project and location

1. The proposed action is an urban village development consisting of approximately 3,800 homes, a town centre, a school, recreational and sporting facilities, restaurants and a foreshore park, within a development footprint of 279.5 hectares in Redland Bay, Queensland (See map at **Attachment B1**). The proposed development includes foreshore open space area stretching the entire eastern boundary of the development and ranging in width from approximately 35 m at its narrowest point to approximately 300 m at its widest point

2. The referral site is mostly cleared for agricultural land uses, with scattered individual trees and vegetated patches associated with drainage lines. The site is abutted to the east by the Moreton Bay Ramsar wetland. Land to the west of the subject site is heavily vegetated and forms part of a larger tract of bushland supporting both remnant and non-remnant vegetation.

Controlling provisions, assessment approach and public consultation

3. The proposal was referred on 12 September 2016 and, on 19 December 2016, the proposed action was determined a controlled action due to likely significant impacts on a wetland of international importance, migratory species and listed threatened species and communities. On the same day it was determined the proposed action would be assessed by preliminary documentation.

4. On 5 January 2017, the Department requested the proponent provide further information to:

    - quantify impacts to Moreton Bay Ramsar wetland and evaluate the effectiveness of measures proposed to mitigate these impacts;
    - quantify impacts to the koala through degradation of habitat as a result of edge effects and ongoing mortality due to dog attack and vehicle strike;
    - evaluate the effectiveness of measures proposed to mitigate impacts to koalas;
    - quantify impacts to the eastern curlew (*Numenius madagascariensis*) and evaluate the effectiveness of measures proposed to mitigate these impacts; and

- determine residual significant impacts and offset requirements in accordance with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*.

5. The preliminary documentation was published from 18 July 2017 to 31 July 2017. One public comment was received by the Quandamooka Yoolooburrabee Aboriginal Corporation (QYAC) on 31 July 2017.

6. The comment from the QYAC concerned the rights and culture of the Quandamooka People as well as raising issues of further engagement and economic opportunities. The proponent provided a response to this comment in their final preliminary documentation submitted 11 September 2017.

7. The proponent has demonstrated historical efforts to engage with the QYAC and has subsequently commenced discussions with the QYAC to engage and address concerns.

State/Territory Assessment and Approval

8. As part of the preliminary documentation (at **Attachment B**) the proponent has provided copies of state planning approval with conditions made mainly in reference to road upgrades. Redland City Council approval has also been received and outlines general management including on some terrestrial matters including the koala and vegetation adjacent to Moreton Bay.

Assessment

Mandatory Considerations – section 136(1)(a) Part 3 controlling provisions

The proposal was determined a controlled action under the following controlling provisions of the EPBC Act:

- wetlands of international importance (sections 16 and 17B);
- listed threatened species and ecological communities (sections 18 and 18A); and
- listed migratory species (sections 20 and 20A);

These controlling provisions are discussed respectively below.

Wetlands of international importance (sections 16 and 17B)

9. Approximately 2 km of the eastern boundary of the project site abuts the Moreton Bay Ramsar wetland (MBRW) (this boundary is not contiguous as it excludes an estimated 370 m length of shoreline opposite to St Clair Island that is not part of the current referral area). Most of the eastern side of the site drains naturally from west to east into Moreton Bay.

10. The MBRW is located in and around Moreton Bay, east of Brisbane in Queensland. It meets six of the nine criteria for listing under the Ramsar convention. The criteria relevant to the proposed action include:

    a. Criterion 1: It is one of the largest estuarine bays in Australia which are enclosed by a barrier island of vegetated sand dunes. Moreton Bay protects the local area from oceanic swells, providing habitat for wetland development.

    b. Criterion 5: The MBRW supports more than 50,000 wintering and staging shorebirds during the non-breeding season.

c. Criterion 6: The MBRW regularly supports more than 1% of the population of the wintering eastern curlews and the grey-tailed tattler.

11. The MBRW covers approximately 113,314 ha and contains 20 different recognised wetland types. The MBRW area directly adjacent to the project site is comprised of mangroves and tidal flats. The tidal flats contain known migratory species foraging habitat, including for the eastern curlew.

12. The project site is used for grazing (with likely concomitant impacts from compaction, use of fertilisers, stock effluent, etc.), the quality of surface water run-off entering the MBRW is likely to be poor. The proponent has undertaken a round of baseline water quality assessment, to support the assertions above.

13. The project site has five catchments, which run into the MBRW. Based on the existing and proposed land use within these catchments, the impacts and management will be different.

14. The key impacts to the MBRW as a result of the action are:

- water quality impacts to wetland mudflats and mangroves, which form migratory bird foraging habitat, as a result of construction and operation; and

- direct and indirect impacts as a result of increased anthropogenic activity including noise, light, rubbish and weed incursion, as well as direct disturbance to foraging migratory birds as a result of human and dog interactions.

Water quality impacts during construction and operation

15. The risks to water quality from construction are quite different to the ongoing impacts of the site once developed. Impacts from construction mainly occur through increased sediment/nutrient runoff (smothering and/or eutrophication).

16. Impacts from ongoing use of the site once developed occur mainly through stormwater runoff quality and altered hydrology. The proponent has modelled the potential impacts using the *Model for Urban Stormwater Improvement Conceptualisation* (MUSIC). The proponent has used varying inputs to represent the five on-site catchments which run into the MBRW and have used differing percentages to represent existing and proposed land uses.

17. The water quality objectives for the Shorelines Redland development have been derived from the *Environmental Protection (Water) Policy 2009 Redland Creeks environmental values and water quality objectives. Basin No. 145 (part), including Coolnwynpin, Eprapah, Hilliards, Lota, Moogurrapum, Tarradarrapin, Tingalpa and Wynnum creeks. July 2010 (DEHP).*

18. The site discharge locations for each sub-catchment have been related to water type ‘Lowland Freshwater’ and ‘Middle Estuary’ as mapped on the *Environmental Protection (Water) Policy 2009 South-east Queensland Map Series Plan WQ1453.*

19. Based on the MUSIC modelling, the proponent has determined that, once constructed, the proposed action will result in reduced sediment and contaminant loads. However, the action will increase in storm water runoff volume (by 20-70%) and frequency (17-28 additional flow dates).

20. To mitigate potential impacts from the increased storm water runoff, the proponent has designed the waterways and drainage outfalls to avoid erosion and scour. Overall, the proponent considers that the increased run-off is likely to have a direct impact on adjacent drainage lines. However, they consider that the increase in freshwater is likely to have limited effects on the mangrove lined waterways, as they are likely to be tolerant of a range of salinities.

21. Water management objectives are based on baseline water quality, determined prior to construction. The discharge criteria requires a reduction in mean annual loads of pollutants compared to the baseline situation, including:

    - 80% reduction for total suspended solids;
    - 60% reduction for total phosphorous;
    - 45% reduction for total nitrogen;
    - 90% reduction for gross pollutants.

22. Treatment measures during operation include:

    - Vegetated swales for the removal of coarse and medium sized sediments.
    - Sedimentation ponds to promote settling of sediments through the reduction of flow velocities and temporary detention.
    - Constructed wetland systems to enhance sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater.
    - Bioretention systems to filter stormwater runoff through densely planted surface vegetation and then percolating runoff through a prescribed filter media. During percolation, pollutants are retained through fine filtration, adsorption and some biological uptake.
    - Revegetated waterways with appropriately selected native species, tolerant to the expected hydrology and hydraulics. The improved condition of the waterways will improve waterway stability, provide habitat and allow fauna passage through the site.

23. As noted above, the existing water quality entering the Moreton Bay Ramsar site is impacted by current land practices. Under state legislation the proponent is required to improve water quality. To achieve this, the proponent has committed to implementing management measures which would result in a net improvement in water quality over current conditions.

24. These commitments are reflected in the *Shorelines Redland Water Quality Management Plan – June 2017*, as submitted in the preliminary documentation. The outcomes of this plan are partially reliant on comparisons with the baseline condition. To achieve these outcomes, the Department considers that further baseline water testing, in addition to the single

sampling event undertaken to date, is required to determine a scientifically robust baseline condition.

25. To ensure the management measures imposed by the proponent are effective in achieving the desired outcomes, the Department also recommends that:
    a. a suitable control/reference monitoring site is identified;
    b. details of the parameters to be monitored are included; and
    c. trigger levels, and contingency measures in the event that trigger levels are breached, are included.

Noise, light, rubbish, weed incursion, people and dogs

26. The proposed action will result in likely noise, light, rubbish and weed incursion impacts on adjacent mangroves and mudflats which provide foraging habitat for shorebirds. There are no shorebird roosting areas on the mainland adjacent to the development. Therefore, impacts to shorebird roosting as a result of the proposed development are unlikely to occur.

27. The proposed development includes a foreshore open space (FOS) area which extends across the entire eastern boundary of the development. The FOS ranges in width from approximately 35 m at its narrowest point to approximately 300 m at its widest point.

28. Within the FOS there will be barbeques, picnic shelters, playgrounds and toilet amenities. A pedestrian walkway will be constructed which will be placed adjacent to, but not within, existing, fringing mangrove vegetation. The closest point of the proposed walkway to shorebird foraging habitat is approximately 45 m.

29. Potential physical disturbances from the development could be the result of:
    - humans and/or dogs traversing low-tide feeding habitats;
    - humans and/or dogs traversing areas in line of sight of feeding shorebirds;
    - increased boat traffic adjacent to feeding areas; or
    - increased noise and light spillage.

30. The proponent has identified that persons using the constructed pedestrian path could disturb shorebirds, including the critically endangered eastern curlew, particularly in areas where open space is adjacent to foraging habitat. The *Conservation Advice for* Numenius madagascariensis *(eastern curlew)* (2015) states that the species is easily disturbed by human interaction within 250m.

31. To separate the development area from shorebird low-tide feeding habitats, a band of mangrove vegetation will be retained, protected and managed. The band ranges in width from approximately 30 m at its narrowest point to approximately 120 m at its widest.

32. The proponent considers that the band of mangrove vegetation provides an effective barrier to human and dog traffic accessing and disturbing low-tide shorebird habitat. The proponent also notes that the soft muddy substrate associated with shorebird foraging habitats is also likely to discourage human or dog traffic accessing these areas. The Department considers that the mangroves and mudflats may have limited effectiveness as a barrier.

33. The proponent has also included an *Eastern Curlew Impact Management Plan* to avoid and/or mitigate impacts to the eastern curlew. The management measures provided in the

Eastern Curlew Impact Management Plan are relevant to all shorebirds within the local area and include:

- A community education program, including educational signage to inform residents and visitors of the presence of shorebirds and the impacts of physical disturbances and noise disturbances to foraging shorebirds.

- Sensitively designed lighting for the proposed walkway and recreational parks within the foreshore open space area.

- Controls to avoid and minimise noise emissions from recreational activities within the foreshore open space area. The Department notes that the examples of noise emission controls, provided as part of the preliminary documentation are limited to signage and the requirement that noise levels from public events in the open space area will be subject to permits from Redland City Council.

34. All open space areas will contain regularly placed refuse bins. The bins will be designed to restrict foraging fauna from accessing the litter and to minimise the potential for them to be blown into Moreton Bay. The bins will be emptied regularly, in line with the Redland City Council's waste strategy.

35. Prior to commencement of construction, specific Health Safety and Environment (HSE) induction material will be developed. It will ensure all relevant site personnel are aware of, and trained in, the environmental requirements of the development. To mitigate dumping of garden waste the proponent has committed to erecting signage at all conservation areas and along the western boundary fencing, stating that dumping of garden refuse into these areas is illegal and punishable under RCC's local laws.

Conclusion

36. The Department considers that the project design and management measures required by the local council and committed to by the proponent, including measures to reduce light, noise and rubbish, will reduce the impact of the action. However, the Department considers that, even with these mitigation measures, the proposed action is likely to have significant impacts on the adjacent MBRW. Therefore, the Department recommends imposing conditions to ensure the direct and indirect impacts from the project on water quality and adjacent wetland habitat are mitigated. The recommended conditions are summarised below:

- a condition to limit the proposed action to within the project boundary as referred (condition 1 at **Attachment D**);

- a condition to ensure that the open space precinct as included in the referral design is implemented (condition 2 at **Attachment D**);

- conditions to enhance the *Eastern Curlew Impact Management Plan – Shoreline Redlands – 20 July 2017* through inclusion of the requirement for scientifically robust monitoring, including to establish a clear understanding of the baseline condition, to detect impacts and to respond to any impacts, if necessary (conditions 3, 4, 5 and 6 at **Attachment D**); and

- a condition to enhance the *Shorelines Redland Water Quality Management Plan – June 2017* through inclusion of the requirement for scientifically robust monitoring, including to establish a clear understanding of the baseline condition, to detect impacts and to respond to any impacts, if necessary (conditions 7, 8 and 9 at **Attachment D**).

37. The Department considers that the above conditions provide certainty that the proposed action will occur outside of the MBRW and that any likely impacts are appropriately mitigated. With these conditions, the Department considers that the proposed action is unlikely to result in a significant impact to the values of the MBRW.

Listed threatened species and ecological communities (sections 18 and 18A)

Koala (*Phascolarctos cinereus*) - Vulnerable

38. The development area currently supports a total of approximately 17.52 ha of potential koala (*Phascolarctos cinereus*) habitat in patches across the 279.5 ha development footprint. It is estimated that a maximum of 3.72 ha of koala habitat will be removed as part of the development.

39. The referral noted that evidence of koalas has been found within the Shoreline development area. The Department requested the proponent undertake an assessment of the adjacent koala habitat to the west of the development area. No evidence of koalas, observations or scats, were found during targeted surveys in this area undertaken over five days in June 2017.

40. The proponent has restricted the proposed development footprint to only include areas that have undergone previous vegetation clearing for agricultural and residential purposes. All large patches of potential koala habitat are being retained, protected, restored and managed under the Shoreline open space landscape strategy.

41. The proposed development includes three dedicated fauna movement facilities to provide koalas with safe mechanisms to cross Serpentine Creek Road. The road currently presents a barrier to safe koala movements. The proposed movement facilities include underpasses and an overpass. The movement facilities will be designed in accordance with the Queensland Department of Transport and Main Roads – Fauna Sensitive Road Design Manual.

42. The management measures proposed to retain, protect, restore and manage koala habitat will ensure that koala use and connectivity of koala habitat across the site will be maintained and potentially improved.

43. Due to the limited koala impacts on site and management measures proposed by the proponent, the Department recommends no further conditions for the protection of the koala. The Department considers the direct loss of 3.72 ha of koala habitat along with limited indirect impacts is unlikely to result in a significant impact to the koala.

Eastern Curlew (*Numenius madagascariensis*) – Critically endangered

44. The eastern curlew is the largest migratory shorebird in the world. Eastern curlews are rarely recorded inland with a continuous distribution from Barrow Island and Dampier Archipelago in Western Australia, through the Kimberley and along the Northern Territory, Queensland, and NSW coasts and the islands of Torres Strait.

45. The eastern curlew mainly forages during the non-breeding season on soft sheltered intertidal sandflats or mudflats, open and without vegetation or covered with seagrass, often near mangroves, on saltflats and in saltmarsh, rockpools and among rubble on coral reefs,

and on ocean beaches near the tideline.

46. The low-tide mudflats, which occur adjacent to the development provide foraging habitat for the eastern curlew and other shorebirds, covering an area of approximately 150 ha. The habitat in the MBRW is internationally important, as it supports more than 1% of the individuals in a population of the eastern curlew (*EPBC Act Policy Statement 3.21 – Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (2017)).

47. The maximum number of eastern curlew recorded during the proponent's four low-tide surveys was seven. The proponent states that, in comparison to shorebird surveys conducted in other areas of Moreton Bay, the densities of eastern curlew and other migratory shorebirds near the development area is quite low. The proponent suggests that foraging habitats adjacent to the development footprint are of low quality. No roosting habitat has been identified on or adjacent to the site.

48. As discussed in the MBRW section above, potential physical disturbances to the eastern curlew could result from:

    - humans and/or dogs traversing low-tide feeding habitats;
    - humans and/or dogs traversing areas in line of sight of feeding shorebirds;
    - increased boat traffic adjacent to feeding areas; or
    - increased noise and light spillage.

49. The proponent has committed to implementing an *Eastern Curlew Impact Management Plan*. As discussed in the MBRW discussion above, the proponent will include community education signage and educational material to advise residents/visitors of the nearby presence of shorebirds and that increased or sudden loud noises can disturb foraging shorebirds.

50. The proponent has developed the following performance/completion criteria for the *Eastern Curlew Impact Management Plan*:

    - Eastern curlew and other migratory shorebird species are at densities that reflect baseline densities (BAAM 2016) in the adjacent feeding habitats, accounting for a background decline in shorebird populations relating to ongoing habitat loss at key stop-over sites in Asia.
    - There is no reporting or other evidence of weed intrusions or mangrove vegetation dieback recorded in areas adjacent to migratory shorebird foraging habitats during construction and for five years following total occupation of the proposed development.
    - There is no reporting or other evidence of increased light or noise disturbance to foraging migratory shorebirds during construction and for five years following total occupation of the proposed development.
    - There is no reporting or other evidence of recreational activities causing sudden loud noises within the foreshore open space area during construction and for five years following total occupation of the proposed development.

51. The proponent notes that these performance criteria will be informed by community reporting and by four low tide surveys per annum. These annual surveys will occur during construction, until 65% of the development is occupied within areas east of Serpentine Creek Road and the Foreshore Open Space Area is developed.

52. The proponent has committed to provide annual reporting to the Department showing the outcomes of this monitoring. If the project manager is alerted to any incidence of shorebird disturbance, or the surveys discussed above detect significant changes in eastern curlew numbers and/or human or dog disturbance, the incident will be investigated within 48 hours and actions to rectify will commence within seven days of the initial report.

53. As discussed in the MBRW section above, the Department considers that the mangroves mudflats may provide limited deterrence to human and dog traffic. The protection of this habitat and the other performance/completion criteria of the *Eastern Curlew Impact Management Plan* as discussed above will help to ensure that impacts to eastern curlew as a result of the action are avoided and minimised.

54. The Department sought advice from the Marine and Freshwater Species Conservation (MFSC) section who note that the Moreton Bay Ramsar Wetland has been identified as one of the most important sites in Australia for the critically endangered eastern curlew. The MFSC Section also noted that 200m would be the minimum appropriate to reduce the adverse impacts of disturbance (i.e. walkers on beach, walker with dogs, etc).

55. To ensure that there are no impacts prior to adequate baseline data on eastern curlew being collated, the Department has recommended a condition stating that no construction can occur within 250m of the MBRW during periods where eastern curlew are likely to be present prior to baseline surveys being completed.

56. In line with conclusions for wetlands of international importance above, the Department recommends conditions to enhance the *Eastern Curlew Impact Management Plan – Shoreline Redlands – 20 July 2017.* The proposed conditions (**Attachment D**) require scientifically robust monitoring to:

    - establish a clear understanding of the baseline conditions prior to any impact occurring on the eastern curlew as a result of the action; and
    - detect impacts, and mechanisms to respond to any impacts, if required.

57. With the commitments made by the proponent and the recommended conditions, the Department considers that the proposed action is unlikely to result in a significant impact to the eastern curlew.

Listed migratory species (sections 20 and 20A)

58. The MBRW is known to support high numbers of migratory species. Surveys undertaken on the mudflats adjacent to the site identified 5 migratory species:

    - Bar-tailed godwit (*Limosa lapponicca*)
    - Whimbrel (*Numenius phaeopus*)
    - Eastern curlew (*Numenius madagascariensis*)
    - Gull-billed tern (*Gelochelidon nilotica*)
    - Common greenshank (*Tringa nebularia*).

59. Likely impacts to these listed migratory species have been discussed under the MBRW section of this report and in relation to the critically endangered eastern curlew, which is also listed in the migratory category.

60. As discussed above for the eastern curlew, with the additional conditions as recommended above, the Department considers that the proposed action is unlikely to result in a significant impact to migratory species.

Considerations for Approval and Conditions under the EPBC Act

Mandatory considerations – section 136(1)(b) Economic and social matters

61. The proponent notes that the $2.3 billion Shorelines project will create 1,800 to 1,900 new jobs within the Shoreline urban area. It will also create approximately 1,550 construction jobs in Redland Bay over the next 10 years.

62. The Redland City Council has calculated that they will receive $5 million in surplus from the Shoreline project over the next five years.

63. The Shoreline Redlands Urban Village development will provide over $100 million in State-controlled road upgrades and $300 million in infrastructure, including the fauna movement facilities.

64. The proponent notes that they have met with the QYAC and discussed cultural heritage surveys, management planning engagement and explored other potential opportunities for the QYAC to have input into the development (e.g. the input of content for interpretative signage along with other heritage features of the site). Both parties have agreed to continue exploring and discussing potential economic and heritage opportunities for the QYAC and the Quandamooka people during the development and delivery of the project.

Factors to be taken into account – section 136(2)(a) Principles of ecologically sustainable development

65. The principles of ESD, as defined in Part 1, section 3A of the EPBC Act, are:

    (a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;

    (b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;

    (c) the principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;

    (d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making;

    (e) improved valuation, pricing and incentive mechanisms should be promoted.

66. In formulating this recommendation, the Department has taken into account the principles of ecologically sustainable development. In particular:

    - This report and the assessment documentation provided contain information on the long-term and short-term economic, environmental, social and equitable considerations that are relevant to the decision and are presented for your consideration.

    - Any lack of certainty related to the potential impacts of the projects is addressed by conditions that restrict environmental impacts, impose strict monitoring and adopt environmental standards which, if not achieved, require the application of response mechanisms in a timely manner to avoid adverse impacts.

- The proposed conditions will ensure protection of EPBC listed species and communities. Those conditions allow for the project to be delivered and operated in a sustainable way to protect the environment for future generations and preserve EPBC listed species and communities in perpetuity.

- The Department has considered the importance of conserving biological diversity and ecological integrity in relation to all of the controlling provisions for this project, and the advice provided within this document reflects that consideration.

- The Department's advice includes reference to and consideration of a range of information on the economic costs, benefits and impacts of the project. Based on the reference to relevant Queensland Government Planning and policy documents in the assessment documentation, the project has given consideration to evaluation, pricing and incentive mechanisms, relevant to the project.

Factors to be taken into account – section 136(2)(bc) – preliminary documentation

67. In accordance with section 136(2)(bc)(i) the documents given to the Minister under section 95B(1) are at **Attachment B.**

68. In accordance with section 136(2)(bc)(ii), this document forms the recommendation report relating to the action given to the Minister in accordance with section 95C.

Person's environmental history – section 136(4)

69. A search on the background of the proponent undertaken by the Department did not identify any recorded adverse environmental history relating to Shoreline Redlands Pty Ltd or any associated directors.

70. The Department has no reason to believe that the company would be unwilling or unable to undertake this proposed action in accordance with the recommended conditions.

Considerations in deciding on condition – section 134

71. In accordance with section 134(1), the Minister may attach a condition to the approval of the action if he or she is satisfied that the condition is necessary or convenient for:

    (a) protecting a matter protected by a provision of Part 3 for which the approval has effect (whether or not the protection is protection from the action); or

    (b) repairing or mitigating damage to a matter protected by a provision of Part 3 for which the approval has effect (whether or not the damage has been, will be or is likely to be caused by the action).

72. As detailed in the Assessment section above, all recommended conditions attached to the proposed approval are necessary or convenient to protect, repair and/or mitigate impacts on a matter protected by provision of Part 3 for which this proposed approval has affect.

73. In accordance with section 134(4), in deciding whether to attach a condition to an approval the Minister must consider:

    (a) any relevant conditions that have been imposed, or the Minister considers are likely to be imposed, under a law of a State or self-governing Territory or another law of the Commonwealth on the taking of the action; and

    (b) the desirability of ensuring as far as practicable that the condition is a cost effective means for the Commonwealth and a person taking the action to achieve the object of the condition

74. The proponent has included the conditions imposed by the local council and the Queensland Department of Infrastructure and State Development in their preliminary documentation at **Attachment B**. The Department has taken these into account during the preparation of this recommendation report. The information provided by the person proposing to take the action has been considered and can be found at **Attachment B**.

75. The Department believes the conditions are practicable and cost effective. They are reflective of the commitments made by the proponent within their preliminary documentation and also complement state approval requirements.

76. The Department considers that the conditions proposed are a cost effective means of achieving their purpose.

Consideration of Condition-setting Policy

77. The Department has considered the likely scope and severity of the impacts to MNES, and the proposed avoidance and mitigation measures, and determined that the proposed action has the potential to result in a significant residual adverse impact on wetland of international importance and the eastern curlew. The Department has considered the state requirements and recommends further conditions are required to ensure that there are no significant residual impacts to MNES.

78. Accordingly the Department considers that it is necessary and convenient to apply approval conditions to this project, as outlined in **Attachment D**. In applying this analysis, the Department has had regard to the EPBC Act Condition-setting Policy (2015).

Requirements for decisions about Ramsar Wetland – section 138

79. In deciding whether or not to approve for the purposes of section 16 or 17B the taking of an action, and what conditions to attach to such an approval, the Minister must not act inconsistently with Australia's obligations under the Ramsar Convention.

80. The Ramsar Convention is available at: http://www.ramsar.org/cda/en/ramsar-home/main/ramsar/1_4000_0__.

81. The Ramsar Convention's broad aims are to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. This requires international cooperation, policy making, capacity building and technology transfer.

Consideration

82. The Ramsar Convention has been considered in, and is not inconsistent with, the recommended approval which requires avoidance, mitigation and management measures for the Ramsar wetland. The recommended approval requires information related to the

proposed action to be publically available to ensure equitable sharing of information and improved knowledge relating to Ramsar Wetlands.

Requirements for decisions about listed threatened species and communities – section 139

83. (1) In deciding whether or not to approve for the purposes of a subsection of section 18 or section 18A the taking of an action, and what conditions to attach to such an approval, the Minister must not act inconsistently with:

(a) Australia's obligations under:

(i) the Biodiversity Convention; or

(ii) the APIA Convention; or

(iii) CITES; or

(b) a recovery plan or threat abatement plan.

(2) If:

(a) the Minister is considering whether to approve, for the purposes of a subsection of section 18 or section 18A, the taking of an action; and

(b) the action has or will have, or is likely to have, a significant impact on a particular listed threatened species or a particular listed threatened ecological community;

the Minister must, in deciding whether to so approve the taking of the action, have regard to any approved conservation advice for the species or community.

The Biodiversity Convention

84. The Biodiversity Convention is available at: http://www.austlii.edu.au/au/other/dfat/treaties/ATS/1993/32.html

85. The objectives of the Biodiversity Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

Consideration

86. The recommendations are not considered by the Department to be inconsistent with the Biodiversity Convention, which promotes environmental impact assessment (such as this process) to avoid and minimise adverse impacts on biological diversity. The Department has also given particular consideration to an appropriate combination of avoidance and mitigation measures for the management of species potentially impacted by the proposed action.

87. The Biodiversity Convention has been considered in, and is not inconsistent with, the recommended approval which requires avoidance, mitigation and management measures for listed threatened species and communities. The recommended approval requires

information related to the proposed action to be publically available to ensure equitable sharing of information and improved knowledge relating to biodiversity.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

88. CITES is available at: http://www.austlii.edu.au/au/other/dfat/treaties/ATS/1976/29.html

89. CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

Consideration

90. The recommendations are not inconsistent with CITES as the proposed action does not involve international trade.

Convention on the Conservation of Nature in the South Pacific (APIA Convention)

91. The APIA Convention is available at: http://www.austlii.edu.au/au/other/dfat/treaties/ATS/1990/41.html

92. The APIA Convention encourages the creation of protected areas which, together with existing protected areas, will safeguard representative samples of the natural ecosystems occurring therein (particular attention being given to endangered species), as well as superlative scenery, striking geological formations, and regions and objects of aesthetic interest or historic, cultural or scientific value.

Consideration

93. The APIA Convention was suspended with effect from 13 September 2006. While this Convention has been suspended, Australia's obligations under the Convention have been taken into consideration. The recommendations are not inconsistent with the Convention which has the general aims of conservation of biodiversity.

Recovery Plans and Threat Abatement Plans

94. There are no relevant Recovery Plans or Threat Abatement Plans to consider.

Conservation Advice

95. The Department has had regard to the following conservation advices in the preparation of this recommendation report:

    a. Threatened Species Scientific Committee (2015). *Approved Conservation Advice for* Numenius madagascariensis *(eastern curlew). Commonwealth of Australia, Canberra. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf*

    b. Threatened Species Scientific Committee (2015). Approved Conservation Advice for Phascolarctos cinereus *(combined populations of Queensland, New South Wales and the Australian Capital Territory) (koala Northern Designatable Unit).* Commonwealth of Australia, Canberra. Available at: *http://www.environment.gov.au/biodiversity/threatened/species/pubs/197-conservation-advice.pdf*

Requirements for decisions about listed migratory species – section 140

96. In deciding whether or not to approve for the purposes of section 20 or 20A the taking of an action relating to a listed migratory species, and what conditions to attach to such an approval, the Minister must not act inconsistently with Australia's obligations under whichever of the following conventions and agreements because of which the species is listed:

    (a) the Bonn Convention;
    (b) CAMBA;
    (c) JAMBA;
    (d) an international agreement approved under subsection 209(4).

The Bonn Convention

97. The Bonn Convention is available at: http://www.cms.int/about/index.htm

98. The Bonn Convention aims to conserve terrestrial, aquatic and avian migratory species throughout their range.

Consideration

99. The recommendations are not considered by the Department to be inconsistent with the Bonn Convention. The Department has also given particular consideration to an appropriate combination of avoidance and mitigation measures for the management of species potentially impacted by the proposed action.

100. The Bonn Convention has been considered in, and is not inconsistent with, the recommended approval which requires avoidance, mitigation and management measures for listed migratory species. The recommended approval requires information related to the proposed action to be publically available to ensure equitable sharing of information and improved knowledge relating to biodiversity.

China-Australia Migratory Bird Agreement (CAMBA)

101. The CAMBA agreement can be found at: http://www.austlii.edu.au/au/other/dfat/treaties/1988/22.html

102. The CAMBA agreement lists terrestrial, water and shorebird species which migrate between Australia and the respective countries. The majority of listed species are shorebirds.

103. The agreement requires the parties to protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded;
- protecting and conserving important habitats;
- exchanging information; and
- building cooperative relationships.

Consideration

104. The CAMBA agreement has been considered in, and is not inconsistent with, the recommended approval which requires avoidance, mitigation and management measures

for listed migratory species. The recommended approval requires information related to the proposed action to be publically available to ensure equitable sharing of information and improved knowledge relating to biodiversity.

Japan-Australia Migratory Bird Agreement (JAMBA)

105. The JAMBA agreement can be found at: http://www.austlii.edu.au/au/other/dfat/treaties/1981/6.html

106. The JAMBA agreement lists terrestrial, water and shorebird species which migrate between Australia and the respective countries. The majority of listed species are shorebirds.

107. The agreement requires the parties to protect migratory birds by:

a. limiting the circumstances under which migratory birds are taken or traded;
b. protecting and conserving important habitats;
c. exchanging information; and
d. building cooperative relationships.

Consideration

108. The JAMBA agreement has been considered in, and is not inconsistent with, the recommended approval which requires avoidance, mitigation and management measures for listed migratory species. The recommended approval requires information related to the proposed action to be publically available to ensure equitable sharing of information and improved knowledge relating to biodiversity.

Bioregional Plans section 176(5)

109. In accordance with section 176(5), the Minister is required to have regard to a bioregional plan in making any decision under the Act to which the plan is relevant. The proposed action is not located within or near an area designated by a bioregional plan. The Department considers that there are no bioregional plans relevant to the proposed action.

Conclusion

110. The proposed action is likely to impact on the Moreton Bay Ramsar Wetland, koala habitat and foraging habitat for the eastern curlew. The Department considers that the likely impacts of the proposed action will be acceptable, provided the action is undertaken in accordance with the recommended conditions and consistent with the mitigation measures proposed by the proponent. Having considered all matters required to be considered under the EPBC Act, the Department recommends the proposed action be approved, subject to the recommended conditions.

Material used to prepare Recommendation Report

Documentation that has been referenced in the Recommendation Report:

- Preliminary documentation.
- Public submissions on assessment documentation
- Threatened Species Scientific Committee (2015). *Approved Conservation Advice for* Numenius madagascariensis *(eastern curlew). Commonwealth of Australia, Canberra.*

Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf

- Threatened Species Scientific Committee (2015). Approved Conservation Advice for Phascolarctos cinereus *(combined populations of Queensland, New South Wales and the Australian Capital Territory) (koala Northern Designatable Unit).* Commonwealth of Australia, Canberra. Available at: *http://www.environment.gov.au/biodiversity/threatened/species/pubs/197-conservation-advice.pdf*
- *EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species*, Commonwealth of Australia 2017

Duration of approval

111. The Department recommends that the approval remain valid for a period of 20 years to allow for construction to take place (estimated between 8 and 15 years), the implementation of mitigation measures and to undertake monitoring to ensure that post construction outcomes have been met.

Annexure A:

10. Within 20 days after the **commencement** of the **action**, the **approval holder** must advise the **Department** in writing of the actual date of **commencement**.

11. The **approval holder** must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement the management plans required by this approval, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act,** or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the **Department's** website. The results of audits may also be publicised through the general media.

12. Within three months of every 12 month anniversary of the **commencement** of the action, the **approval holder** must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans as specified in the conditions. Documentary evidence providing the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** at the same time as the compliance report is published. Reports must remain on the website for the period this approval has effect. The **approval holder** may cease preparing and publishing compliance reports required by this condition with written agreement of the **Minister** to do so.

13. Upon the direction of the **Minister**, the **approval holder** must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the commencement of the audit. Audit criteria must be agreed to by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister**.

14. The **approval holder** may choose to revise a plan approved by the **Minister** under Conditions 4 or 7 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised plan would not be likely to have a new or increased **impact**. If the **approval holder** makes this choice they must:

    i. notify the **Department** in writing that the approved plan has been revised and provide the **Department** with an electronic copy of the revised plan;

    ii. implement the revised plan from the date that the plan is submitted to the **Department**; and

    iii. for the life of this approval, maintain a record of the reasons the **approval holder** considers that taking the action in accordance with the revised plan would not be likely to have a new or increased **impact**.

14A. The **approval holder** may revoke its choice under Condition 14 at any time by notice to the **Department**. If the **approval holder** revokes the choice to implement a revised plan without approval under section 143A of the EPBC Act, the **approval holder** must implement the version of the plan most recently approved by the **Minister**.

14B. Condition 14 does not apply if the revisions to the approved plan include changes to environmental offsets provided under the plan in relation to a matter protected by a controlling provision for the action, unless otherwise agreed in writing by the **Minister**. This does not otherwise limit the circumstances in which the taking of the action in accordance with a revised plan would, or would not, be likely to have new or increased **impacts**.

14C. If the **Minister** gives a notice to the **approval holder** that the **Minister** is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new or increased impact, then:

i. Condition 14 does not apply, or ceases to apply, in relation to the revised plan; and

ii. the approval holder must implement the version of the plan most recently approved by the Minister.

iii. to avoid any doubt, this condition does not affect any operation of Conditions 14, 14A and 14B in the period before the day after the notice is given.

At the time of giving a notice under condition 14A, the **Minister** may also notify that for a specified period of time condition 14 does not apply for one or more specified plans required under the approval.

14D. Conditions 14, 14A, 14B and 14C are not intended to limit the operation of section 143A of the EPBC Act which allows the **approval holder** to submit a revised plan to the **Minister** for approval.

15. If, at any time after five years from the date of this approval, the **approval holder** has not **commenced** the **action**, then the **approval holder** must not **commence** the action without written agreement from the **Minister.**

16. Unless otherwise agreed to in writing by the **Minister**, the **approval holder** must publish all management plans referred to in these conditions of approval on its website. Each management plan must be published on the website within one month of being approved by the **Minister** or being submitted under conditions 4, 7 or 14.

Definitions

Approval holder: means the person to whom the approval is granted or any person acting on their behalf, or to whom the approval is transferred under section 145B of the EPBC Act.

Commence/commencement means the erection of a building or structure that is or is to be fixed to the ground and wholly or partially fabricated on-site; the alteration, maintenance, repair or demolition of any building or structure; preliminary site preparation work which involves breaking of the ground (including pile driving); the laying of pipes and other prefabricated materials in the ground, and any associated excavation work; excluding the installation of fences and signage.

Department means the Australian Government Department administering the *Environment Protection and Biodiversity Conservation Act 1999*.

EPBC/ EPBC Act means the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

Impact/s: as defined in section 527E of the EPBC Act.

Minister means the Minister administering the Environment Protection and Biodiversity Conservation Act 1999 and includes a delegate of the Minister**.**

National water quality guidelines means guidelines under the *National Water Quality Management Strategy* including the *Australian and New Zealand guidelines for fresh and marine water quality – 2000* or future revisions of these guidelines*.*

Site means the area shown as the Application Area shown at Attachment A.

Suitably qualified person means a person who has professional qualifications, training, skills and/or experience related to the nominated subject matter and can give independent assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods and/or literature.

FOI 190207
Document 1b

Shoreline Redlands

Preliminary Documentation
(EPBC Ref: 2016/7776)

Response to additional information request

Document Control Sheet

File Number: 0345-004

Project Manager/s: Adrian Caneris

Client: Shoreline Redlands

Project Title: Response to EPBC request for preliminary documentation (EPBC Ref: 2016/7776)

Project Author/s: Dr Jo Chambers and Adrian Caneris

Project Summary: Respond to request for preliminary documentation relating to potential impacts to Matters of National Environmental Significances as a result of the Shoreline Urban Village development.

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Purpose of Report

Biodiversity Assessment and Management Pty Ltd has produced this report in its capacity as {consultants} for and on the request of Shoreline Redlands (the "Client") for the sole purpose of responding to the Commonwealth’s request for preliminary documentation in regards to the Shoreline Urban Village Development, and providing management strategies to avoid or mitigate significant impacts (the "Specified Purpose"). This information and any recommendations in this report are particular to the Specified Purpose and are based on facts, matters and circumstances particular to the subject matter of the report and the Specified Purpose at the time of production. This report is not to be used, nor is it suitable, for any purpose other than the Specified Purpose. Biodiversity Assessment and Management Pty Ltd disclaims all liability for any loss and/or damage whatsoever arising either directly or indirectly as a result of any application, use or reliance upon the report for any purpose other than the Specified Purpose.

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Signed on behalf of
Biodiversity Assessment and Management Pty Ltd

Date: 20 June, 2017

Managing Director

RESPONSE TO EPBC REF 2016/7776
SHORELINE DEVELOPMENT

Table of Contents

List of Attachments

Table of Terms and Abbreviations

ASS	Acid Sulfate Soils
BAAM	Biodiversity Assessment and Management Pty Ltd
DEHP	Queensland Department of Environment and Heritage Protection
DoEE	Commonwealth Department of Environment and Energy
EMP	Environmental Management Plans
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FID	Flight Initiation Distance
HSE	Health Safety and Environment
KIMP	Koala Impact Management Plan
KSPRP	*South East Queensland Koala Conservation State Planning Regulatory Provisions (May 2010)*
NC Act	Queensland *Nature Conservation Act 1992*
PASS	Potential Acid Sulfate Soils
RCC	Redland City Council
WONS	Weeds on National Significance
WQO	State Water Quality Objectives

1. General

The following preliminary documentation follows the structure of the information request (EPBC Ref: 2016/7776). The Table of Contents to this document acts as a reference table indicating where to locate additional information to fulfil this request.

2. Description of the Environment – Moreton Bay Ramsar Wetland

2.1 Water quality leaving the proposed action site

There are five sub-catchments within the site draining directly to Moreton Bay (**Figure 2.1**). The catchments are relatively small (<100ha) such that the drainage lines are characterised by broad, low gradient ephemeral flow paths without a defined channel. The terrain across the five catchments draining to Moreton Bay is dominated by low to moderate undulating topography (4-12%).

A snapshot of baseline water quality leaving the site has been completed (**Attachment 1**). The assessment involved water quality sampling of base flows following two rain events, and desktop modelling assessment of water quality (using MUSIC software). A brief description of the existing drainage pathways for each sub-catchment is provided below:

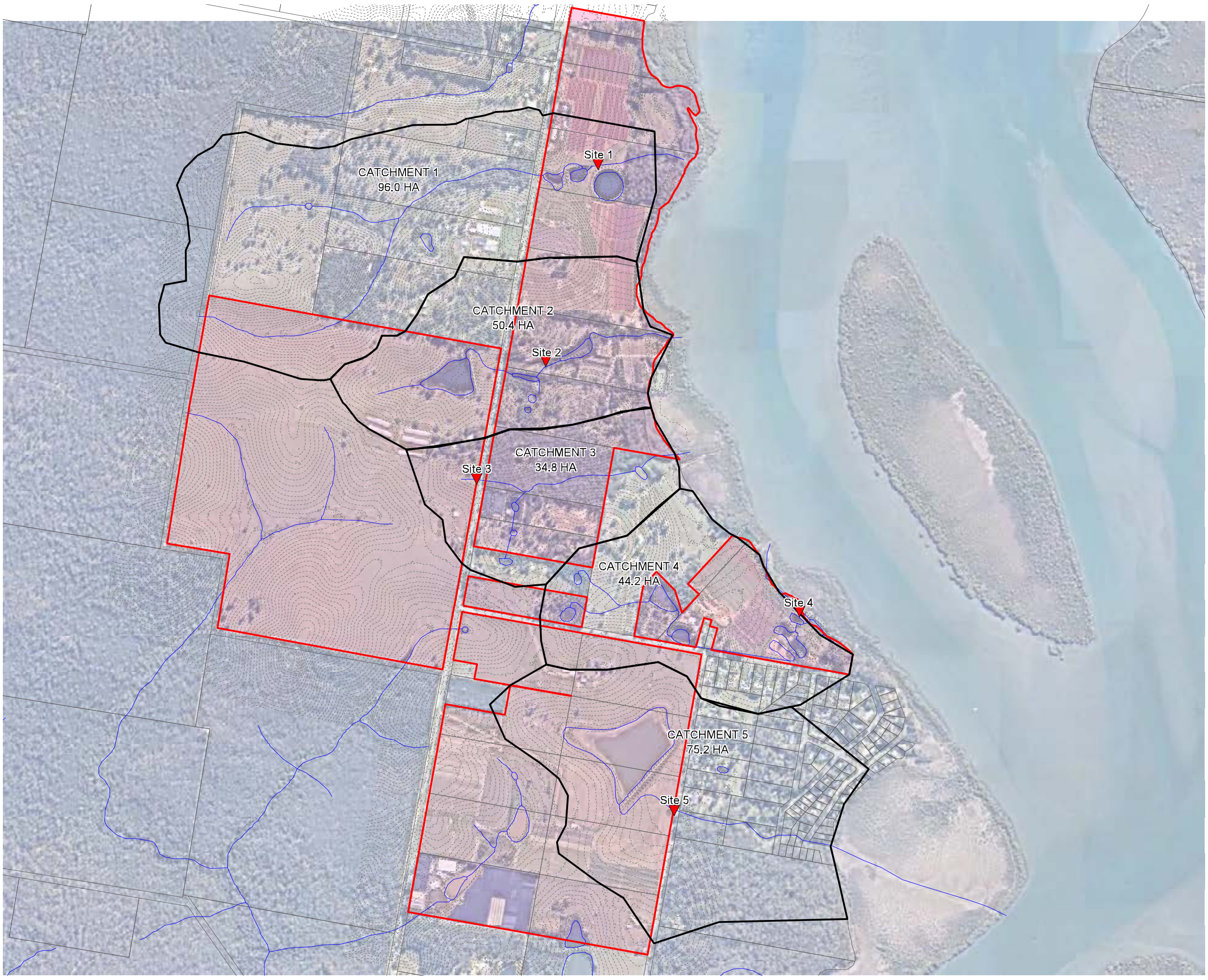
Catchment 1 (96.0ha) - Runoff in the northern portion of the site drains via sheet flow to a drainage depression along the northern boundary. Flows from this catchment enter private property to the north and then ultimately back into Shoreline under Serpentine Creek Road and discharges via a series of farm dams. The drainage line downstream of the dams has been infilled and flows appear to only leave this sub-catchment following large rain events. The tidal reach downstream of the farm dams is Mangrove dominated.

Catchment 2 (50.4ha) - Runoff from the grazed upper catchment drains via sheet flow into a large dam. Once the dam is filled it over tops to a grassed depression and discharges under Serpentine creek road into a series of online dams, which previously provided water for a plant nursery. Much of the vegetation along this drainage line has been modified by the previous nursery land use. Downstream of the dams remnant vegetation occurs for approximately 420m before flows enter another farm dam and then discharge to a mangrove lined drain into Moreton Bay.

Catchment 3 (34.8ha) - This smaller sub-catchment includes historic aquaculture land use. A series of online dams and ponds occur on the main drainage line heading northwards. A small grazed sub-catchment discharges from the western side of Serpentine Creek Road via sheet flow.

Catchment 4 (44.2ha) - This sub-catchment is comprised of numerous farm dams which are used for irrigation of crops and stock watering. This catchment also includes areas of urban runoff. Runoff from the site entering Moreton Bay occurs only once farm dams are full or directly via sheet flow from the cane farm. The drainage outfall is via a mangrove line drain.

Catchment 5 (75.2ha) - The upper sub-catchment includes large areas of grazed open grass land draining via sheet flow to a very large dam. Downstream of the dam is another stock watering hole immediately upstream of Orchard Road. Downstream of Orchard Road the drainage line enters an area of remnant vegetation with no clearly defined channel (broad shallow depression). The outfall of this waterway was not accessible at the time of the inspection.



LEGEND

🟥	Shoreline Application Boundary
—	RP Boundary
┈	1m contours
—	Drainage
━	Moreton Bay draining catchment
▼	Water quality sample site

Scale:
1 : 12,000 (A3)

FIGURE 2.1
CATCHMENTS, DRAINAGE AND EXISTING LAND USE

Project: 4235
Shoreline Redlands

Date:
15 June 2017

Client:
Shoreline Redlands Pty Ltd

The two sampling event results for each site indicate that nutrient levels (including bio-available forms of nitrogen and phosphorous) may regularly exceed State Water Quality Objectives (WQOs) (DEHP 2016) when there is sufficient rainfall to generate flows from the onsite farm dams. Suspended solids levels were only elevated at Sites 1 and 4.

The results (**Table 1** taken from Attachment 1) indicate generally poor water quality in the site's streams, particularly following periods of no flow when stagnant water stored within farm dams is flushed downstream. This result is expected for the existing agriculture and grazing land use, which was confirmed via desktop models. The onsite farm dams are likely compounding water quality issues, resulting in elevated nutrients (nitrogen and phosphorus).

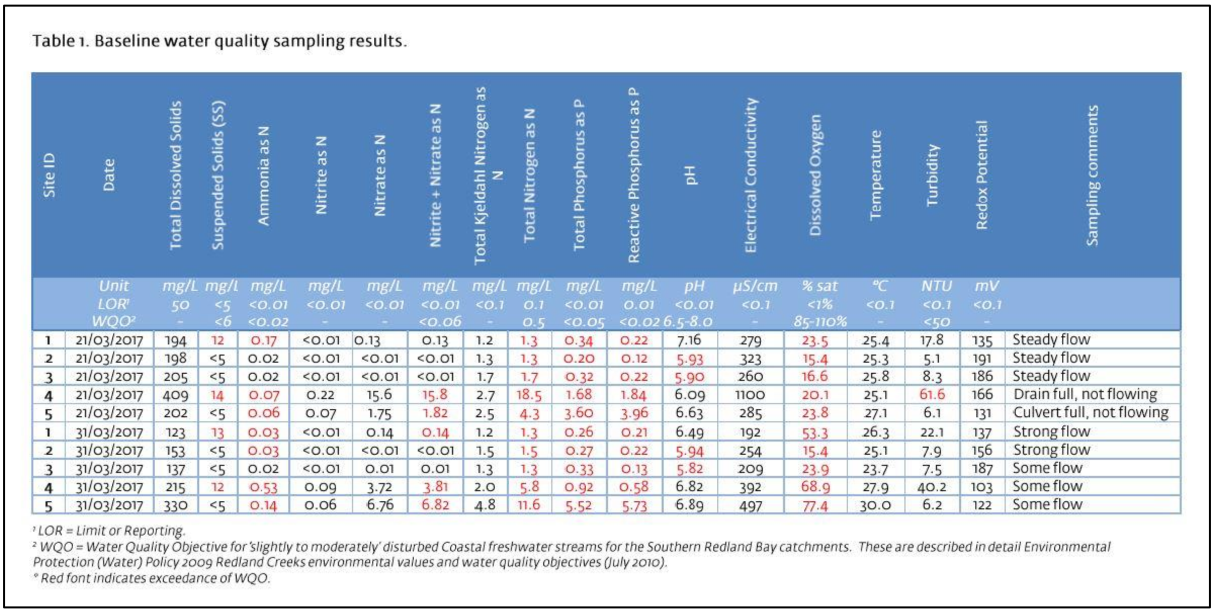


Table 1. Baseline water quality sampling results.

Site ID	Date	Total Dissolved Solids	Suspended Solids (SS)	Ammonia as N	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Reactive Phosphorus as P	pH	Electrical Conductivity	Dissolved Oxygen	Temperature	Turbidity	Redox Potential	Sampling comments
	Unit	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*pH*	*µS/cm*	*% sat*	*°C*	*NTU*	*mV*	
	LOR¹	*50*	*<5*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.1*	*0.1*	*<0.01*	*0.01*	*<0.01*	*<0.1*	*<1%*	*<0.1*	*<0.1*	*<0.1*	
	WQO²	*-*	*<6*	*<0.02*	*-*	*-*	*<0.06*	*-*	*0.5*	*<0.05*	*<0.02*	*6.5-8.0*	*-*	*85-110%*	*-*	*<50*	*-*	
1	21/03/2017	194	12	0.17	<0.01	0.13	0.13	1.2	1.3	0.34	0.22	7.16	279	23.5	25.4	17.8	135	Steady flow
2	21/03/2017	198	<5	0.02	<0.01	<0.01	<0.01	1.3	1.3	0.20	0.12	5.93	323	15.4	25.3	5.1	191	Steady flow
3	21/03/2017	205	<5	0.02	<0.01	<0.01	<0.01	1.7	1.7	0.32	0.22	5.90	260	16.6	25.8	8.3	186	Steady flow
4	21/03/2017	409	14	0.07	0.22	15.6	15.8	2.7	18.5	1.68	1.84	6.09	1100	20.1	25.1	61.6	166	Drain full, not flowing
5	21/03/2017	202	<5	0.06	0.07	1.75	1.82	2.5	4.3	3.60	3.96	6.63	285	23.8	27.1	6.1	131	Culvert full, not flowing
1	31/03/2017	123	13	0.03	<0.01	0.14	0.14	1.2	1.3	0.26	0.21	6.49	192	53.3	26.3	22.1	137	Strong flow
2	31/03/2017	153	<5	0.03	<0.01	<0.01	<0.01	1.5	1.5	0.27	0.22	5.94	254	15.4	25.1	7.9	156	Strong flow
3	31/03/2017	137	<5	0.02	<0.01	0.01	0.01	1.3	1.3	0.33	0.13	5.82	209	23.9	23.7	7.5	187	Some flow
4	31/03/2017	215	12	0.53	0.09	3.72	3.81	2.0	5.8	0.92	0.58	6.82	392	68.9	27.9	40.2	103	Some flow
5	31/03/2017	330	<5	0.14	0.06	6.76	6.82	4.8	11.6	5.52	5.73	6.89	497	77.4	30.0	6.2	122	Some flow

[1] LOR = Limit or Reporting.
[2] WQO = Water Quality Objective for 'slightly to moderately' disturbed Coastal freshwater streams for the Southern Redland Bay catchments. These are described in detail Environmental Protection (Water) Policy 2009 Redland Creeks environmental values and water quality objectives (July 2010).
° Red font indicates exceedance of WQO.

2.2 Storm water runoff volumes

Total modelled existing storm water outflows for the five catchments are provided below:

Catchment	**1**	**2**	**3**	**4**	**5**
Outflow Volume (ML/yr)	311	170	107	153	230
Surface flow (days)*	49	37	26	35	58

* Count of days where outflows are > 4l/s (approx. equivalent to 5 mm rainfall).

2.3 Acid sulfate soils on site

The Acid Sulphate Soils (ASS) assessment and reporting (**Attachment 2**) involved detailed field sampling at 40 bore holes in three areas and laboratory analysis to provide a comprehensive understanding of the presence/absence and potential risk of ASS impacting on the ecological values of Moreton Bay as a result of the development.

Only two samples showed evidence of Potential Acid Sulfate Soils (PASS) in locations towards the south-eastern portion of the development area. The remainder of the tested sites showed the development area currently supports naturally acidic soils, but not ASS.

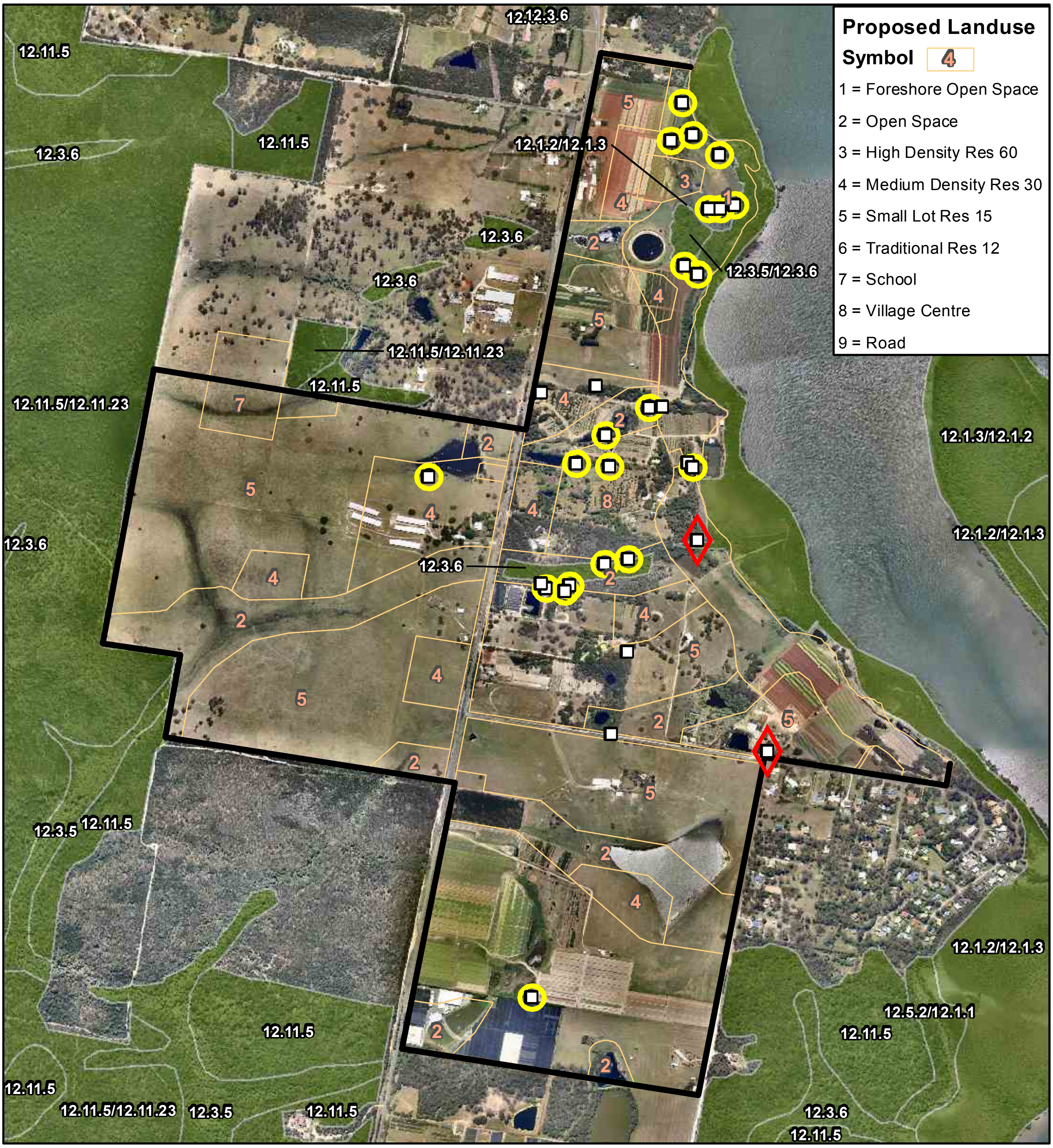
2.4 Types and prevalence of invasive species

Two weeds of national significance (WONS), Lantana *Lantana camera* and Asparagus fern *Asparagus aethiopicus,* were detected within the development area (BAAM 2014, updated 2016). The locations where WONS were recorded are shown on **Figure 3.4,** extracted from BAAM (2014).

In addition to Lantana and Asparagus, small infestations of Camphor Laurel *Cinnamomum camphora*, Brazilian Pepper *Schinus terebinthifolius* and Singapore Daisy *Sphagneticola trilobata,* listed as Category 3 restricted invasive plants under the Queensland *Biosecurity Act 2014,* were recorded from the development area. These weeds were particularly evident around the edges of bushland patches and within the central drainage line mapped as remnant vegetation (refer to **Figure 3.4**).

Although no targeted fauna pest surveys have been undertaken, scats of either Fox or dog were recorded during targeted Koala surveys (BAAM 2014). The development area currently provides habitats for the European Fox *Vulpes vulpes,* and feral Cat *Felis catus* and it is considered likely that these pests are present throughout the local area.

Cane Toads *Rhinella marina* are present throughout the development area, as they are throughout all urbanised areas of south-east Queensland.



Notes: Imagery sourced from Nearmaps 2013

1:17,000 at A4

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

0 50 100 200 300 400 500 600 700 800 900 1,000
Meters

LEGEND

Weeds of National Significance:

◇ *Asparagus aethiopicus*

○ *Lantana camara*

Remnant Vegetation

🟩 Regional Ecosystem Designations (DEHP)

Land Protection (Pest and Stock Route Management) Act 2002:

☐ Class 3 Weed

Figure: 3-4

Title: State Vegetation Mapping and Significant Weed Infestations on Site

Project: **Shoreline Ecological Study**

Client: **Fox and Bell Group**

BAAM
ECOLOGICAL CONSULTANTS

Document Location: D:\GIS\Jobs\0345-002 Shoreline Ecological Studies\GIS\MXDs\Report\FINALFIGURES V18052014\Figure 3-4 State Vegetation Mapping and Significant Weed Infestations on Site.mxdDate: 20/05/2014 9:07:53 AM

Drawn By: MG Reviewed by: AC Date: 20/05/2014

2.5 Types and levels of disturbances to shorebirds and shorebird habitat arising from current use of the site

Existing potential threats to shorebirds and shorebird habitats from current and past land uses include:

- Humans and dogs disturbing feeding birds. **Level of Disturbance**: is considered low due to retained mangrove vegetation barrier between any proposed works and foraging habitats together with the thick mud substrate which makes traversing low tide areas by humans or dogs extremely difficult.
- Unmitigated storm water runoff into Moreton Bay, which may contain excess levels of fertilizers, herbicides and pesticides, as well as sedimentation. Storm water runoff could impact on shorebird food resources (benthic invertebrates). **Level of Disturbance**: is considered to be relatively high.
- Noise disturbance to feeding shorebirds from farm machinery. **Level of Disturbance**: is likely to be moderately low and very intermittent.
- Construction of dams changing natural hydrological flows, which could impact on shorebird food resources. **Level of Disturbance**: expected to be low as tidal movements will flush any excess freshwater into the wider Moreton Bay where it will be diluted to undetectable amounts.
- Clearing of mangrove vegetation for infrastructure and boat access. **Level of Disturbance**: Google aerial imagery shows three unapproved boat launch points in close proximity to the development. Year of construction of these launch points and level of use is unknown, but it is expected that use would be restricted to local residents only and, therefore, the level of disturbance would be relatively low.

3. Quantification of Impacts to Moreton Bay Ramsar Wetland

3.1 Stormwater quality during construction

The construction phase involves earthworks and significant disturbance to the existing landform, which presents the greatest potential for impacts to Moreton Bay. Coarse and fine sediment runoff into Moreton Bay could smother benthic flora and fauna and cause an increase in turbidity. These potential impacts could cause a change in benthic species composition, which could impact shorebird foraging habitats. The existing band of mangrove vegetation would provide some buffering of sediment runoff; however, if unmitigated the severity of this impact could be high, although the extent would be fairly localized.

3.2 Stormwater quality during operation

MUSIC Modelling has been undertaken to assess impacts to water quality and hydrology during the operational phase. MUSIC is the *Model for Urban Stormwater Improvement Conceptualisation* and provides the ability to simulate both quantity and quality of runoff based on continuous rainfall time series data. The modelling assessment involved:

- Predicting the existing site baseline water quality and flows.
- Predicting the proposed fully developed and mitigated urban water quality and flows.
- Comparing the results to assess for impacts between the two scenarios.

As discussed in **Section 2.1** existing water entering Moreton Bay from the development area is currently of poor quality. **Table 3.1** (extracted from **Attachment 1**) provides the MUSIC modelling for existing water quality. **Table 3.2** (extracted from **Attachment 1**) provides the MUSIC modelling for a mitigated development scenario, which shows there will be an overall improvement in water quality entering Moreton Bay following construction.

Table 3.1 provides MUSIC model results for existing water quality.

Parameter		Catch 1	Catch 2	Catch 3	Catch 4	Catch 5
Water quality - pollutant annual loads	Total suspended Solids (tonnes/yr)	100	57.7	28.7	55.4	64.3
	Total Phosphorous	111	63.5	33.5	61.6	73.2
	Total Nitrogen (kg/yr)	651	358	194	326	398
Water quality - Storm flow pollutant concentration*	Mean TSS (mg/L)	266	323	278	337	126
	Mean TP (mg/L)	0.303	0.379	0.335	0.406	0.179
	Mean TN (mg/L)	1.79	2	1.81	2.05	1.15

Table 3.2 provides MUSIC model results for developed mitigated water quality. Bracket values indicate change compared with existing case scenario.

Parameter		Catch 1	Catch 2	Catch 3	Catch 4	Catch 5
Water quality - pollutant annual loads	Total suspended Solids (tonnes/yr)	74.8 (-25%)	16.7 (-71%)	11.4 (-60%)	16.8 (-70%)	25.8 (-60%)
	Total Phosphorous (kg/yr)	97.1 (-13%)	34.2 (-46%)	24.9 (-26%)	32.6 (-47%)	46.4 (-37%)
	Total Nitrogen (kg/yr)	613 (-6%)	38.6 (-89%)	191 (-2%)	235 (-28%)	326 (-18%)

Parameter		Catch 1	Catch 2	Catch 3	Catch 4	Catch 5
Water quality - Storm flow pollutant concentration*	Mean TSS (mg/L)	65.8 (-75%)	26.2 (-92%)	26.6 (-90%)	31.9 (-91%)	27.2 (-78%)
	Mean TP (mg/L)	0.0947 (-69%)	0.0591 (-84%)	0.063 (-81%)	0.0705 (-83%)	0.0615 (-66%)
	Mean TN (mg/L)	0.915 (-49%)	0.74 (-63%)	0.76 (-58%)	0.773 (-62%)	0.738 (-36%)

3.3 Nutrient enrichment or contamination during construction and operation

Nutrient enrichment or contamination could result in the following impacts to Moreton Bay:

- Eutrophication / water quality impacts;
- Change in species composition;
- impacted on shorebird foraging habitats Algal blooms;
- Invasion of aquatic weeds.

These impacts could affect benthic organism abundance and diversity, thereby negatively impacting on shorebird foraging habitats without appropriate management actions. The extent and severity of wastewater flow to Moreton Bay from various points in the network is limited due to the proposed wastewater system design, network monitoring and control capabilities and the operational response procedures that will be enacted to mitigate the volume or migration of a sewer leak into environmentally sensitive areas.

3.4 Acid sulfate soil runoff during construction

The Queensland Acid Soil Technical Manual V4.0 (DSITIA 2014) indicates that, although sea water has a moderate buffering capacity, a depletion of carbonate can occur when acidic waters are discharged or leached into a marine environment. The depletion of carbonate may impact near-shore and estuarine organisms and may lead to an irreversible change in tidal and marine ecosystems.

As ASS management plan and recommendations to treat highly acidic soils have been developed, as provided in **Attachment 2**. The low occurrence of ASS within the development area together with the prescribed management measures indicate that the extent and severity of impacts to Moreton Bay as a result of discharge or leaching of ASS or acidic waters is low and manageable.

3.5 Increased storm water runoff

The introduction of impervious surface and the removal of farm dams within the Shoreline Redland development site will result in increased flood flows leaving the site. This was confirmed via MUSIC modelling which indicates that total annual run-off volumes are expected to increase by 20-50% (**Attachment 1**). **Table 3.3** presents the modelled existing and predicted outflow volumes for the development area.

Table 3.3 shows results of modelled existing outflow volumes and modelled predicted outflow volumes on completion of proposed development (data extracted from Attachment 1).

Parameter		Catch 1	Catch 2	Catch 3	Catch 4	Catch 5
Existing Hydrology	Total outflow volume (ML/yr)	311	170	107	153	230
	Surface flow (days)*	49	37	26	35	58
Predicted Hydrology on completion of development	Total outflow volume (ML/yr)	370 (19%)	228 (34%)	163 (52%)	202 (32%)	290 (26%)
	Surface flow (days)*	66 (+17)	64 (+28)	54 (+28)	61 (+26)	83 (+25)

** Count of days where outflows are > 4l/s (approx. equivalent to 5mm rainfall event)*

The increased flow results in between 17-28 additional flow days within the streams per year. These additional flow days relate to the increase number of smaller rainfall events that previously would not have triggered runoff. The increase flow volumes may have potential impacts on the stability of the waterways and water quality entering Moreton Bay.

The predicted changes to catchment hydrology would only be expected to have measureable impacts within the drainage lines that interface with the Moreton bay Ramsar Wetland. The additional runoff volumes and increased frequency of smaller events predicted by the modelling will result in the waterways becoming wetter downstream and could cause erosion in stormwater outlet locations if not managed appropriately. Within the tidal reaches the addition of extra freshwater would translate to slightly lower salinity levels compared to the current runoff profile (particularly in the upper tidal zones of each waterway). However, all of the development area waterways that discharge to Moreton Bay do so via tidally influenced, mangrove lined waterways. Mangroves are typically tolerant of a range of salinities so the additional freshwater is not expected to unduly impact on this vegetation.

The impact on Moreton Bay and Ramsar wetland values beyond the tidal waterways leaving the Shoreline Redlands development would be negligible given the significantly large size of the bay, the proximity to Logan River, which drains into Moreton Bay and the effect of tidal flushing.

3.6 Ongoing impacts on shorebird roosting and foraging from land-based human and animal activity, light and noise

Any form of disturbance which causes a bird to take flight can lead to a decrease in energy uptake and an increase in energy expenditure, which can lead to an overall reduction in health and fitness, dependent on the frequency and duration of disturbance. Increased disturbances as a result of the development could potentially cause additional pressures on shorebird populations that are already showing signs of population decline.

Potential physical disturbances from the development could be the result of:

- Humans and/or dogs traversing low-tide feeding habitats;
- Humans and/or dogs traversing areas in line of sight of feeding shorebirds;
- Increased noise; and
- Increased light spillage.

As determined through targeted shorebird surveys (BAAM 2016), there are no shorebird roosting areas within the immediate vicinity of the development area; therefore, potential impacts to shorebird roosting as a result of the proposed development are unlikely to occur.

In terms of disturbance to foraging shorebirds, Eastern Curlew have been shown to initiate flight response to disturbance (referred to as FID – flight-initiation distance) at greater distances than other shorebirds (Smit and Visser 1993; Paton et al. 2005; Glover *et al.* 2011), with larger body mass being interpreted as the factor influencing their sensitivity to disturbance. A study of shorebird FID conducted in Victoria, Australia, showed the mean FID for Eastern Curlew was 126 m (Glover *et al.* 2011).

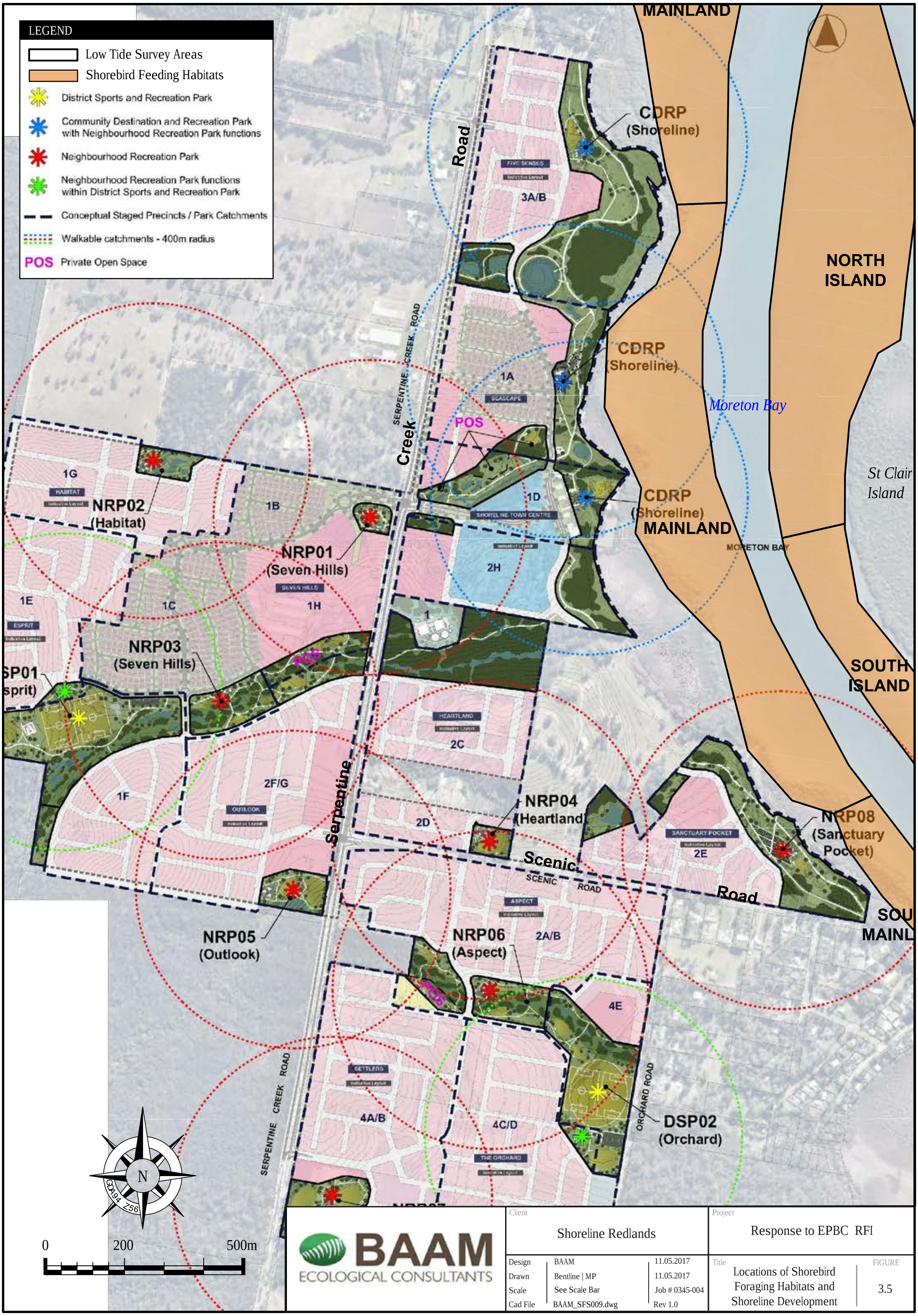
The proposed development includes foreshore open space area stretching the entire eastern boundary of the development and ranging in width from approximately 35 m at its narrowest point to approximately 300 m at its widest point. A pedestrian walkway will be established throughout much of the foreshore open space area, adjacent to, but not within, existing, fringing mangrove vegetation. The closest point of the proposed walkway to shorebird foraging habitats is approximately 45 m (**Figure 3.1**). Therefore, there will be a risk that persons using the constructed pedestrian path could disturb shorebirds, particularly in areas where active open space occurs within 126 m (Glover *et al.* 2011) of potential foraging habitats.

However, a band of mangrove vegetation ranging in width from approximately 30 m at its narrowest point to approximately 120 m at its widest cover will be retained, protected and managed to separate the development area from shorebird low-tide feeding habitats. This band of mangrove vegetation would form an effective barrier to human and dog traffic accessing low-tide shorebird habitats due to the dense growth form of mangroves and associated ground cover of pneumatophores. The soft muddy substrate associated with shorebird foraging habitats is also likely to discourage human or dog traffic into these areas; therefore, the extent and severity of this potential impact is considered to be minimal and manageable.

Research has also shown that shorebirds habituate to non-lethal repetitive disturbances (refer BAAM 2016 and references therein), and two Eastern Curlew have been recently observed foraging within 20 m of the passenger ferry terminal at Toondah Harbor, with neither of the birds showing any signs of disturbance when the ferry left the terminal (personal observations J. Chambers & S. Trevaskis). It is therefore considered that Eastern Curlew and other shorebirds will habituate to general pedestrian access along the proposed walkway, as well as to other non-lethal, repetitive disturbances from light and noise.

The retained band of mangrove vegetation would also form an effective barrier to noise and light disturbances to Eastern Curlew and other migratory shorebirds due to the dense growth form of mangroves.

Overall, when these factors are considered together with the low densities of Eastern Curlew and other migratory shorebirds adjacent to the development area (see BAAM 2016 and references therein), it is considered that the extent and severity of impacts to Eastern Curlew and other migratory shorebirds due to physical disturbances arising from activities within the proposed foreshore open space area and adjacent residential development will be minimal and manageable.



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Client	Project
Shoreline Redlands	Response to EPBC RFI

Design	BAAM	11.05.2017	
Drawn	Bentline | MP	11.05.2017	
Scale	See Scale Bar	Job # 0345-004	
Cad File	BAAM_SFS009.dwg	Rev 1.0	

Title
Locations of Shorebird Foraging Habitats and Shoreline Development

FIGURE
3.5

3.7 Ongoing impacts on shorebirds and other nationally protected species within the greater Moreton Bay area arising from increased recreational use of waterways

Potential impacts on shorebirds and other nationally protected species from increased recreational use of waterways include:

- physical disturbance to roosting or foraging shorebirds;
- propeller hits causing injury to turtles or marine mammals;
- increased hydrocarbon pollution causing degradation of water quality; and
- increased fishing.

The population growth for Redland City is forecast to increase by approximately 40,000 by 2031 with Redland Bay forecast to increase by approximately 4,000 (refer VLC 2015). It is unknown the percentage of Redland City or Redland Bay residents that own power boats or use these boats to fish within Moreton Bay; therefore, it is unknown what increase in boat traffic and fishing will be experienced within the greater Moreton Bay area as a result of the proposed development. However, as there are no development plans for construction of a boat ramp within the development area, it is considered that the proposed development will not cause any significant increase in boating traffic or fishing in the local area.

Even so, boating traffic within Moreton Bay is expected to increase, regardless of the proposed development. It is therefore considered that the extent and severity of any increase in boating traffic as a result of the proposed development would be negligible in comparison to what is likely to occur in the broader Moreton Bay area.

3.8 Spread of weeds and pests during construction and operation

Construction vehicles moving through weed infested sites have the potential to spread weed propagules to any weed-free areas via attachment to vehicles during muddy conditions.

Residents have the potential to dump garden refuge into any nearby bushland sites, thus causing an increase in diversity and prevalence of invasive species such as Asparagus Fern and Lantana.

Construction activities which create extended pooling of water, and storm water treatment areas such as bioretention basins, have the potential to create Cane Toad breeding habitats.

None of the existing weed species within the development area infiltrate marine environments; therefore, the extent and severity of the potential impact to adjacent marine areas from weed invasions is considered to be negligible.

Once developed, the potential threat from fauna pest species is expected to decrease with an increase in human presence; therefore, the extent and severity of this potential impact is considered to be minimal and manageable.

3.9 Increased litter during operation

Human refuse can cause death or severe injury to marine wildlife as a result of animals either ingesting plastic or becoming tangled in discarded ropes, fishing lines (C&R Consulting 2009). The increase in human refuse as a result of the development could see an increase in impacts to the local marine fauna in the adjacent Moreton Bay. Without appropriate management strategies, this impact could be severe in the local area.

4. Avoidance and Mitigation of Impacts to Moreton Bay Ramsar Wetland

4.1 Stormwater quality during construction and operation

To minimise any significant impacts to the ecological functioning of the Ramsar wetland, erosion and sediment control will occur on a development stage by stage basis in accordance with Best Practice Erosion and Sediment Control (IECA 2008) to achieve the objectives listed in the State Planning Policy (DSDIP 2016). This will involve a combination of:

- Erosion control - Ensuring that all exposed surfaces are stabilised as soon as possible and that erosion of un-stabilised areas of works are minimised;
- Drainage control - Ensuring that provision is made to control all onsite runoff to designated treatment areas and to enable appropriate bypass of external flows which do not require treatment;
- Sediment capture - Ensuring that mobilised sediment is captured through a combination of source controls such as silt fences and appropriately designed sediment basins. Where possible sediment basins for construction will be located within the voids required for the future storm water quality treatment systems (sediment basins, bioretention basins, wetlands etc.).

The details of the local erosion and sediment controls for each stage of development are not provided as part of this response, but have been previously provided for Stages 1a, b and c in DesignFlow (2016 a,b). The mitigation measures provided in these Stormwater Quality Management Plans include construction of bioretention systems, and MUSIC modelling (refer **Section 3.2** and **Attachment 1**) predicts that these proposed bioretention systems and other mitigation measures will see a reduction in total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) in comparison to predicted existing levels of these parameters. This improvement is shown both in terms of annual pollutant loads and concentration based values (i.e. during flow events). Detailed Stormwater Quality Management Plans will be prepared for each future development stage, to be submitted with each development application.

The improvement in water quality during the operational phase is due to the adoption of stormwater quality treatment systems that are required under the State Planning Policy (DSDIP, 2016) for all new urban developments in Queensland. It is recognised that no additional mitigation measures are required beyond the current State Planning Policy legislative requirements already applicable to the site as the proposed actions will result in an improvement on the current situation.

Water quality objectives for stormwater leaving the development area are provided in Table 8 (extracted from **Attachment 1**).

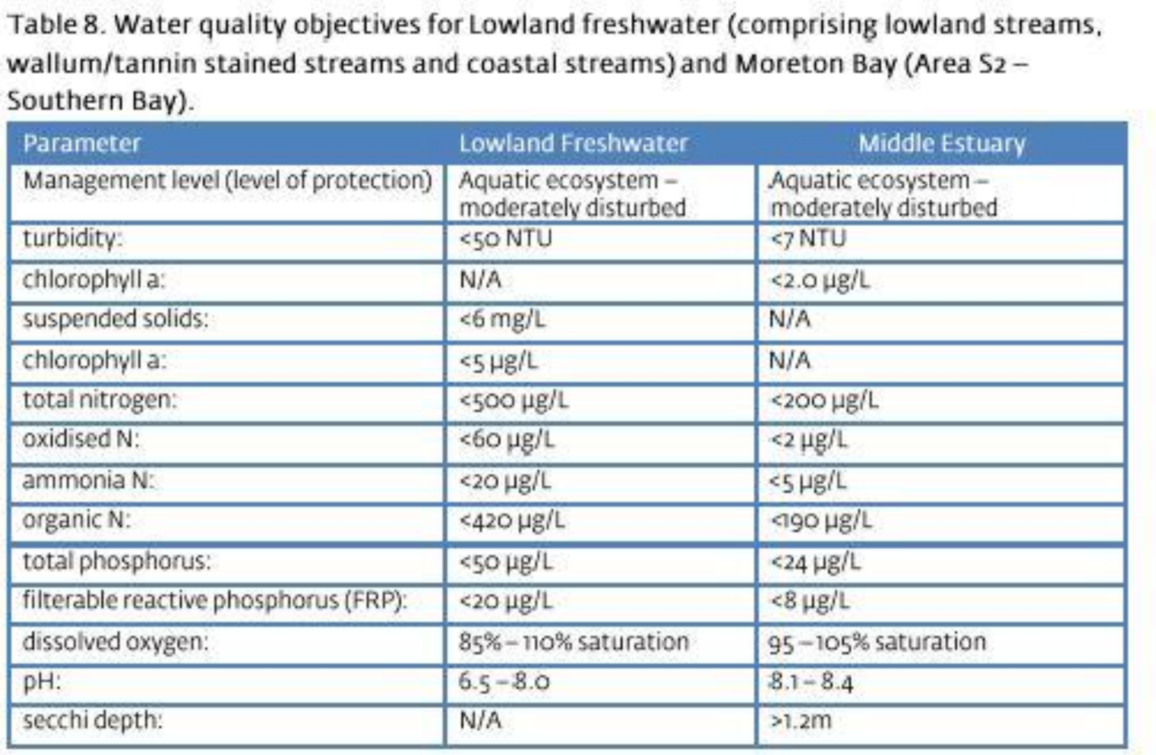


Table 8. Water quality objectives for Lowland freshwater (comprising lowland streams, wallum/tannin stained streams and coastal streams) and Moreton Bay (Area S2 – Southern Bay).

Parameter	Lowland Freshwater	Middle Estuary
Management level (level of protection)	Aquatic ecosystem – moderately disturbed	Aquatic ecosystem – moderately disturbed
turbidity:	<50 NTU	<7 NTU
chlorophyll a:	N/A	<2.0 µg/L
suspended solids:	<6 mg/L	N/A
chlorophyll a:	<5 µg/L	N/A
total nitrogen:	<500 µg/L	<200 µg/L
oxidised N:	<60 µg/L	<2 µg/L
ammonia N:	<20 µg/L	<5 µg/L
organic N:	<420 µg/L	<190 µg/L
total phosphorus:	<50 µg/L	<24 µg/L
filterable reactive phosphorus (FRP):	<20 µg/L	<8 µg/L
dissolved oxygen:	85% – 110% saturation	95 – 105% saturation
pH:	6.5 – 8.0	8.1 – 8.4
secchi depth:	N/A	>1.2m

4.2 Spills of hydrocarbons and other contaminants during construction

To minimise the risk that contaminants may impact on the ecological functioning of the adjacent Ramsar wetland, the Project Manager will, prior to commencement of construction develop specific Health Safety and Environment (HSE) induction material and will ensure all relevant site personnel are aware of, and trained in, the environmental requirements of the development, by undergoing a project specific HSE induction. The HSE induction will include the following components to ensure no hydrocarbons or other pollutants impact on Moreton Bay during construction:

- Adherence to HSE legislative requirements and environmental policies, including the potential consequences of not meeting environmental responsibilities;
- Site access requirements;
- Organisational structure, roles and responsibilities and communication protocols;
- Erosion and sediment control;
- Protection of water quality;
- Amenity (including noise and light management);
- Flora and fauna management (including interaction with fauna, particularly MNES species);
- Equipment hygiene requirements;
- Waste management;
- Hazardous materials management;
- Spill management and response, including spill kit types and locations;
- Incident management; and
- Crisis and emergency management.

4.3 Nutrient enrichment or contamination during construction and operation

To minimise the risk of increased nutrients entering and impacting on the ecological functioning of the adjacent Ramsar wetland, a pressure sewer system has been designed for the development. The proposed Flow Systems (Flow) recycled water scheme at the Shoreline Redlands development involves the collection of sewage from the development through a pressure sewer system, treatment to a high grade of recycled water at the Local Water Centre and redistribution to the development through a dedicated recycled reticulation network.

All sewage is confined either within tanks located on individual properties, within the sealed, pressurised pipe system, or within closed flow balance tanks at the front-end of the Local Water Centre.

Traditional sewer infrastructure in Australia transports sewer by gravity. The engineering of a gravity sewer network means it is inherently open to groundwater and stormwater inflow, which dramatically increases the volume of water and types of waste the network needs to be able to accommodate. Gravity sewer networks discharge untreated sewage into the environment if the network overflows with additional wet weather inflow. These overflows are uncontrolled and concentrated at specific locations and, because gravity sewer networks need to manage the water from rainfall and stormwater, as well as wastewater, treatment facilities have to be much larger, creating a greater impact on the community and environment.

A key feature of Flow’s approach to sewer servicing involves the use of a pressure sewer system rather than traditional gravity sewer systems. Pressure sewer is a well-established alternative to gravity sewer and eliminates inflow from rain events, which eradicates the possibility of flooding and overflowing of the sewer system to the environment. In addition, as the pressure sewer system is sealed, there is no opportunity for sewer to escape from the system except in the rare circumstance of pipe or tank failure, in which case is immediately identified. Across all schemes, Flow specifies the use of thick walled HDPE pipes with fusion welded joints to alleviate any concern of such a leak. In any case, in such an event, Flow is able to isolate affected pipe sections to limit any leaks and re-route sewage to maintain continuity of service as well as maintain a degree of control over the on-lot pumps that are supplying the pressure sewer network. More information on pressure sewer systems can be found in the pressure sewer FAQ located in **Attachment 3**.

With regards to the Local Water Centre which treats sewer to recycled water quality suitable for internal reuse and unrestricted irrigation, it incorporates a closed system process which means it does not discharge waste into the local environment. Unlike a traditional gravity sewer system, which is susceptible to overflows, the Local Water Centre does not need a wet weather overflow detention pond as there is no minimal increase in sewer flows in rain events. In addition, pressure pumps are individually controlled to maintain constant inflows to ensure the Local Water Centre doesn’t exceed intake capacity at any time. This mitigates the possibility of an overflow including remote monitoring and control, and, as a last resort, tankering.

The Flow wastewater system comprises the following elements:

1. Local Water Centre – the core treatment plant infrastructure that processes sewer into high grade recycled water
2. Network Infrastructure – the pressure sewer collection pipe network and recycled water reticulation network including associated appurtenances

3. On-lot Infrastructure – individual sewage storage tanks and macerator pumps that feed the pressure sewer network and provide buffer storage plus the recycled water meter

In terms of continuity of operations, the Flow approach to sewer servicing is robust and not susceptible to problems that can occur under a traditional gravity sewer and treatment plant approach across all network elements. The impact and response to various events are summarised below:

Component	Area Flooding	Critical Equipment Failure
Core infrastructure (LWC)	Above 1:100 flood extent	Duty/standby on critical equipment and Mitigating Operational Measures
Sewer Network	Isolated from inflow	Blockage Mitigation
On-lot Infrastructure	Above 1:100 flood extent	Buffer storage in design and Mitigating Measures

Relating to the Local Water Centre, the following design and mitigating measures are included as part of the Local Water Centre design and operation to ensure continuity of operations and minimise the risk of excess nutrients entering Moreton Bay:

- Excess storage capacity of the flow balance tanks (plant sewer collection point).
- Multiple treatment streams for process redundancy and the incorporation of duty/standby equipment at each critical process unit.
- Remote monitoring and control of the plant control system with 24/7 critical alarm notifications.
- In built additional capacity at the treatment plant.
- Backup generation on site for key processes and control systems.
- Critical spare parts availability.
- Contingency plans and policies including: minimisation of sewage through customer notifications, rapid response to infrastructure failure, emergency tankering procedures.

For the network operation, the following design and operational measures are employed to reduce the possibility of blockage:

- All pressure sewer flows fed by macerated pumps which alleviates clogging.
- Systems design specification and minimum velocities.
- System redundancy through multiple routes after network isolation of pipe sections.
- Use of flushing points and systematic maintenance.
- Network flow and pressure monitoring instruments with alarms.

For on-lot pumping equipment, the following measures ensure continuity of in the event of power failure, blockage or malfunction of a macerating submersible pump supplying the pressure sewer network:

- On lot equipment alarms and level monitoring.
- Minimum on-lot excess tank capacity (ensures 48 hours of continued operation until possibility of overflow).
- Responsive callouts and procedures.

- Direct on-lot tankering pumpout (emergency only).

Flow operates several schemes involving critical infrastructure and continually improves upon the systems, procedures and design in each successive iteration of the facility.

4.4 Acid sulfate soil runoff during construction

Potential acid sulfate soils (PASS) were recorded at two sampling locations towards the south-eastern boundary of the development area. Prior to construction, further ASS investigations will be undertaken to determine if ASS are actually present and if the prescribed mitigation measures in the ASS Management Plan (**Attachment 2**) need to be implemented.

If present and if excavation below RL 5m is required, liming of soils will be undertaken as excavation progresses. Six (6) kg of lime per tonne is the recommended liming rate for the development area.

Disturbed soils will be placed in a bunded, lined pad with perimeter drainage and sump to allow collection and treatment of any leachate formed during the soil drying and liming process. The existing dams at the location of the recorded PASS will provide suitable treatment areas for disturbed soils.

All water draining from the soil will be held in bunded areas to prevent entry into waterways or Moreton Bay until pH testing determines that the pH of the water is >5.5.

The low level of occurrence of ASS within the development area together with the prescribed management measures indicate that potential impacts to Moreton Bay as a result of the development is low and manageable.

Tableprovides the target levels for soil and water entering Moreton Bay following mitigation measures should ASS be disturbed as part of the development.

Table 4: Target Levels of Neutralised Soil and Water

Test	Component	Target Level
Monitoring of water (refer also to Section 6.2)	pH	8.0 < pH < 8.4(1)
	Turbidity	Established local water quality data prior to site disturbance and ensure that these values are not exceeded
	Aluminium (Al) and Iron (Fe)	90% to 105% saturation (1)
	Dissolved Oxygen	
Field screening of soil	pHF	5.5 < pHF ≤ 8.5
Acid based accounting of soil (sPOCAS or chromium suite test method)	Existing + potential acidity	Zero or negative
	pHKCl	pHKCl ≥ 8.5
	TAA	Zero
	TPA	Zero

Note: (1) Recommended threshold limits from Table 3.1.1 of Ref 4.

4.5 Increased stormwater runoff

For peak flow for the 1-year and 100-year ARI event, constructed sediment basins will be used to attenuate the discharge rate of stormwater from the site. Waterway stability objectives (i.e. revegetation of existing creek lines, as per Shoreline Open Space Landscape Strategy (BAAM 2016)) are also proposed which focus on protecting the site's drainage lines from erosion as a result of increased flow from urban development.

Impacts from increased stormwater runoff are not expected to unduly impact upon mangrove vegetation lining the tidally influenced reaches entering Moreton Bay, whereas impacts beyond the tidal waterways adjacent to the development area would be negligible given the size of Moreton Bay and the effect of tidal flushing.

To minimise the risk of erosion at locations of stormwater discharge impacting on the ecological functioning of the adjacent Ramsar wetland, the stormwater drainage will be designed to ensure compliance with QUDM (2013). In particular, all new stormwater drainage outfalls will be designed and constructed to ensure the following is achieved:

- appropriately integrated with receiving environment (Moreton Bay);
- does not cause erosion to bed and bank within the receiving waterway;
- outlet scour protection will be provided typically in accordance with Figure 4.

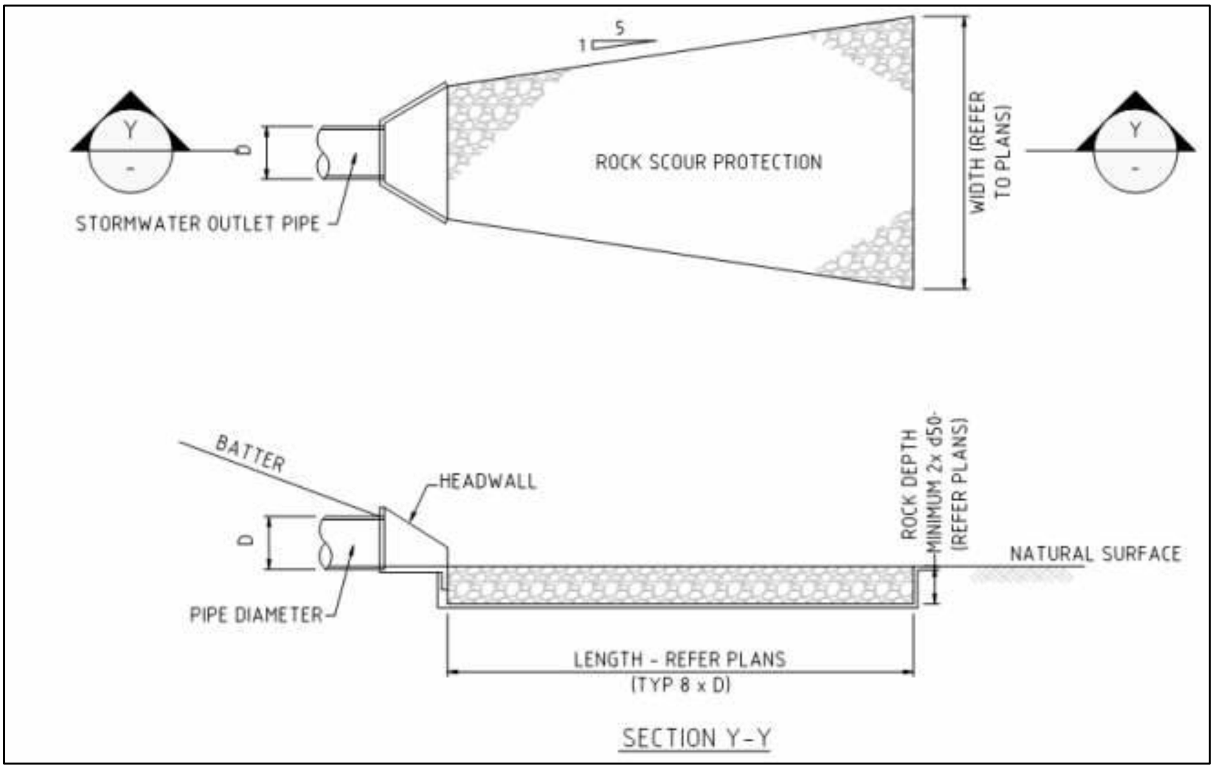


Figure 4. Typical rock scour protection detail for new drainage outlets.

4.6 Ongoing impacts on shorebird roosting and foraging from land-based human and animal activity, light and noise

To identify and mitigate all potential impacts to Eastern Curlew foraging habitats (no roost sites are present, with the closest known roost site approximately 10 km to the north of the development area), an Eastern Curlew Impact Management Plan has been compiled (**Attachment 4)**. Mitigation measures to avoid and/or mitigate potential impacts to Eastern Curlew provided in this Plan are relevant to all shorebirds within the local area and include:

- A community education program, including educational signage to inform residents and visitors of the presence of shorebirds and the impacts of physical disturbances and noise disturbances to foraging shorebirds;
- Sensitively designed lighting for the proposed walkway and recreational parks within the foreshore open space area;
- Controls on noise emissions from recreational activities within the foreshore open space area.

Numerous studies (Evans & Birchenough 2001; Burger *et al.* 2005; Glover et al. 2011); have shown that community education and engagement can play an important role in protecting shorebird habitats and minimising disturbance to shorebirds. It is therefore considered that a comprehensive education program, compiled in consultation with DoEE, will see future residents of the development actively engaging in protecting shorebird foraging habitats and minimizing any potential impacts to Eastern Curlew and other migratory shorebirds.

4.7 Ongoing impacts on shorebirds and other nationally protected species within the greater Moreton Bay area arising from increased recreational use of waterways

The forecast population growth for south-east Queensland, including Redland City, will likely see an increase in boating traffic throughout the entire Moreton Bay wetland. As there are no development plans for construction of a boat ramp within the development area, it is considered that the proposed development will not cause any significant increase in boating traffic in the adjacent section of Moreton Bay. Regardless, the presence of nationally protected species, such as marine turtles and mammals, and the need to adhere to all local and state boating/fishing requirements, will be communicated to all residents and visitors to the proposed development as part of the community education program.

It is considered that community education and engagement will play an important role in minimising potential ongoing impacts on shorebirds and other nationally protected species within the greater Moreton Bay area.

4.8 Spread of weeds and pests during construction and operation

Prior to commencement of construction the Project Manager will develop specific Health Safety and Environment (HSE) induction material and will ensure all relevant site personnel are aware of, and trained in, the environmental requirements of the development, by undergoing a project specific HSE induction (refer **Section 4.2**).

Signage will be erected at all conservation areas and along the western boundary fencing stating that dumping of garden refuse into these areas is illegal and punishable under RCC's local laws.

4.9 Increased litter during operation

All open space areas will contain regularly placed refuse bins that are designed to restrict access to litter by foraging fauna such as ibis and possums and minimise the risk that refuse would be blown out of the bins into Moreton Bay. Bins will be emptied regularly in line with RCC's waste strategy.

5. Quantification of Impacts to Koala

To provide a greater understanding of the Koala habitat values and Koala presence within bushland habitats adjacent to the western and south-western boundaries of the development, a targeted Koala survey was conducted in these habitats by BAAM Principal Ecologist and Managing Director and Dr Jo Chambers, BAAM Senior Ecologist on 16th June, 2017.

The targeted surveys involved direct (searching for Koala) and indirect (scat searches). For the indirect surveys, the bases of all Koala food trees within measured 100 x 10 m wide transects were searched for Koala scats. The locations of the transects were chosen to provide a representative sample of vegetation communities within the bushland habitats.

A total of 16 100 x 10 m wide transects were directly and indirectly surveyed over a single day. No Koala were sighted and no scats were observed. Much of the bushland habitats within 200 m of the boundary of the development is dominated by *Allocasuarina littoralis* and Angophora spp.; neither of which is recognised as a Koala food tree (AKF 2015).

The locations of the survey transects together with counts of Koala habitat trees surveyed and photographs of vegetation present at the start and end of each transect are provided in **Attachment 5**.

Management of Koala has been addressed within a Koala Impact Management Plan (KIMP) (**Attachment 6**), which has been prepared to ensure all potential impacts to the local Koala population from the Shoreline urban village development are identified and appropriately managed.

The compilation of the KIMP specifically addresses the DoEE request for further information for the Shoreline urban village development and provides details of the mitigation and corrective actions proposed.

5.1 Edge effect impacts on Koala habitat abutting the south western edge of the proposed action site

The bushland reserve abutting the southern and western edge of the development footprint on the western side of Serpentine Creek Road includes a 20 m wide road reserve. This road reserve currently consists of a cleared, dirt vehicle track that can be accessed by walkers or pushbike riders and Council maintenance vehicles and fire control, surrounded by native, mature trees and often dense stands of regrowth vegetation (**Photo 1**). During recent surveys of Koala habitat within the road reserve, no evidence of weed invasions was observed, although some dieback of regrowth vegetation, a result of natural thinning, was observed. Despite five days of surveying of Koala habitat within the adjoining road reserve, and conducting targeted Koala surveys within 16, 100 x 10 m transects in western bushland (**Attachment 5**), there was no evidence of Koala visitation recorded.

Photo 1 shows access road and regrowth vegetation.

The Shoreline development hydrological assessment (Design Flow 2016c) has identified two minor catchments draining into this western bushland reserve. There will be some minor increase in the quantity of runoff expected as a result of the development. This runoff will continue within the existing waterway flow paths where it enters into *Melaleuca*-dominated vegetation, which is well adapted for such minor changes. The proposed water treatment mitigation responses have identified that there will be an improvement in the water quality entering this area.

The proposed development will provide road frontage to the retained bushland habitats as a buffer from the residential dwellings, and provides vehicular access for fire management and emergency services. The roadway will include Koala exclusion fencing on the outer edge to choreograph Koala movement to the proposed Open Space corridors. This fencing will also provide a dual purpose in reducing access to the western bushland reserve by humans, domestic pets, etc. Currently there is no limitation on where or how Koalas access the development area and there is no provision of suitable habitat linkages.

The western bushland reserve is owned and managed by Redland City Council for conservation purposes and their approval of any future development within the road reserve is required. Council undertakes regular inspections and maintenance of this bushland reserve for the presence of environmental weeds and other management issues (e.g. track erosion, illegal access points). It is therefore considered there will be no increase in weed invasion as a result of the development and the extent and severity of edge effect impacts is predicted to be low and manageable.

5.2 Vehicle strike mortality along Serpentine Creek Road

A review of the Department of Environment and Heritage Protection (DEHP) Koala records for Redland City indicates there has only been one reported vehicle strike within the vicinity of the proposed development over the past ten years (refer **Figure 2.1** of **Attachment 6**).

In contrast, there have been 23 reported vehicle related Koala deaths over the past 10 years within the neighbouring Logan City suburbs of Cornubia and Carbrook and along Mount Cotton Road to the west (refer **Figure 2.1** of **Attachment 6**).

The low number of Koala/vehicle strikes within the development area compared to nearby southern areas could be due to higher development and therefore higher vehicle traffic movements to the south or to low Koala population densities within the southern portions of Redland City, including Redland Bay. This low number of Koala records is also indicated by the absence of Koala evidence in the western bushland reserve, despite targeted Koala surveys (**Attachment 5**) and five days of Koala habitat assessment.

The population of Redland City is forecast to increase by approximately 40,000 by 2031 with Redland Bay forecast to increase by approximately 4,000 (refer VLC 2015). Traffic modelling (VLC 2015) suggests traffic volume heading north from the proposed development along Serpentine Creek Road will increase by almost 50% by 2031 in line with increased population growth of Redland City, and traffic volumes along Beenleigh-Redland Bay Road to the south will increase by approximately 11% by 2031.

It is therefore expected that the extent and severity of Koala/vehicle mortality impacts along Serpentine Creek Road at the location of the proposed development could also increase although, given the low number of Koalas present in the local landscape, this is unlikely to be a significant impact on the local (Redland/Logan City) Koala populations.

5.3 Revised area of Koala habitat directly and indirectly impacted by the proposed action

The development area, excluding the western road reserve, currently supports approximately 15 ha of potential Koala habitats, of which approximately 12 ha will be retained, 1.2 ha will potentially be cleared, and 1.4 ha will incorporate sensitive design to minimise impacts to Koala feed trees.

The total area of the 20 m wide road reserve located to the west of the development, which will provide road access, is 2.52 ha. Final design plans for the western roadway are yet to be completed and approved by Council, although with sensitive design, and minimising earthworks wherever practical, it is expected that 30% of the Koala habitat trees within this 2.52 ha area will be retained.

To be conservative in our calculations of area of Koala impacted by the development, we have assumed that all trees within the road reserve will be removed. It is therefore estimated that a maximum of 3.72 ha of Koala habitat will be removed as part of the development.

All retained, restored and newly created Koala habitats will be managed and monitored in accordance with the Shoreline Open Space Landscape Strategy and an Offsets Delivery Plan prepared in accordance with the *Queensland Environmental Offsets Policy V1.2*, (to be compiled once final offset obligation has been calculated – refer to **Section 9.0**). It is therefore considered that there will be no edge effects, such as weed invasions, influencing the retained and newly created areas of Koala habitat.

The proposed development does not include any significant excavations or changes to the water table; therefore, there will be no indirect impacts to retained, restored or created Koala habitats as a result of changes to the existing hydrological regime.

It is estimated that the maximum total area of Koala habitats to be directly or indirectly impacted by the development is 3.72 ha.

6. Avoidance and Mitigation of Impacts to Koala

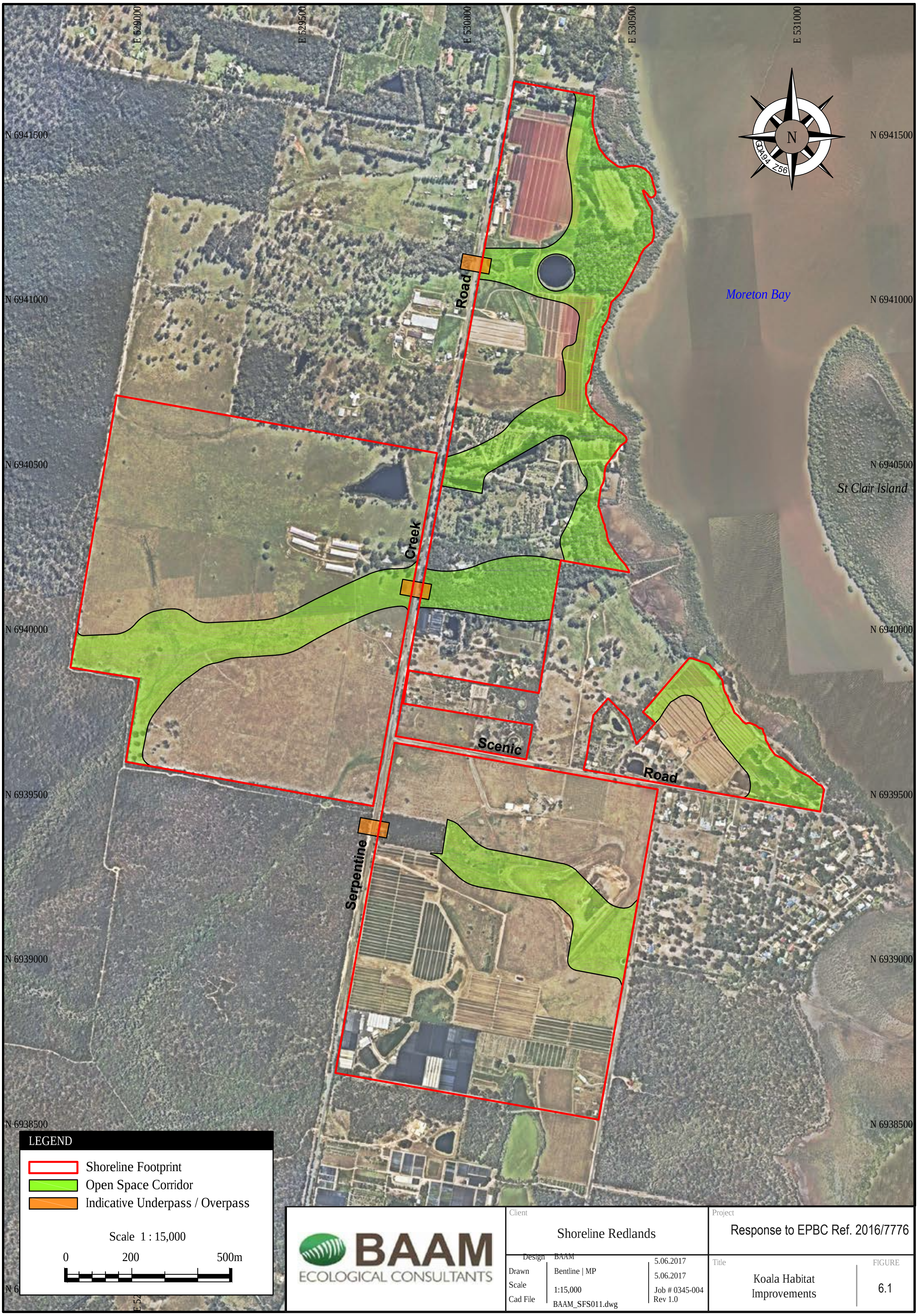
6.1 Avoidance and mitigation measures in relation to edge effects and vehicle strike impacts

For the most part, the proposed development has been restricted to areas that have undergone previous vegetation clearing for agricultural and residential purposes, with all large patches of potential Koala habitat being retained, protected and managed under the approved Shoreline Open Space Landscape Strategy. **Figure 6.1** shows how the development will provide linkage between isolated patches of Koala habitats in the east of Serpentine Creek Road with a large contiguous area of Koala habitats to the west of Serpentine Creek Road.

All retained, restored and newly created Koala habitats will be managed and monitored in accordance with the Shoreline Open Space Landscape Strategy (BAAM 2016) and the Offsets Delivery Plan (to be compiled once final offset obligation has been calculated). In addition, signage will be erected at strategic locations within all conservation areas and retained bushland areas, instructing residences of the consequences of illegal dumping of garden refuse into these habitats.

In terms of addressing vehicle strike impacts, the proposed development also includes three dedicated fauna movement facilities to provide safe movement across Serpentine Creek Road, a major roadway which currently presents a significant barrier to safe Koala movements. The proposed underpasses and overpass are to be designed in accordance with the Queensland Department of Transport and Main Roads – Fauna Sensitive Road Design Manual. The specific aim for the construction of the fauna movement facilities will include Koala as the Key target species for design elements.

The fauna movement facilities across Serpentine Creek Road are located immediately adjacent to proposed Open Space Corridors providing direct access for Koala. In addition to the safe movement facilities, the proponent will be providing Koala exclusion fencing in these locations to choreograph Koala movement to and through the safe passages. Initial design estimates have identified that approximately $10 Million will be required for the creation of the fauna movement facilities and associated fencing and habitat enhancements along Serpentine Creek Road.



BAAM ECOLOGICAL CONSULTANTS

Client
Shoreline Redlands

Project
Response to EPBC Ref. 2016/7776

Design	BAAM	5.06.2017
Drawn	Bentline | MP	5.06.2017
Scale	1:15,000	Job # 0345-004
Cad File	BAAM_SFS011.dwg	Rev 1.0

Title
Koala Habitat Improvements

FIGURE
6.1

6.2 Expected effectiveness of mitigation measures

It is expected that the protection and management of retained Koala habitats under the approved Shoreline Open Space Landscape Strategy will avoid any significant impacts on existing Koala habitat values through edge effects.

In terms of the measures proposed to avoid or mitigate impacts from vehicle strike, the proposed fauna movement crossing facilities over/under Serpentine Creek Road will be designed in accordance with peer reviewed guidelines as provided within by the Queensland Department of Transport and Main Roads – Fauna Sensitive Road Design Manual. Monitoring of similar facilities has demonstrated that Koalas will and do utilise these type of structures for movement (e.g. Dexter *et al*. 2016).

While it is recognised that the proposed development will result in a localised increase in vehicular traffic, the proposed mitigation measures will result in the removal of Koala vehicle interaction along the development frontage to Serpentine Creek Road and increased safe movement options throughout the site.

It should also be noted that, regardless of the Shoreline development, an increase in traffic in the proximity of the site and surrounds is inevitable. The Queensland Government Statisticians Office predicts that the Redland City population will continue to increase from the population in 2011 of 143,700 persons to a medium prediction of 184,700 or a high estimate of 193,200 by 2036. In regard to this predicted growth, the *South East Queensland Regional Plan 2009-2031* estimates that approximately an additional 21,000 dwellings will be required by 2031 within Redland City. Redland Bay is identified as one of the key growth areas within Redland City. The draft South East Queensland Regional Plan currently being finalised estimates that within Redland City the population at 2015 was 150,000 persons and this will grow to a medium prediction of 188,000 by 2041.

Therefore, although the Shoreline development will result in increased traffic, such traffic increases are expected on the main road networks within the Redland City regardless of whether Shoreline is developed.

Due to its size, the Shoreline development proposal presents a unique opportunity to provide appropriate mitigation responses (as are currently proposed for Serpentine Creek Road) as opposed to numerous, smaller developments that would eventually result in the same traffic increases but each of which alone would not trigger any EPBC referral or be required to provide similar fauna movement facilitation across the adjoining roadway. Furthermore, the Shoreline development currently has several state and local government approval conditions imposed to ensure that the development results in appropriate mitigation responses including the provision of safe Koala movement.

7. Avoidance and Mitigation of Impacts to Eastern Curlew

7.1 Avoidance and mitigation measures

There will be no development below the Highest Astronomical Tide (HAT) level; therefore, there will be no direct impacts on Eastern Curlew habitats.

The existing band of mangrove vegetation that provides an effective barrier to human, dog, noise and light disturbances to Eastern Curlew and other migratory shorebirds and their foraging habitats will also be retained, protected and managed as part of the proposed development.

An Eastern Curlew Impact Management Plan is provided in **Attachment 4**. Mitigation measures to avoid and/or mitigate potential impacts to Eastern Curlew provided in this Plan are relevant to all shorebirds within the local area and include:

- A community education program, including educational signage to inform residents and visitors of the presence of shorebirds and the impacts of physical disturbances and noise disturbances to foraging shorebirds, and to encourage community engagement in protecting foraging shorebirds and their habitats;
- Sensitively designed lighting for the proposed walkway and recreational parks within the foreshore open space area;
- Controls on noise emissions from recreational activities within the foreshore open space area.

7.2 Expected effectiveness of mitigation measures

Advice from DoEE will be sought when compiling the community education package to ensure this mitigation strategy achieves the objectives of the Eastern Curlew Impact Management Plan, which are to ensure no significant direct or indirect impacts to Eastern Curlew Numenius and other migratory shorebirds or their habitats occur as a result of the development. Research has shown that community education can play a significant role in decreasing physical disturbance threats to migratory shorebirds (Burger *et al*. 2005).

The retained band of mangrove vegetation and sensitive design is predicted to provide sufficient buffering of Eastern Curlew foraging habitats from any necessary lighting and noise within the adjacent foreshore area.

8. Environmental Management Plans for All MNES

The following Environmental Management Plans addressing the points raised in Item 8 of the EPBC RFI have been attached to this response:

- Hydrological and Water Quality Assessment and Management Plan (**Attachment 1**);
- Acid Sulfate Soils Assessment and Management Plan (**Attachment 2**);
- Eastern Curlew Impact Management Plan (**Attachment 4**); and
- Koala Impact Management Plan (**Attachment 5**).

9. Proposed Offsets

There are offset requirements imposed on the development as part of the assessment at Local and State government levels.

The development area, excluding the western road reserve, currently supports approximately 15 ha of potential Koala habitats, of which approximately 12 ha will be retained, 1.2 ha is proposed to be cleared, and 1.4 ha will incorporate sensitive design to minimise impacts to Koala feed trees.

The total area of the 20 m wide road reserve located to the west of the development, which will provide road access, is 2.52 ha. Final design plans for the western roadway are yet to be completed, although with sensitive design, and minimising earthworks wherever practical, it is expected that over 30% of the Koala habitat trees within this 2.52 ha area will be retained.

The specific offset requirements relate to the maximum 3.72 ha of Koala habitat potentially to be removed, which is distributed across the development footprint and the clearing of which will be staged in line with development progress. Approval conditions require that all Koala habitat trees are to be offset in accordance with the *Queensland Environmental Offsets Policy V1.2*, which requires a 3:1 replacement ratio and for those newly established trees to be protected through a statutory covenant.

It is considered that the direct impact of a maximum of 3.72 ha will not cause any significant impacts to the local Koala population and the required offsetting and mitigation actions proposed will compensate for any direct and indirect impacts through an increase in Koala habitat values and facilitation of safe movement opportunities. The EPBC Act Referral guidelines for the vulnerable Koala (DotE 2014) indicate that a significant impact would not be expected if 5 hectares of habitat scoring 9 or 10 was selectively cleared. The development is removing <5 ha of habitat which scored 7 using the EPBC assessment tool.

Therefore, there are no additional offsets proposed as there are no identified residual significant impacts to Koala.

10. Social and Economic Costs and/or Benefits

The Shoreline Redlands Urban Village development will provide over $100 million in road upgrades and a further $300 million in infrastructure, including two dedicated fauna underpasses and one dedicated fauna overpass (land bridge) to facilitate safe fauna movements across Serpentine Creek Road.

The $2.3 bn project will create between 1,800 to 1,900 new jobs within the Shoreline urban area, and will also create 1,550 construction jobs in Redland Bay for the next 10 years.

Redland City Council has calculated that they will receive a $5 million surplus from Shoreline over the next five years.

The Shoreline Redlands Urban Village development will provide over $100 million in State-controlled road upgrades and a further $300 million in infrastructure, including two dedicated fauna underpasses and one dedicated fauna overpass (land bridge) to facilitate safe fauna movements across Serpentine Creek Road.

The $2.3 bn project will create circa 1,800 to 1,900 new jobs within the Shoreline urban area, and will also create 1,550 construction jobs in Redland Bay for the next 10 years.

Redland City Council has calculated that they will receive a $5 million surplus from Shoreline over the next five years.

Over 75% of Redland residents surveyed by Shoreline Redlands polling, conducted several times over recent years, supported the project.

There is a close alignment between Commonwealth, State and Redland City policies and strategies and those proposed for Shoreline and the associated Redlands Business Park.

Key policy areas are summarized below and the Economic and Employment Aspects Summary Report is provided in **Attachment 7**:

Policy Direction	Project Contribution
Commonwealth Transfer resources from Mining to other construction and residential	The project is expected to ramp up as the mining sector construction contracts, with $400m in civil construction and $1700m in housing construction and about $100m in commercial and community projects.
Commonwealth, State and Local Increased investment	Overall $2.2b in direct investment
Commonwealth, State and Local Increased employment	Generation of 3,300 new direct ongoing jobs. Directly generating 8,193 FTE person years employment Up to 15,500 FTE person years employment with flow-on impacts in the regional economy
Commonwealth, State and Local Increased economic growth	Direct Value Add growth to the economy of $544m and up to $969m as Type 1 impacts flow throughout the Brisbane Moreton economy
State and Local Better jobs balance	Substantial increase in jobs balance to 73.6% against Redland City rate of 59.0%
State and Local Employment self-containment	Potential based on jobs balance, jobs mix and existing patterns for increased employment

Policy Direction	Project Contribution
	selfcontainment. The potential increase in self-containment reduces pressures on the road system.
State and Local Increased employment opportunities for disadvantaged Redland Islands residents	The location of Shoreline and the jobs mix proposed offers potential for increased opportunities in the southern Redlands area particularly for disadvantaged Island residents.
State and Local Likely lower infrastructure costs compared with other alternative locations	Shoreline offers an ‘infill’ development opportunity based on existing road networks and likely more efficient and lower cost services and other infrastructure provision.
State and Local Assured residential land supply	The Broadhectare Study for residential land supply for Redland is a high risk approach based on assumptions of consolidation of small parcels and conversion from theoretical to expected yield that are extreme when compared with other LGAs.
State and Local Assured shovel ready delivery	The track record and experience of Fox+Bell and Fitini homes, and the ownership of the site means that lengthy delays in amalgamation, financing and construction that often plague other developments will not occur.
State and Local Meeting local socioeconomic needs	The socio-economic needs identified in the report in relation to age structure, employment opportunities, participation, income and wealth generation are met by Shoreline and the associated Redlands Business Park.

11. References

AKF (2015). *National Koala Tree Planting List.* Prepared by Dave Mitchell of the Australian Koala Foundation.

BAAM (2014). *Shoreline Ecological Assessment.* Report prepared for Shoreline Redlands Pty Ltd. Updated 2016.

BAAM (2016). *EPBC listed Migratory Shorebird Surveys – Shoreline.* Report prepared for Shoreline Redlands Pty Ltd.

Burger, J, Jeitner, C, Clark, K and Niles LJ (2005). The effect of human activities on migrant shorebirds: successful adaptive management. *Environmental Conservation* **31** (4) pp. 283-288.

C&R Consulting (2009). *Impacts of plastic debris on Australian Marine Wildlife.* Report prepared for Commonwealth Department of Environment and Energy, formerly Department of Environment, Water, Heritage and the Arts Water, Heritage and the Arts.

Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. (**2014**). *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines.* Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government.

DEHP (2016). Queensland Water Quality Guidelines. Department of Environment and Heritage Protection https://www.ehp.qld.gov.au/water/guidelines/

DERM (2010). Environmental Protection (Water) Policy 2009 Redland Creeks environmental values and water quality objectives Basin No. 145 (part), including Coolnwynpin, Eprapah, Hilliards, Lota, Moogurrapum, Tarradarrapin, Tingalpa Wynnum creeks. Prepared by Qld Department of Environment and Resource Management.

DERM (2004). *Acid Sulfate Soils Laboratory Methods Guideline).* Qld Department of Natural Resources, Mines and Energy.

DesignFlow (2016a). *Shoreline Stage 1A Stormwater Quality Management Plan.* Prepared for Shoreline Redlands Pty Ltd.

DesignFlow (2016b). *Shoreline Stage 1B,C Stormwater Quality Management Plan.* Prepared for Shoreline Redlands Pty Ltd.

DesignFlow (2016c). *Shoreline Redlands Water Sensitive Urban Design Preliminary Advice.* Prepared for Shoreline Redlands Pty Ltd.

C. E. Dexter A C , R. G. Appleby A B , J. P. Edgar B , J. Scott A and D. N. Jones (2016). Using complementary remote detection methods for retrofitted eco-passages: a case study for monitoring individual koalas in south-east Queensland. *Wildlife Research* **43** (5): 369-379.

Evans, S.M. and Birchenough (2001). Community-based management of the environment: lessons from the past and options for the future. Aquatic Conservation **11** (2): 137-147.

Glover, HK, Weston, MA, Maguire, GS, Miller, KK and Christie, BA (2011). Towards ecologically meaningful and socially acceptable buffers: response distances of shorebirds in Victoria, Australia, to human disturbance. Landscape and Urban Planning 103: 326– 334.

Paton, DC, Ziembicki, M, Owen, P and Heddle, C (2000). Disturbance distances for water birds and the management of human recreation with special reference to the Coorong region of South Australia. *The Stilt* **37** (2000).

Smit, CJ and Visser, GJ (1993). Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bulletin 68: 6-19.

Van Polanen Petel, T and Bunce, A (2012). Understanding Beach Users' Behavior, Awareness, and Attitudes to Shorebird Conservation in Central Queensland: Tools for Effective Shorebird Conservation. Coastal Management **40** (5): 501-509.

Veitch Lister Consulting Pty Ltd (2015). *Shoreline Urban Village, Redland Bay South – Traffic Impact Assessments.*

ATTACHMENT 1

Shoreline Redlands Water Quality Management Plan

SHORELINE REDLANDS

WATER QUALITY MANAGEMENT PLAN

DesignFlow
Prepared for Shoreline Redlands Pty Ltd
June 2017

Document Control Sheet

Report Title:	Shoreline Redlands - Water Quality Management Plan
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Approved By:	SL
Date:	20/06/2017
File Location:	S:\Projects\4235
Circulation:	Shoreline Redlands Pty Ltd

Disclaimer

Table of Contents

1 GENERAL INTRODUCTION

Shoreline Redlands Pty Ltd has been planning the development of the proposed Shoreline project. The plan is to create an urban village on 303 hectares of grazing and cropping land including 4,000 homes, shops, restaurants, 2.2km of foreshore parkland and wildlife corridors along major drainage pathways.

Part of the site drains directly to Moreton Bay Ramsar wetland. The Shoreline urban village development has been identified under the EBPC Act as a controlled action that will be assessed on preliminary documentation. As per EPBC Ref: 2016/7776 additional information was requested to assess impacts of the proposed action.

This report has been prepared to provide the information response documentation relating to the hydrology and water quality items.

2 DESCRIPTION OF THE ENVIRONMENT

2.1 LOCATION

The Shoreline development site is located at the southern end of Redland Bay. The application extent and proposed development land use are presented in Figure 1.

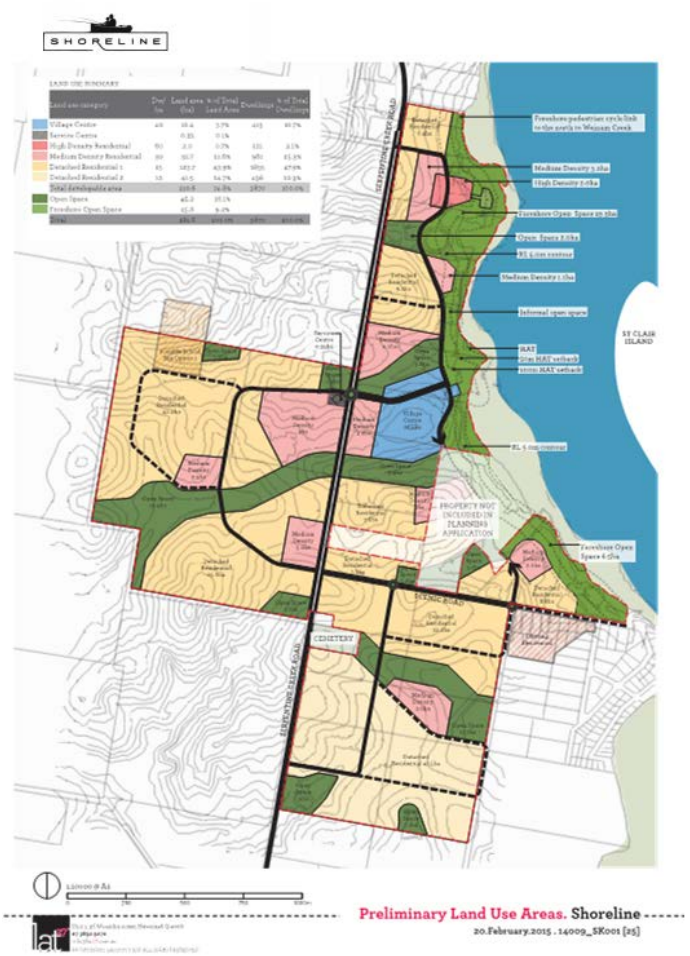


Figure 1. Locality Plan and Land Use (Source: LAT27).

2.2 SOILS AND VEGETATION

The soils across the site are typical of Redlands being the "red" volcanic soils which are well structured soils of medium permeability. The soils are highly fertile and have supported agriculture for a century.

Remnant vegetation occurs at the downstream extent of Catchment 1 and 3, as well as along the foreshore areas outside the proposed development areas (Figure 2).

The proposed residential and commercial development areas are located in areas that have been previously cleared of native vegetation. These area are currently used for grazing and agriculture. The existing foreshore and vegetated drainage lines through the site are proposed to be retained.

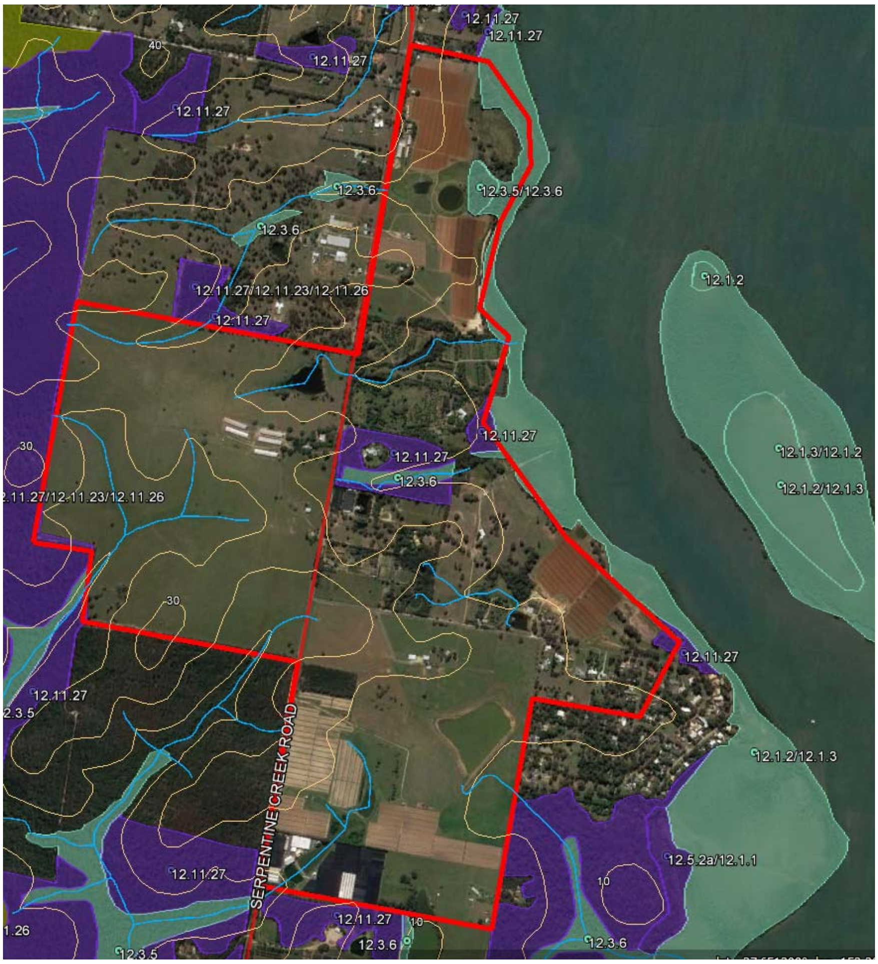


Figure 2. Remnant vegetation mapping for the Shoreline Redlands site (Source: Google Earth).

2.3 TOPOGRAPHY AND DRAINAGE

Figure 4 presents the catchment plan for the eastward draining catchments for the Shoreline development site considered in this report. There are no dominant ridgelines on the site but there are a few high points meaning catchments are split into a number of small drainage lines which drain either east into Moreton Bay or westward out of the site towards Serpentine Creek.

There are five sub-catchments draining directly to Moreton Bay. The catchments are relatively small (<100ha) meaning the drainage lines are characterised by broad, low gradient ephemeral flow paths without a defined channel. The terrain across the five catchments draining to Moreton Bay are dominated by low to moderate undulating topography (4-12%).

There are numerous farm dams located within the five sub-catchments draining to Moreton Bay (Figure 3). These dams have a major impact on the natural flow characteristics and waterway health. Generally these dams are relatively large compared to the contributing catchment meaning that they limit the volume of runoff leaving the site.

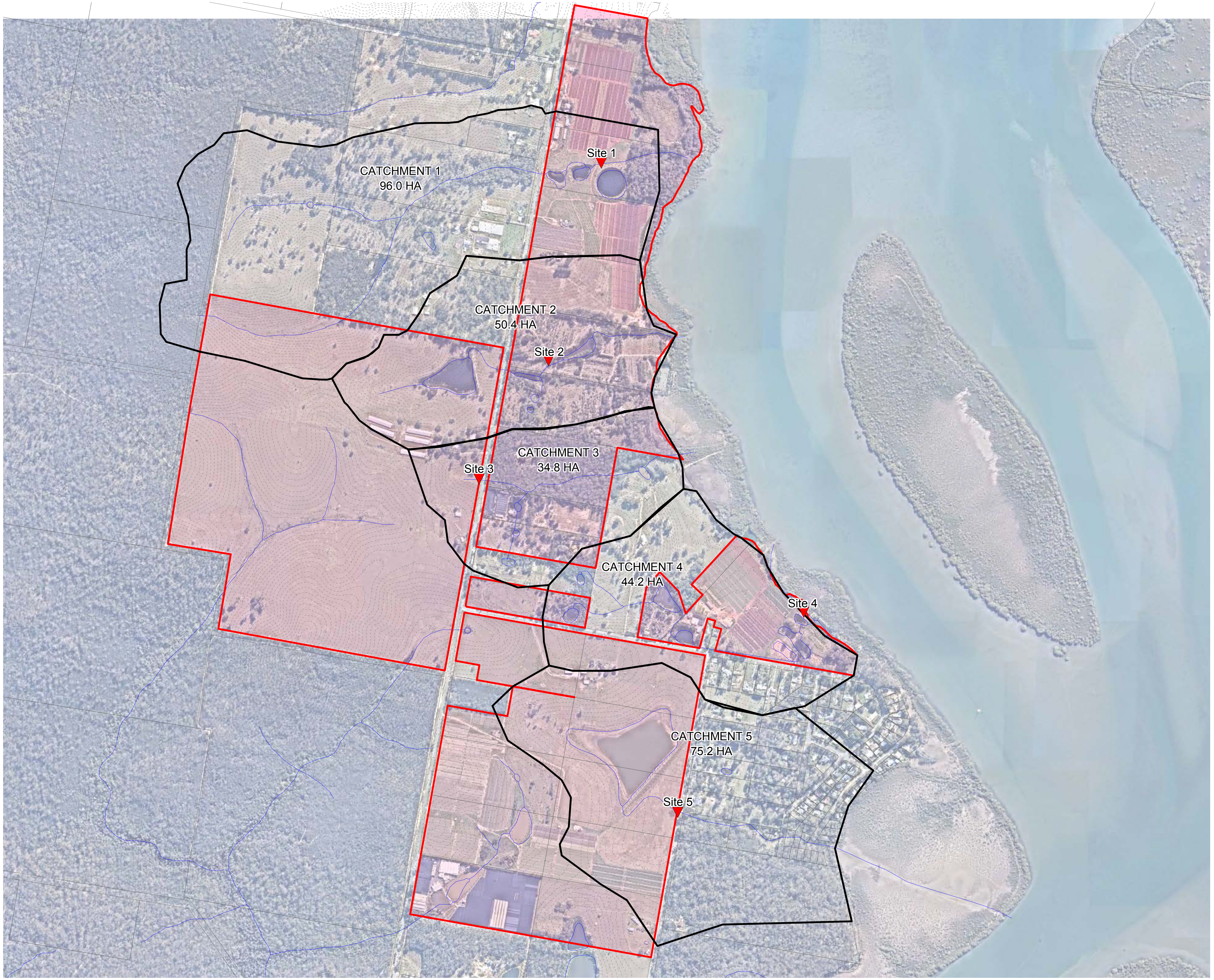
Figure 3. Images of farm dams are located across the site.

A brief description of the existing drainage pathways for each sub-catchment is provided below:

- **Catchment 1 (96.0ha)** - Runoff in the northern portion of the site drain via sheet flow to a drainage depression along the northern boundary. Flows from this catchment enters private property to the north and then ultimately back into Shoreline under Serpentine Creek Road and discharges via a series of farm dams. The drainage line downstream of the dams has been infilled and flows appear to only leave this sub-catchment following large rain events. The tidal reach downstream of the farm dams is Mangrove dominated.
- **Catchment 2 (50.4ha) -** Runoff from the grazed upper catchment drains via sheet flow into a large dam. Once the dam is filled it over tops to a grassed depression and discharges under Serpentine creek road into a series of online dams which provided water for a plant nursery. Much of the vegetation along this drainage line has been modified by the previous nursery land use. Downstream of the dams remnant vegetation occurs for approximately 420m before flows enter another farm dam and then discharge to mangrove lined drain into Moreton Bay.
- **Catchment 3 (34.8ha)** - This smaller sub-catchment includes aquaculture land use. A series of online dams and ponds occur on the main drainage line heading northwards. A small

grazed sub-catchment discharges from the western side of Serpentine Creek Road via sheet flow.

- **Catchment 4 (44.2ha) -** This sub-catchment is comprised of numerous farm dams which are used for irrigation of crops and stock watering. This catchment also include areas of urban runoff. Runoff from the site entering Moreton Bay occurs only once farm dams are full or directly via sheet flow from the cane farm. The drainage outfall is via mangrove line drain.
- **Catchment 5 (75.2ha) -** The upper sub-catchment includes large areas of grazed open grass land draining via sheet flow to a very large dam. Downstream of the dam is another stock watering hole immediately upstream of Orchard Road. Downstream of Orchard Rd the drainage line enters remnant vegetation area with no clearly defined channel (broad shallow depression). The outfall of this waterway was not accessible at the time of the inspection.



DesignFlow

LEGEND

🟥	Shoreline Application Boundary
—	RP Boundary
----	1m contours
—	Drainage
—	Moreton Bay draining catchment
▼	Water quality sample site

Scale:

1 : 12,000 (A3)

FIGURE 4

CATCHMENTS, DRAINAGE AND EXISTING LAND USE

Project: 4235

Shoreline Redlands

Date:
15 June 2017

Client:
Shoreline Redlands Pty Ltd

3 BASELINE WATER QUALITY (MONITORING DATA)

Water quality sampling has been completed on two occasions from each of the five sub-catchments draining to Moreton Bay. The sampling has been used to provide a snapshot of the water quality within the waterways across the site and to enable comparison with expected ranges for discharges to Moreton Bay waterways under the *EPP Water* (2009), and also expected ranges from the proposed developed urban land use.

Water quality sampling Sites 1-5 are identified on Figure 4. Samples were collected following rainfall on two occasions (21/03/2017 and 31/03/2017). Samples were collected following reasonable rain flow events due to the highly ephemeral flow regime of the drainage lines (all were dry one week prior to the first sample date). Sample collection directly from farm dams can result in misleading results (i.e. poor water quality would be expected within the farm dams) and so were avoided. Details of the antecedent rainfall prior to the two sampling rounds are shown in Figure 5.

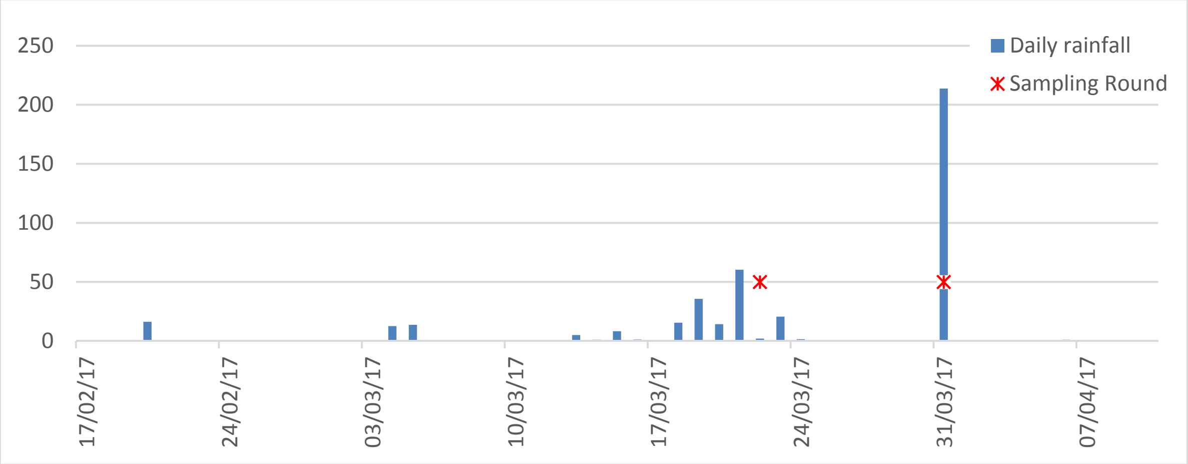


Figure 5. Daily rainfall totals for the 4 weeks prior to baseline water quality sampling.

Results for the sampling rounds are presented in Table 1 (red text indicates exceedance of WQO). Graphical plots of results for the Total Nitrogen (Figure 6), Total Phosphorus (Figure 7) and Suspended Solids (Figure 8) are presented below.

Water quality results have been compared to the Water Quality Objectives (WQO) applicable to 'slightly to moderately' disturbed coastal freshwater streams for the Southern Redland Bay catchments. These are described in detail *Environmental Protection (Water) Policy 2009 Redland Creeks environmental values and water quality objectives* (July 2010).

The two sampling event results for each site indicate that nutrient levels (including bio-available forms of nitrogen and phosphorous) are likely to regularly exceed the WQO when there is sufficient rainfall to generate flows from the onsite farm dams. Suspended solids levels were only elevated at Sites 1 and 4.

The results indicate generally poor water quality in the sites streams, particularly following periods of no flow when stagnant water stored within farm dams is flushed downstream.

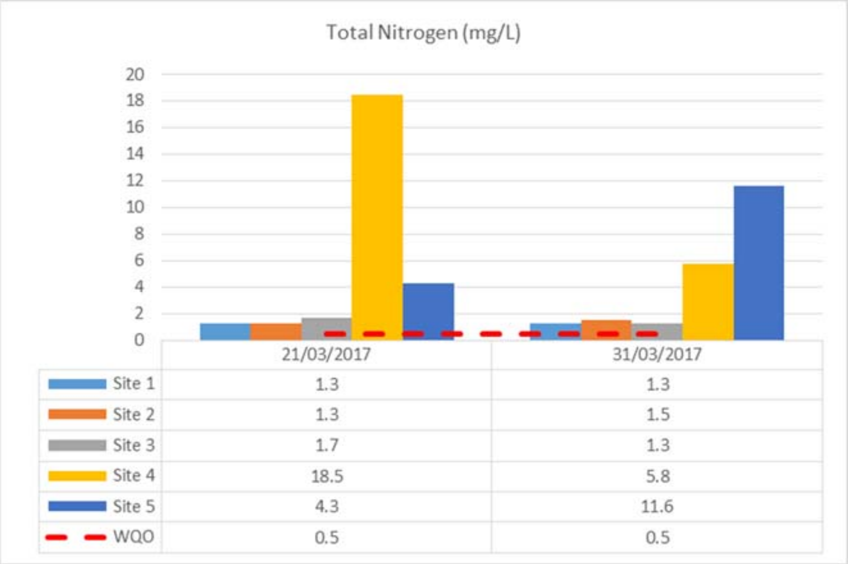
Table 1. Baseline water quality sampling results.

Site ID	Date	Total Dissolved Solids	Suspended Solids (SS)	Ammonia as N	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Reactive Phosphorus as P	pH	Electrical Conductivity	Dissolved Oxygen	Temperature	Turbidity	Redox Potential	Sampling comments
	Unit	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*pH*	*µS/cm*	*% sat*	*℃*	*NTU*	*mV*	
	LOR[1]	*50*	*<5*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.1*	*0.1*	*<0.01*	*0.01*	*<0.01*	*<0.1*	*<1%*	*<0.1*	*<0.1*	*<0.1*	
	WQO[2]	*-*	*<6*	*<0.02*	*-*	*-*	*<0.06*	*-*	*0.5*	*<0.05*	*<0.02*	*6.5-8.0*	*-*	*85-110%*	*-*	*<50*	*-*	
1	21/03/2017	194	12	0.17	<0.01	0.13	0.13	1.2	1.3	0.34	0.22	7.16	279	23.5	25.4	17.8	135	Steady flow
2	21/03/2017	198	<5	0.02	<0.01	<0.01	<0.01	1.3	1.3	0.20	0.12	5.93	323	15.4	25.3	5.1	191	Steady flow
3	21/03/2017	205	<5	0.02	<0.01	<0.01	<0.01	1.7	1.7	0.32	0.22	5.90	260	16.6	25.8	8.3	186	Steady flow
4	21/03/2017	409	14	0.07	0.22	15.6	15.8	2.7	18.5	1.68	1.84	6.09	1100	20.1	25.1	61.6	166	Drain full, not flowing
5	21/03/2017	202	<5	0.06	0.07	1.75	1.82	2.5	4.3	3.60	3.96	6.63	285	23.8	27.1	6.1	131	Culvert full, not flowing
1	31/03/2017	123	13	0.03	<0.01	0.14	0.14	1.2	1.3	0.26	0.21	6.49	192	53.3	26.3	22.1	137	Strong flow
2	31/03/2017	153	<5	0.03	<0.01	<0.01	<0.01	1.5	1.5	0.27	0.22	5.94	254	15.4	25.1	7.9	156	Strong flow
3	31/03/2017	137	<5	0.02	<0.01	0.01	0.01	1.3	1.3	0.33	0.13	5.82	209	23.9	23.7	7.5	187	Some flow
4	31/03/2017	215	12	0.53	0.09	3.72	3.81	2.0	5.8	0.92	0.58	6.82	392	68.9	27.9	40.2	103	Some flow
5	31/03/2017	330	<5	0.14	0.06	6.76	6.82	4.8	11.6	5.52	5.73	6.89	497	77.4	30.0	6.2	122	Some flow

[1] LOR = Limit or Reporting.

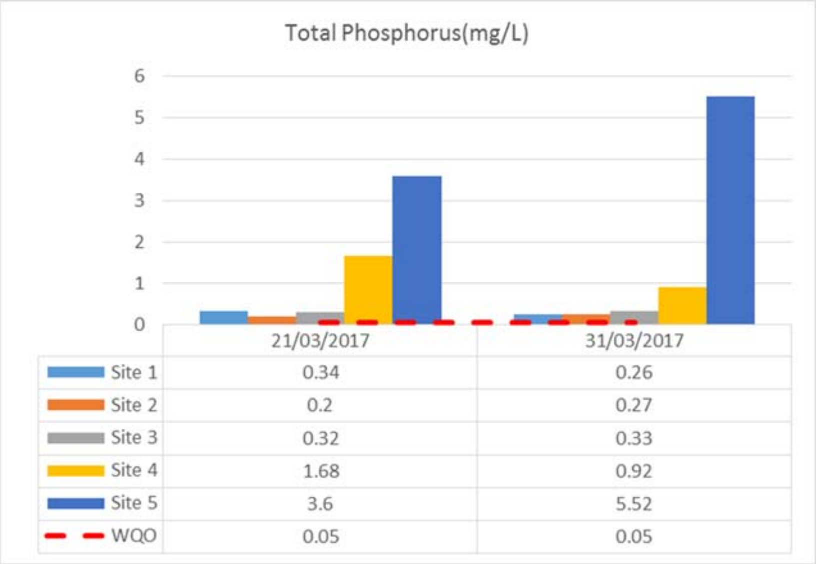
[2] WQO = Water Quality Objective for 'slightly to moderately' disturbed Coastal freshwater streams for the Southern Redland Bay catchments. These are described in detail Environmental Protection (Water) Policy 2009 Redland Creeks environmental values and water quality objectives (July 2010).

** Red font indicates exceedance of WQO.*



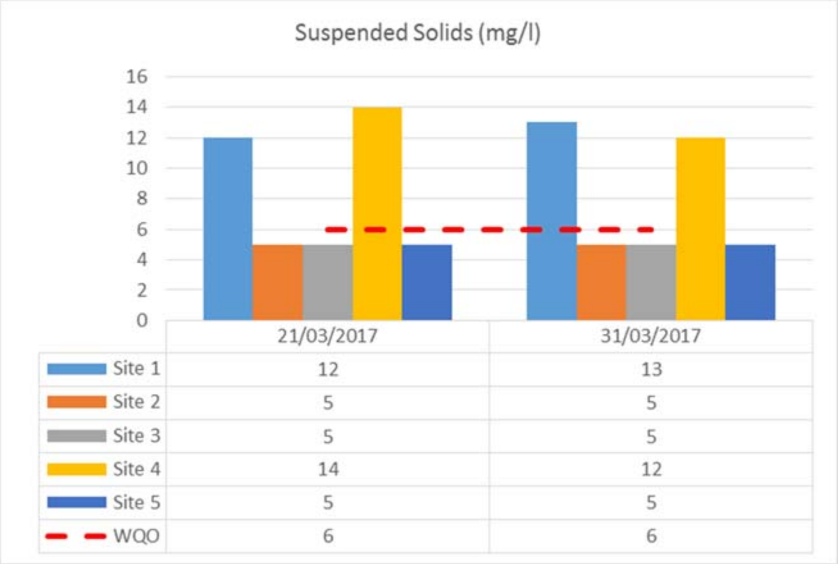
	21/03/2017	31/03/2017
Site 1	1.3	1.3
Site 2	1.3	1.5
Site 3	1.7	1.3
Site 4	18.5	5.8
Site 5	4.3	11.6
WQO	0.5	0.5

Figure 6. Total Nitrogen (mg/L) values for Sites 1-5 for sample round 1 and 2.



	21/03/2017	31/03/2017
Site 1	0.34	0.26
Site 2	0.2	0.27
Site 3	0.32	0.33
Site 4	1.68	0.92
Site 5	3.6	5.52
WQO	0.05	0.05

Figure 7. Total Phosphorus (mg/L) values for Sites 1-5 for sample round 1 and 2.



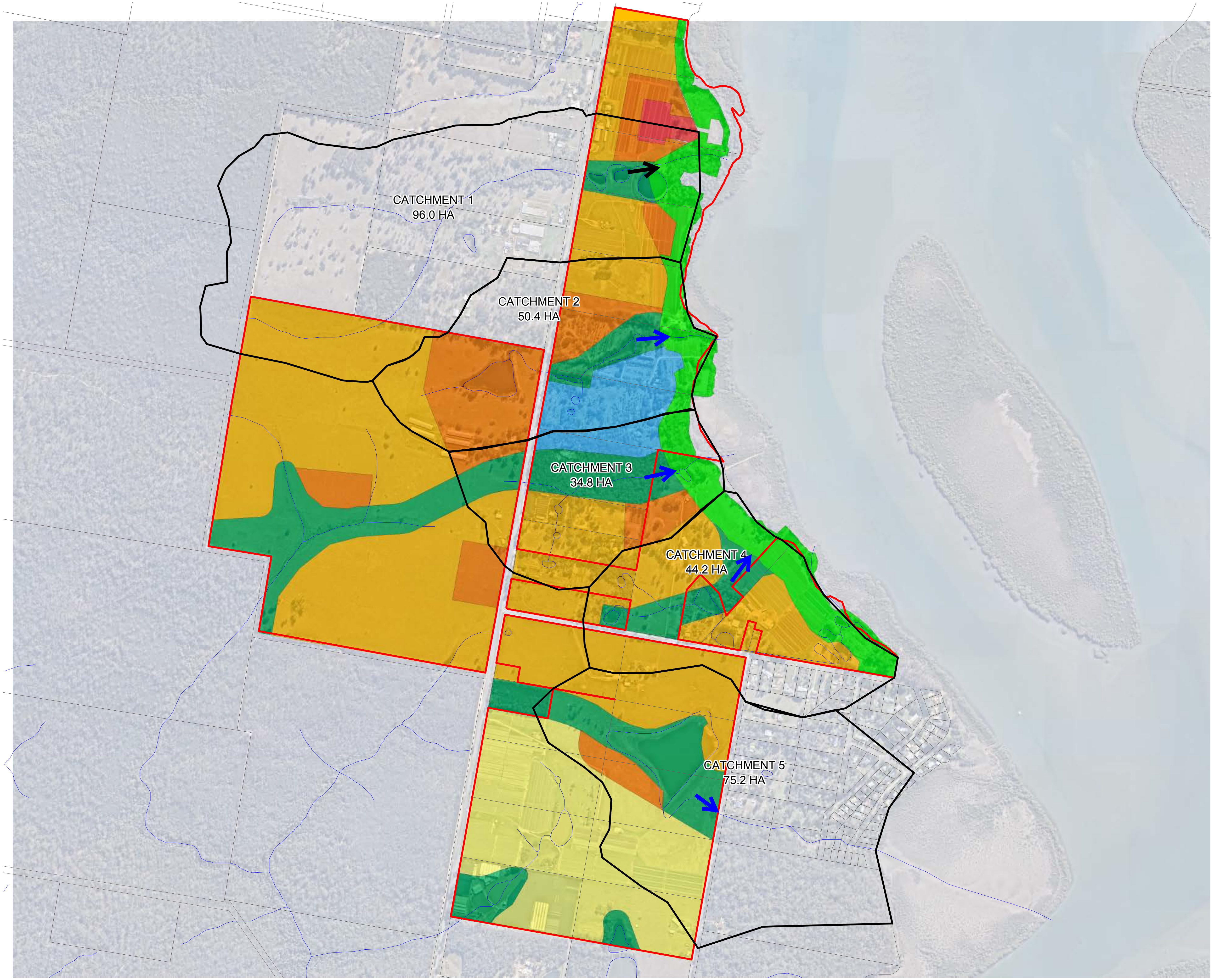
	21/03/2017	31/03/2017
Site 1	12	13
Site 2	5	5
Site 3	5	5
Site 4	14	12
Site 5	5	5
WQO	6	6

Figure 8. Suspended Solids (mg/L) values for Sites 1-5 for sample round 1 and 2.

4 PROPOSED LAND USE CHANGES

Figure 9 shows the proposed future land use for Catchments 1-5 of the Shoreline Redlands development overlaid on the existing site aerial image. Generally, the existing grazing and agricultural areas of the site are proposed to be converted to a mix of residential and commercial land uses.

The sites waterways, remnant vegetation and the Moreton Bay foreshore are proposed to be preserved. Drainage lines through existing agriculture and grazing areas are proposed to be retained as open space.



DesignFlow

LEGEND

— Shoreline Application Boundary
— RP Boundary
— Drainage line
— Catchment boundary

🟩 Foreshore Open Space
🟥 High Density Res
🟧 Medium Density Res
🟩 Open Space
🟨 Small Lot Res
🟨 Traditional Res
🟦 Village Centre
➔ Discharge locations

Scale:
1 : 12,000 (A3)

FIGURE 9
PROPOSED FUTURE LAND USE

Project: 4235
Shoreline Redlands

Date:
28 April 2017

Client:
Shoreline Redlands Pty Ltd

5 QUANTIFICATION OF IMPACTS

The conversion of agriculture and grazing land to urban uses will result in a changes to the sites water quality and hydrology as a result of both 'construction' and 'operational' phases of the development. The following subsections quantify the impacts associated with each of these phases of the Shoreline Redlands development.

5.1 CONSTRUCTION PHASE IMPACTS

The construction phase impacts relate to the civil and landscape works associated with the subdivision of the site from large rural blocks to smaller residential allotments and associated roads and services. This phase involves earthworks and significant disturbance to the existing landform and presents the greatest potential for impact to receiving waterways. If left unmitigated construction phase activities present a significant risk to receiving waterways and Moreton Bay.

Table 1 summarises the potential impacts of sediment runoff to receiving environments if not appropriately mitigated.

Table 2. Potential impacts associated construction phase runoff

Pollutant	Impact
Coarse sediments	• Smothering of benthic flora and fauna • Loss of habitat • Change in species composition • Costs associated with desilting
Fine sediments	• Water quality impacts • Smothering of benthic flora and fauna • Aquatic health impacts • Increased turbidity
Nutrients	• Eutrophication / water quality impacts • Change in species composition • Algal blooms • Aquatic weeds

5.2 OPERATIONAL PHASE IMPACTS

The operational phase refers to the developed urban catchment once construction and building works are complete. At this stage the catchment is relatively stable but the stormwater runoff quality and hydrology are altered.

The urbanisation of the site as a minimum must comply with the requirements of the *Single State Planning Policy* (DSDIP, 2016). This requires all urban developments to include stormwater quality treatment measures to manage impacts of urbanisation. Therefore the quantification of impact assessment includes these mitigation measures by default.

MUSIC Modelling has been undertaken to assess for impacts to water quality and hydrology during the operational phase. MUSIC is the *Model for Urban Stormwater Improvement Conceptualisation* and provides the ability to simulate both quantity and quality of runoff based on continuous rainfall time series data. This software is the industry standard software program used to assess the impact of urban development on stormwater quality. The modelling was completed following the approach documented in the '*MUSIC Modelling Guidelines Version 1.0*' (Healthy Waterways, 2010).

The modelling assessment involved:

1. Predicting the existing site baseline water quality and flows
2. Predicting the proposed fully developed and mitigated urban water quality and flows
3. Comparing the results to assess for impacts between the two scenarios.

Modelling approach

The assessment of the existing and developed land use scenarios was completed for the five catchments draining to Moreton Bay from the subject. Table 3 presents the existing land use for each sub-catchment based on areas measured from aerial imagery. Table 4 presents the proposed developed land use based on the master plan layout provided in Section 4. These land uses were then created as catchment source nodes in MUSIC. The proposed development layout results in a significant reduction in agriculture and grazing land use as well as an increase in retained open space as forest/waterway.

Table 3. Existing land use.

Catchment ID	Forest/ waterway (ha)	Rural residential (ha)	Agriculture/ grazing (ha)	Road (ha)	Total (ha)
1	9.1	10.8	74.4	1.7	96.0
2	1.9	7	39.5	2	50.4
3	8.1	6.25	19.2	1.3	34.8
4	1.4	5.3	34.9	2.6	44.2
5	20.1	15.8	34.6	4.7	75.2
Total	40.6	45.15	202.6	12.3	300.6

Table 4. Developed land use.

Catchment ID	Forest/ waterway (ha)	Rural residential (ha)	Agriculture/ grazing (ha)	Road (ha)	Proposed Urban (ha)	Total (ha)
1	15.6	8.6	48.7	1.7	21.4	96.0
2	15.4	7	1	2	25	50.4
3	13.9	0	0	1.3	19.6	34.8
4	14.5	5.3	0	2.6	21.8	44.2
5	30.7	15.8	0	4.7	24	75.2
Total	90.1	36.7	49.7	12.3	111.8	300.6

The adopted modelling layout for the existing land use is presented in Figure 10 and for the developed scenario in Figure 11. The developed scenario includes the mitigation measures required by the *State Planning Policy* (DSDIP, 2016) to reduced stormwater pollutants for new urban development. The treatment systems adopted were bioretention systems sized at 0.8% of the urbanised catchment.

A 10 year rainfall data set for the period 1997-2006 from Bureau of Meteorology Rainfall Station #40625 *Redlands HRS* was used for the assessment. The 10 year continuous rainfall simulation was then run for the existing and proposed developed scenario to quantify changes to hydrology and water quality. These results are discussed in the following subsection.

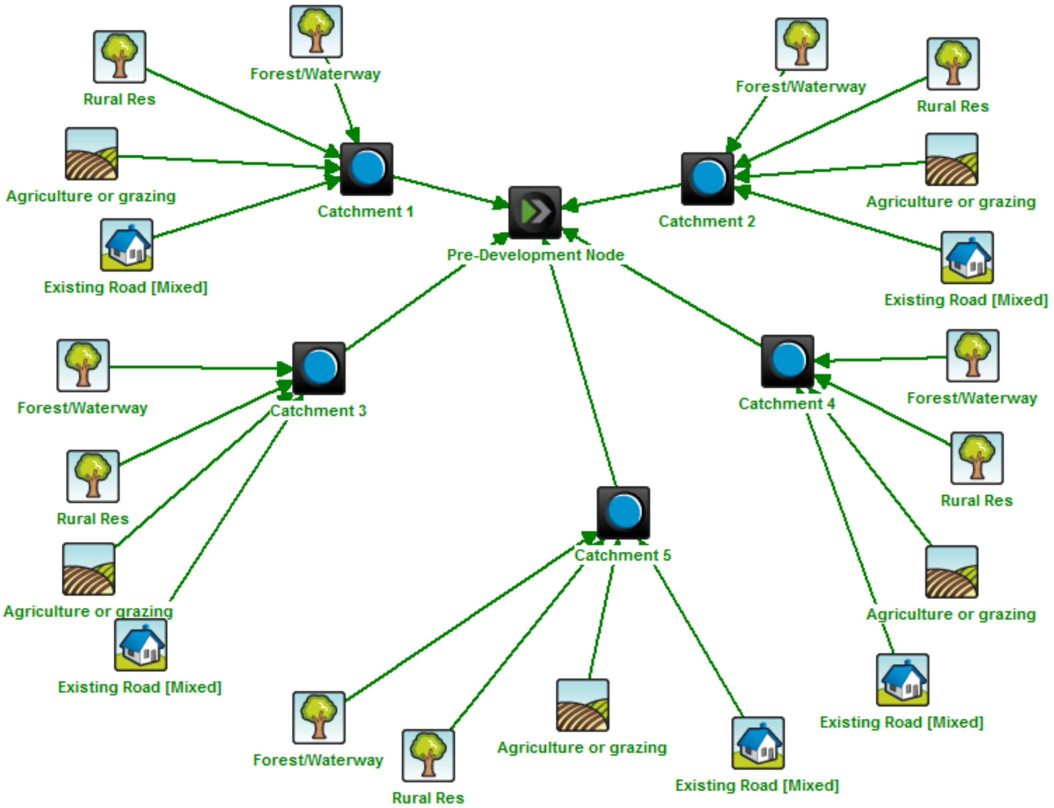


Figure 10. Existing land use MUSIC model layout.

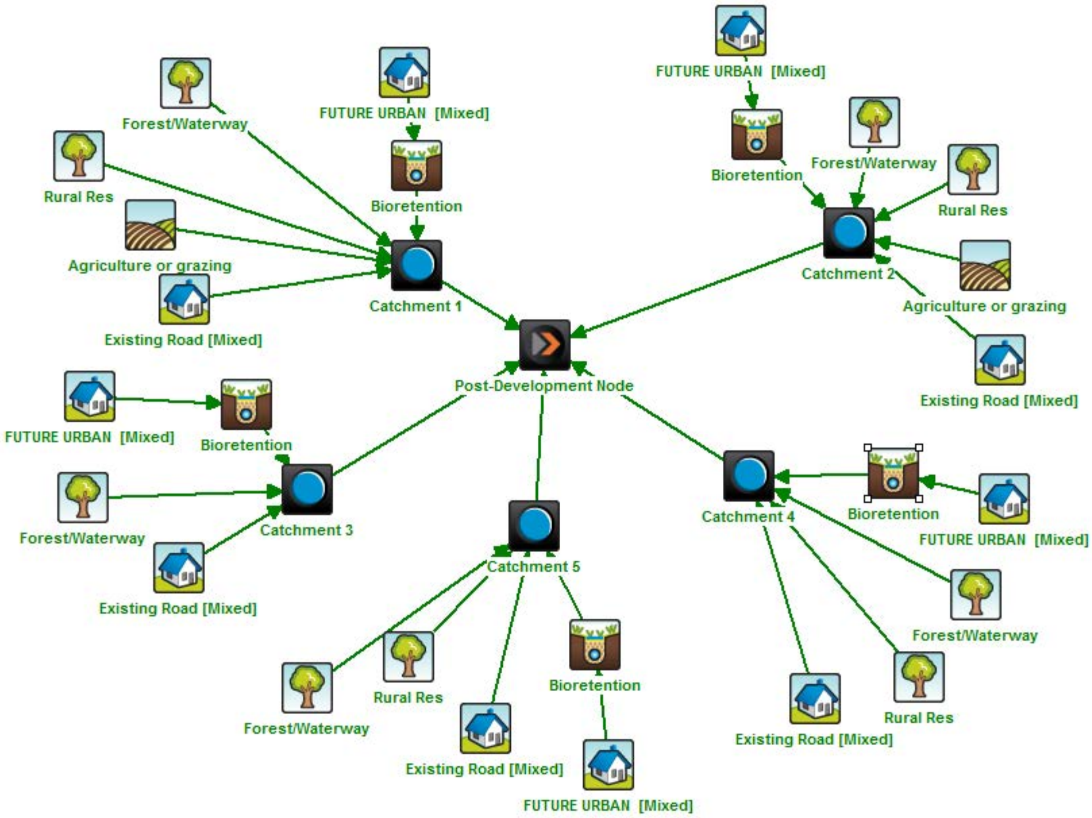


Figure 11. Developed land use MUSIC model layout.

5.2.1 Water Quality impacts operational phase

Table 5 presents the predicted water quality concentrations for the baseline and developed scenarios.

The predicted pollutant concentrations for the existing scenario are generally consistent with, or more conservative than, the physical water quality results presented in Table 1.

Table 5. Comparison of baseline and developed water quality pollutant concentrations

Parameter		Catch 1	Catch 2	Catch 3	Catch 4	Catch 5
Total suspended Solids (mg/L)	Existing baseline	266	323	278	337	126
	Developed mitigated	65.8 (-75%)	26.2 (-92%)	26.6 (-90%)	31.9 (-91%)	27.2 (-78%)
Total Phosphorous (mg/L)	Existing baseline	0.30	0.38	0.34	0.41	0.18
	Developed mitigated	0.09 (-69%)	0.06 (-84%)	0.06 (-81%)	0.07 (-83%)	0.06 (-66%)
Total Nitrogen (mg/L)	Existing baseline	1.79	2.00	1.81	2.05	1.15
	Developed mitigated	0.92 (-49%)	0.74 (-63%)	0.76 (-58%)	0.77 (-62%)	0.74 (-36%)

** Excludes flows <4 l/s (approx. equivalent to 5mm rainfall event).*

Table 6 presents the predicted annual pollutant loads for the baseline and developed scenarios.

Table 6. Comparison of baseline and developed water quality pollutant annual loads

Parameter		Catch 1	Catch 2	Catch 3	Catch 4	Catch 5
Total suspended Solids (tonnes/yr)	Existing baseline	100	57.7	28.7	55.4	64.3
	Developed mitigated	74.8 (-25%)	16.7 (-71%)	11.4 (-60%)	16.8 (-70%)	25.8 (-60%)
Total Phosphorous (kg/yr)	Existing baseline	111	63.5	33.5	61.6	73.2
	Developed mitigated	74.8 (-25%)	16.7 (-71%)	11.4 (-60%)	16.8 (-70%)	25.8 (-60%)
Total Nitrogen (kg/yr)	Existing baseline	651	358	194	326	398
	Developed mitigated	613 (-6%)	38.6 (-89%)	191 (-2%)	235 (-28%)	326 (-18%)

The water quality results predict that the water quality during the operational phase of the development will improve. This was shown both in terms of annual pollutant loads and concentration based values (i.e. during flow events).

The improvement in water quality is due to:

1. Significant reduction in agriculture and grazing land use (high polluting)
2. Expansion of open space areas (creation of restored waterways and natural areas)
3. The adoption of stormwater quality treatment systems to treat runoff from all new urban development areas, which are required under the *State Planning Policy* (DSDIP, 2016).

The improvement of water quality in the developed scenario demonstrate that the proposed mitigation measures are appropriate.

5.2.2 Hydrology impacts operational phases

Table 7 presents the predicted total runoff volumes and surface flow days from the existing and developed scenarios from each sub-catchment.

Table 7. Comparison of baseline and developed total runoff volumes

Parameter		Catch 1	Catch 2	Catch 3	Catch 4	Catch 5
Total outflow volume (ML/yr)	Existing baseline	311	170	107	153	230
	Developed mitigated	370 (19%)	228 (34%)	163 (52%)	202 (32%)	290 (26%)
Surface flow (days)*	Existing baseline	49	37	26	35	58
	Developed mitigated	66 (+17)	64 (+28)	54 (+28)	61 (+26)	83 (+25)

**Count of days where outflows are greater than 4 l/s (approx. equivalent to 5mm rainfall event).*

The results show that the runoff volumes and frequency are predicted to increase. The modelling which indicates that total annual run-off volumes are expected to increase by 20-50% (Table 7). The increased flow results in between 17-28 additional flow days within the drainage lines each year (on average). These additional flow days relate to the increase number of smaller rainfall events that previously would not have triggered runoff. The additional flows are due to the removal of farm dams and irrigation systems, as well as the introduction of more impervious surfaces (e.g. roads, houses etc) combined with efficient piped stormwater drainage network.

The change to hydrology within the sites waterways will need to be managed in terms of impacts to waterway stability due to increase flow volumes and velocity. Waterway stability objectives are proposed which focus on protecting the sites drainage lines from erosion as a result of increased flow from urban development.

Stormwater drainage system will be designed to ensure compliance with QUDM (2013). In particular, all new stormwater drainage outfalls will be designed and constructed to ensure the following is achieved:

1. Appropriately integrated with receiving environment.
2. Does not cause erosion to bed and bank within the receiving waterway.
3. Outlet scour protection will be provide typically in accordance with Figure 12.

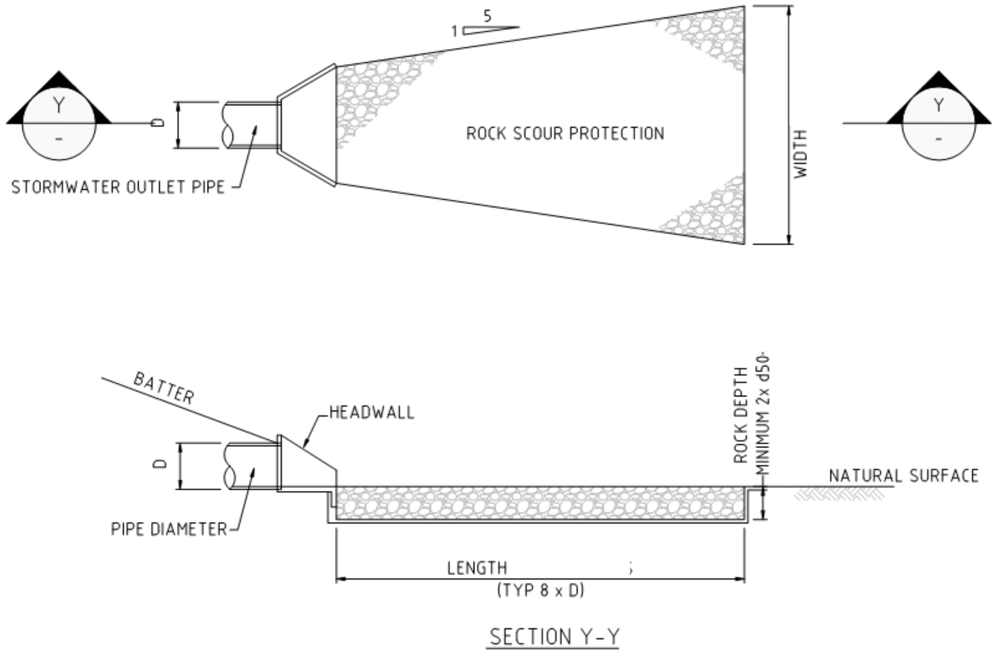


Figure 12. Typical rock scour protection detail for new drainage outfalls.

The additional runoff volumes and increased frequency of smaller events predicted by the modelling will result in the waterways generally becoming 'wetter' (less ephemeral). Within the tidal reaches the addition of extra freshwater could result in slightly lower salinity levels compared to the current situation. However, this is expected to have limited effect on the mangrove lined waterways. This is because mangroves are tolerant of a range of salinities and so the additional freshwater and as such are not expected to unduly impact on these vegetation communities. Beyond the immediate site drainage lines the changes to hydrology are not expected to have any measurable effect on Moreton Bay and associated environmental values.

6 ENVIRONMENTAL OUTCOMES

The water quality objectives for the Shorelines Redland development are presented in Table 8.

These values have been derived from the *Environmental Protection (Water) Policy 2009 Redland Creeks environmental values and water quality objectives. Basin No. 145 (part), including Coolnwynpin, Eprapah, Hilliards, Lota, Moogurrapum, Tarradarrapin, Tingalpa and Wynnum creeks. July 2010* (DEHP).

The site discharge locations for each sub-catchment shown on Figure 9 have been related to water type 'Lowland Freshwater' and 'Middle Estuary' as mapped on the *Environmental Protection (Water) Policy 2009 South-east Queensland Map Series Plan WQ1453.*

Table 8. Water quality objectives for Lowland freshwater (comprising lowland streams, wallum/tannin stained streams and coastal streams) and Moreton Bay (Area S2 – Southern Bay).

Parameter	Lowland Freshwater	Middle Estuary
Management level (level of protection)	Aquatic ecosystem – moderately disturbed	Aquatic ecosystem – moderately disturbed
turbidity:	<50 NTU	<7 NTU
chlorophyll a:	N/A	<2.0 µg/L
suspended solids:	<6 mg/L	N/A
chlorophyll a:	<5 µg/L	N/A
total nitrogen:	<500 µg/L	<200 µg/L
oxidised N:	<60 µg/L	<2 µg/L
ammonia N:	<20 µg/L	<5 µg/L
organic N:	<420 µg/L	<190 µg/L
total phosphorus:	<50 µg/L	<24 µg/L
filterable reactive phosphorus (FRP):	<20 µg/L	<8 µg/L
dissolved oxygen:	85% – 110% saturation	95 – 105% saturation
pH:	6.5 – 8.0	8.1 – 8.4
secchi depth:	N/A	>1.2m

7 PERFORMANCE AND COMPLETION CRITERIA

In order to achieve the Environmental Outcomes in Section 6 stormwater discharge criteria have been established for the site based on the *State Planning Policy* (DSDIP, April 2016). Achieving the *State Planning Policy* requirements ensures the potential impacts at the site on the Environmental Outcomes are minimised.

7.1 CONSTRUCTION PHASE

The design objectives for erosion and sediment control for the Shoreline Redlands development have been established based on the following:

- *State Planning Policy* (DSDIP, April 2016): Appendix 3 SPP Code: Water Quality PO6.
- *RPS Planning Scheme*: Part 8 General Codes, Division 6 Erosion Prevention and Sediment Control.

The performance criteria for the construction phases are presented in Table 9. To achieve these objectives requires erosion and sediment control measures to be implemented in accordance with the *Best Practice Erosion and Sediment Control* (IECA, 2008).

Table 9 Minimum design objectives for ESC for Shoreline Redlands (source: SPP code: Water Quality, Appendix 3, Table A).

ISSUE		SPP Design Objective
Drainage Control	Temporary drainage works	1. Design life and design storm for temporary drainage works: • Disturbed area open for <12 months—1 in 2-year ARI event • Disturbed area open for 12–24 months—1 in 5-year ARI event • Disturbed area open for > 24 months—1 in 10-year ARI event 2. Design capacity excludes minimum 150 mm freeboard 3. Temporary culvert crossing—minimum 1 in 1-year ARI hydraulic capacity
Erosion Control	Erosion control measures	1. Minimise exposure of disturbed soils at any time 2. Divert water run-off from undisturbed areas around disturbed areas 3. Determine the erosion risk rating using local rainfall erosivity, rainfall depth, soil-loss rate or other acceptable methods 4. Implement erosion control methods corresponding to identified erosion risk rating
Sediment Control	Sediment control measures Design storm for sediment control basins Sediment basin dewatering	1. Determine appropriate sediment control measures using: • potential soil loss rate, or • monthly erosivity, or • average monthly rainfall 2. Collect and drain stormwater from disturbed soils to sediment basin for design storm event: • design storm for sediment basin sizing is 80th% five-day event • or similar 3. Site discharge during sediment basin dewatering: • TSS < 50 mg/L TSS, and • Turbidity not >10% receiving waters turbidity, and • pH 6.5–8.5 or as per local requirements for Oakey Ck
Water quality	Litter and other waste, hydrocarbons and other contaminants	1. Avoid wind-blown litter; remove gross pollutants 2. Ensure there is no visible oil or grease sheen on released waters 3. Dispose of waste containing contaminants at authorised facilities
Waterway stability objective and flow management	Changes to the natural waterway hydraulics and hydrology	4. For peak flow for the 1-year and 100-year ARI event, use constructed sediment basins to attenuate the discharge rate of stormwater from the site

7.2 OPERATIONAL PHASE

The stormwater quality management objectives that apply to the operational phase of Shoreline Redlands are listed in Table 10 (as required by *State Planning Policy* (DSDIP, 2016).

The load reduction targets are aimed at protecting the environmental values of Moreton Bay from the impacts of urban stormwater runoff and are consistent with the stormwater treatment mitigation measures modelled in Section 5.2, which predict improved water quality leaving the site compared to the existing land use. The objectives will be achieved through a combination of stormwater treatment measures including bioretention, wetlands, sediment basins and revegetated waterways. These will be documented in Stormwater Quality Management Plans (SQMPs) to be submitted with each development application.

Table 10 Stormwater quality objectives

Pollutant	Discharge criteria (% reduction in mean annual load)
Total suspended solids (TSS)	80%
Total phosphorous (TP)	60%
Total nitrogen (TN)	45%
Gross pollutants (GP)	90%

The waterway stability objective has been derived for a range of situations as shown in Table 11. These objectives are consistent with the *State Planning Policy* (DSDIP, 2016).

Table 11: Derived waterway stability objectives

Waterway classification	Waterway Stability Criteria
Waterway draining directly to Moreton Bay within Shoreline Redlands Pty Ltd land holdings	Rehabilitate waterway to convey the post development 1 year ARI flows without the risk of erosion*
Waterway draining to Private Property	Limit 1 year ARI flows at site boundary for critical duration event (60 minutes or longer) to pre-development conditions

* Localised increases in 1 year ARI flows can be accepted provided the erosion criteria for sandy vegetated soils (50% cover for native grasses) is achieved in accordance with QUDM. The objective supports the rehabilitation of degraded waterways and allows local increases in 1 year ARI provided the rehabilitation design provides an appropriately stable waterway for the increased 1 year ARI flows.

8 MANAGEMENT MEASURES

8.1 CONSTRUCTION PHASE

Erosion and sediment control is to be implemented across all development stages in accordance with the *State Planning Policy* (DSDIP, April 2016) and the *Best Practice Erosion and Sediment Control* (IECA, 2008). This will involve:

- Erosion control
- Drainage control
- Sediment Control.

8.1.1 Erosion Control

Erosion control is to be undertaken in accordance with best practice land clearing and rehabilitation requirement provided in Table 4.4.7 (IECA, 2008) for the specific erosion risk.

Minimising the time for which areas are exposed is the most important aspect of ESC. This will be achieved in the following ways:

1. The amount of area exposed at any one time will be minimised by staging the works wherever possible and aiming to achieve finished level in each area as quickly as possible before opening new areas
2. Topsoil will be stripped and stockpiled separately to sub-soils. Stockpiles will be provided with surface cover using a chemical surface stabiliser such as Vital Chemicals Vital-Bon Matt Stonewall (as directed)
3. If works are delayed or put on hold in a particular area due to unforeseen circumstances, then a temporary erosion control covering will be provided (as directed). For broad-scale areas requiring temporary erosion control a chemical soil stabiliser such as Vital Chemicals Vital-Bon Matt P47-VR1 is preferred
4. Once areas reach finished level topsoil will be spread and be drill-seeded with a mixture of annual and perennial grass species (appropriate for the time of year) and applied with a temporary soil cover consisting of a chemical soil stabiliser such as Vital Chemicals Vital-Bon Matt P47-VR1 (as directed)

8.1.2 Drainage Control

Drainage diversions will be a combination of channels and diversion banks depending on the phase of earthworks. Drainage diversion will be such as to direct dirty water to sediment basins for treatment and clean water away from potential contamination. Drainage diversion will also be such as to prevent rilling as a result of overland flow or down fill batter slopes.

The use of linings and stabilisers will be determined on site, where erosive velocities may be expected to occur. Products such as Vital HR or equivalent are considered suitable. Use of rock check dams may also be required along drainage channels where gr4ades are steep and erosive velocities may occur.

The following drainage control standards are to be the adopted for any temporary drainage control measures:

- Drainage design standard for temporary drainage structures which either divert clean water around areas of disturbance or convey flows to sediment basins to have at least the capacity required by Table 4.3.1 of IECA (2008). In the case of short-life diversion channels (<12 months) this equates to a 1 in 2yr ARI event capacity, while for the diversion channels which will remain in place throughout construction the required capacity is 1 in 10yr ARI.
- Flow diversion of all upslope runoff from undisturbed/stable areas >1500m^2
- Lateral spacing of catch drains and flow diversion banks are to be as per IECA Table 4.3.2 and adjusted as per Table 4.3.3.

8.1.3 Sediment Control

Sediment capture controls will be required to ensure that mobilised sediment is captured through a combination of source controls such as silt fences and appropriately designed sediment basins. Where possible sediment basins for construction will be located within the voids required for the future stormwater quality treatment systems (sediment basins, bioretention basins, wetlands etc.). Sediment basins are required to service all exposed site areas and to be designed and managed in accordance with the current version of the *Best Practice Erosion and Sediment Control* (IECA, 2008).

8.2 OPERATION PHASE

Stormwater management measures for the operational phase are to be documented in a Stormwater Management Plans.

These treatment measures include:

- **Vegetated swales**: Vegetated swales provide removal of coarse and medium sediments.
- **Sediment ponds**: Sedimentation ponds promote settling of sediments through the reduction of flow velocities and temporary detention.
- **Constructed Wetlands**: Constructed wetland systems are densely vegetated water bodies that use enhanced sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater.
- **Bioretention systems**: Bioretention systems operate by filtering stormwater runoff through densely planted surface vegetation and then percolating runoff through a prescribed filter media. During percolation, pollutants are retained through fine filtration, adsorption and some biological uptake. These systems are quite flexible in their design and can be applied at many different scales, taking many different forms including street tree systems, bioretention swales, and raingardens.
- **Revegetated waterways**: Degraded waterways are to be rehabilitated and revegetated with appropriately selected native species, tolerant to the expected hydrology and hydraulics. The improved condition of the waterways will improve waterway stability, provide habitat and allow fauna passage through the site. The revegetated waterway corridors will provide the treatment benefit of a re-vegetated swale, slowing flows and help to settle out suspended sediments during events.

9 MONITORING AND AUDITING

9.1 CONSTRUCTION PHASE

9.1.1 Principal Contractor

Site inspections and monitoring are to be undertaken by the principal contractor in accordance with Sections 6.17 and 7.4 of the *Best Practice Erosion and Sediment Control Document* (IECA, 2008) as detailed below. Best practice site management requires all ESC measures to be inspected at the following frequencies and include the following checks as a minimum:

Daily site inspections (during rainfall):

- All drainage, erosion and sediment control measures
- Occurrences of excessive sediment deposition (whether on-site or off-site)
- All site discharge points (including dewatering activities as appropriate)

Weekly site inspections (even if work is not occurring on-site)

- All drainage, erosion and sediment control measures
- Occurrences of excessive sediment deposition (whether on-site or off-site)
- Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements
- Litter and waste receptors
- Oil, fuel and chemical storage facilities

Prior to anticipated runoff producing rainfall (within 24 hours of expected rainfall)

- All drainage, erosion and sediment control measures
- All temporary flow diversion and drainage works

Following runoff producing rainfall (within 18 hours of rainfall event)

- All drainage, erosion and sediment control measures
- Occurrences of excessive sediment deposition (whether on-site or off-site)
- Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements

9.1.2 CPESC Compliance Audits

The ESC measures implemented at the site are to be inspected on a monthly basis by a CPESC (*Certified Professional in Erosion and Sediment Control*) who is independent of the principal contractor and an audit report kept on file. The purpose of the audits to is to ensure the developed and the contractors are meeting their obligations for ESC under the *Environmental Protection Act* (EP Act). The site will be assessed against these requirements in accordance with *Procedural Guideline: Standard work method for the assessment of the lawfulness of releases to waters from construction sites in South East Queensland EM1135* (DEHP, 2011).

The compliance audits will involve:

- Site inspection with the contractors to assess ESC actions on the site against the ESC plans and the requirements *of EP Act and Procedural Guideline: Standard work method for the assessment of the lawfulness of releases to waters from construction sites in South East Queensland EM1135* (DEHP, 2011).
- Identifying non-compliances on the site, photographing and recording these for reporting.
- Where the rectification action is simple, these will be recorded and verbally communicated to the contractor for action.
- Review of any water quality and rainfall information for the site
- Compilation of a ESC Audit report which:
    - Identifies the ESC obligations
    - ESC issue and non-compliances
    - Actions (simple) to be taken to rectify the issues and non-compliances.

The triggers for inspections and reporting by the CPESC are as follows:

- Prior to the commencement of clearing works in each catchment
- Prior to the commencement of bulk earthworks;

- Prior to the commencement of civil works; and
- At regular monthly intervals during works.

9.2 OPERATION PHASE

Certification and inspection of operational measures is to occur as per the *State Planning Policy* (DSDIP, April 2016) and in accordance with the following guidelines:

- Water by Design (2006), *Water Sensitive Urban Design Technical Design Guidelines for South East Queensland Version 1*. Moreton Bay and Waterways Catchments Partnership. Brisbane, Queensland.
- Water by Design (2009), *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*, SEQ Healthy Waterways Partnership. Brisbane, Queensland.
- Water by Design (2012), *Transferring Ownership of Vegetated Stormwater Assets Version 1*. Healthy Waterways Partnership. Brisbane, Queensland.

10 CORRECTIVE MEASURES

Required maintenance should be completed as soon as possible. Within 24 hours is the preferred response time.

Additional temporary controls shall be implemented until the maintenance can be completed,

Potential contamination shall be contained and investigated. Water is not to be released until investigation has shown water is of suitable quality.

From the investigation it will be determined what course of action is required, including that for notification to the relevant stakeholders, including regulatory authorities.

Incidents shall be documented, investigations conducted and action plans established in order that the event does not occur again.

11 RESPONSIBLE PERSONNEL

11.1 SHORELINE REDLANDS (PRINCIPAL)

The roles and general responsibilities of the Principal are to:

- Comply with this Water Quality Management Plan (WQMP);
- Comply with legislation and Council policy;
- Nominate a Project Manager who will represent the Principal in reviewing the performance of contractors and assess implementation of the construction and operation phase measures; and
- Provide appropriate and adequate resources to allow for the effective implementation and maintenance of the WQMP.
- Conduct periodic reviews of environmental performance are conducted.
- Promptly notify the regulatory authorities of any changes to this WQMP and its implementation, reporting or monitoring, and any breaches and proposed corrective action.
- Report any major environmental incidents that may have a significant impact on the surrounding environment.

- Provide employees and contractors with the relevant environmental instruction in relation to the WQMP and awareness and understanding of their obligations and duties.

It will be the responsibility of the Principal to ensure that the contents of the WQMP are adequately communicated to all contractors, and that they are advised of the seriousness of potential impacts if the recommended actions are not observed.

11.2 PROJECT MANAGER

This Water Quality Management Plan (WQMP) will be overseen by the Project Manager.

The Project Manager is responsible for:

- Implementation of the WQMP to ensure the minimisation of environmental impact from the project;
- Ensuring the mitigation measures detailed in this plan are implemented,
- Ensuring a review of this WQMP is undertaken in year 3 in the first instance and then at intervals of not less than five years or sooner if required. Any significant or unexpected alteration in the proposed development may require the WQMP to be revised and amended accordingly. Any changes or amendments proposed to the WQMP will be forwarded to DoEE for comment/approval prior to their adoption;
- Keeping up-to-date records of all disturbance incidence reports, monitoring events, results and corrective actions;
- Reviewing and advising DoEE of any proposed changes to the WQMP; and
- Designate suitably experienced persons for the management and auditing of the ECMP as required.

11.3 DESIGNATED PERSON (DP)

The roles and responsibilities of the Designated Person are to:

- Liaise with the Project Manager to facilitate compliance with legislation, Council policy and conditions during the development;
- Conduct audit inspections as required /requested during earthworks, and clearing or other inspections as triggered by environmental events or incidents;
- Advise the Project Manager on the compliance and effectiveness of the WQMP /Site Instructions and its implementation;
- Immediately contact the Project Manager regarding any environmental incidents that have the potential to cause environmental harm to Moreton Bay, request written details within 24 hours of occurrence, and issue Site Instructions for rectification/remediation to the Project Manager as soon as possible;
- Issue Site Instructions (for correction of non-compliance) to the Project Manager within seven (7) days of inspections and completion of the Inspection Procedures and Checklist(s);
- Maintain accurate reports (incidents, near miss, results of monitoring) to be provided to DoEE within ten days of request.

12 REFERENCES

DEHP (2010) *Environmental Protection (Water) Policy 2009 Redland Creeks environmental values and water quality objectives.*

DEHP (2011) *Procedural Guideline: Standard work method for the assessment of the lawfulness of releases to waters from construction sites in South East Queensland EM1135.* Department of Environment and Heritage Protection

DLGIP (2016). *State Planning Policy*

Healthy Waterways (2010). *MUSIC Modelling Guidelines*

QUDM, (2013). *Queensland Urban Drainage Manual*. 2013. Department of Natural Resources and Water

ATTACHMENT 2

Acid Sulfate Soil Investigation Report

Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Shoreline Redlands Acid Sulfate Soils Assessment and Management Plan

Proposed Residential Subdivision
218 Serpentine Creek Road, Redland Bay

Prepared for
Shoreline Redland Pty Ltd

Project 92838.00
May 2017

Integrated Practical Solutions

Document History

Document details

Project No.	92838.00	Document No.	R.001.Rev3
Document title	Report on Shoreline Redlands Acid Sulfate Soils Assessment and Management Plan, Proposed Residential Subdivision		
Site address	218 Serpentine Creek Road, Redland Bay		
Report prepared for	Shoreline Redland Pty Ltd		
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Revision 3	1	0	Mr Ray Wassenberg, Shoreline Redland Bay Pty Ltd

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		20 June 2017
Reviewer		20 June 2017

bsi. ISO 9001 Quality Management

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Executive Summary

This acid sulfate soils (ASS) investigation report and management plan was undertaken at the request of Shoreline Redlands Pty Ltd for a proposed residential subdivision. The investigation identified elevated net acidity attributed to potential acid sulphate soils (PASS) in two of the samples tested, indicating PASS are locally present. All other elevated net acidity results are attributed to acidic, non ASS.

Soil disturbance greater than 1000 tonne in the area identified as containing ASS will require implementation of the ASS management plan (ASSMP). Some management of naturally occurring acidic non ASS soils is warranted for other soil disturbances.

Table of Contents

Report on Shoreline Redlands Acid Sulfate Soils Assessment and Management Plan

Proposed Residential Subdivision

218 Serpentine Creek Road, Redland Bay

1. Introduction

This report presents the results of an shoreline redlands acid sulfate soils assessment and management plan (ASS) and management plan undertaken for a proposed residential subdivision at 218 Serpentine Creek Road, Redland Bay. The plan was prepared at the request of Mr Ray Wassenberg of Shoreline Redland Pty Ltd, site owners and developers and was undertaken in accordance with Douglas Partners' Pty Ltd (DP) proposal BNE170194 dated 27 February 2017.

It is understood that the ''Shoreline'' residential development area is approximately 280 ha and will include residential lots, recreational parks, sports fields, natural floodways, bikeways, walkways, and open space. Bulk earthworks details have not been provided for the preparation of this report, however are anticipated to comprise 'cut and fill' to create level ground for buildings and recreational areas; civil infrastructure works including roads, services and stormwater control; and erosion and sediment control.

It is further understood that no dewatering (ie. lowering of the groundwater) is proposed however, if dewatering is proposed then this should be investigated further.

The site area that has been identified as potentially containing acid sulfate soils (ASS) is approximately 21 ha. The areas potentially containing ASS are roughly arranged in three separate areas, designated Area A, B and C as shown on Drawing 1 in Appendix B.

This report provides the results of ASS investigation and a site specific acid sulfate soils management plan (ASSMP).

The investigation comprised the drilling of 40 bores and the installation of three standpipes, followed by laboratory testing of selected samples from the bores. DP has also undertaken a geotechnical investigation at this site between 16 December 2016 and 11 January 2017 which comprised two ASS bores in the northern portion of Area B which have been included in this ASSMP.

This report must be read in conjunction with the notes entitled 'About This Report' in Appendix A and any other explanatory notes, and should be kept in its entirety without separation of individual pages or sections.

2. Site Description and Geology

The development site is located along Serpentine Creek Road in Redland Bay (refer to Drawing 1 in Appendix B for approximate site boundary).

The site was mostly grass covered agricultural land with areas of open bushland. Northern and southern parts of the site were used for cropping. There were also a number of houses, dams and gravel roads present across the site. The individual site areas are described further below.

Area A: Area A generally sloped gently down towards the east from approximately RL 7 to approximately RL 1 m. A general view of Area A is presented in Figure 1 below.

Figure 1: General view of Area A, looking west towards Serpentine Creek Road from Bore 9.

Area B: Area B generally sloped gently down towards the east from approximately RL 5 m to RL 1 m. A general view of Area B is presented in Figure 2 below.

Figure 2: View of eastern boundary of Area B, looking south.

Area C: Area C was generally sloped very gently down towards the south from approximately RL 5 m to RL 2 m. A general view of Area C is presented in Figure 3 below.

Figure 3: General view of Area C, looking north from Scenic Road

The Geological Survey of Queensland's 1:100,000 series 'Brisbane' Sheet SG56-15 indicates that the site is underlain by a number of geological units. An excerpt of digital geological mapping overlain onto the Google Earth image and cadastral mapping for the site is shown in Figure 4 below.

Most of the site is underlain by Neranleigh-Fernvale Beds (DCi shown in green below), and unconsolidated sediments (Qhct shown in brown) encroach onto the eastern boundary, along Moreton Bay. The western part of the site is underlain by a shallow alluvium (yellow unit) channel and several small (<3 ha) sand deposits (Q1 shown in orange) primarily in the southern part of the site, with one in the northern part of the site.

Mapping descriptions for these units are shown below:

- Neranleigh-Fernvale Beds – mudstone, shale, arenite, chert, jasper, basic metavolcanics, pillow lava, conglomerate;
- Miscellaneous Unconsolidated Sediments – marine basin; thin veneer of muddy sand, sandy mud, mud; over Pleistocene sediments;
- Alluvium – clay, silt, sand, gravel; flood plain alluvium
- Sand – dunes; sand, organic deposits

Localised filling and overlying natural soils were encountered during the investigation, consistent with the units described above.

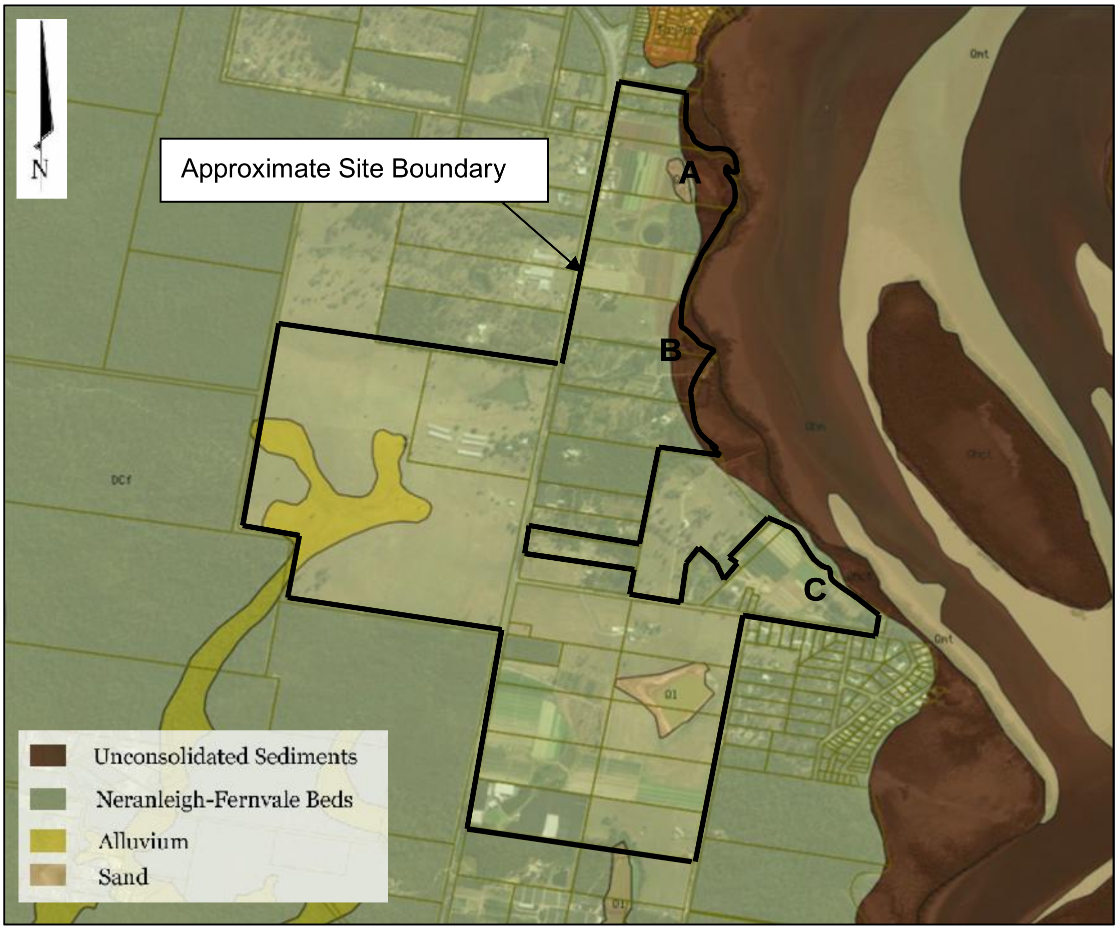

Figure 4: Geological mapping in the vicinity of the site

The Queensland Government 1:100,000 ‘Acid Sulfate Soils, Tweed Heads to Redcliffe, Map 1’ indicates that ASS will ‘probably occur’ (red) or have a ‘low probability of occurrence’ (yellow) along the coastline. An excerpt of the digital ASS map overlain onto the Google Earth image and cadastral mapping for the site is shown in Figure 5 below and on Drawing 1 to 4 in Appendix B.

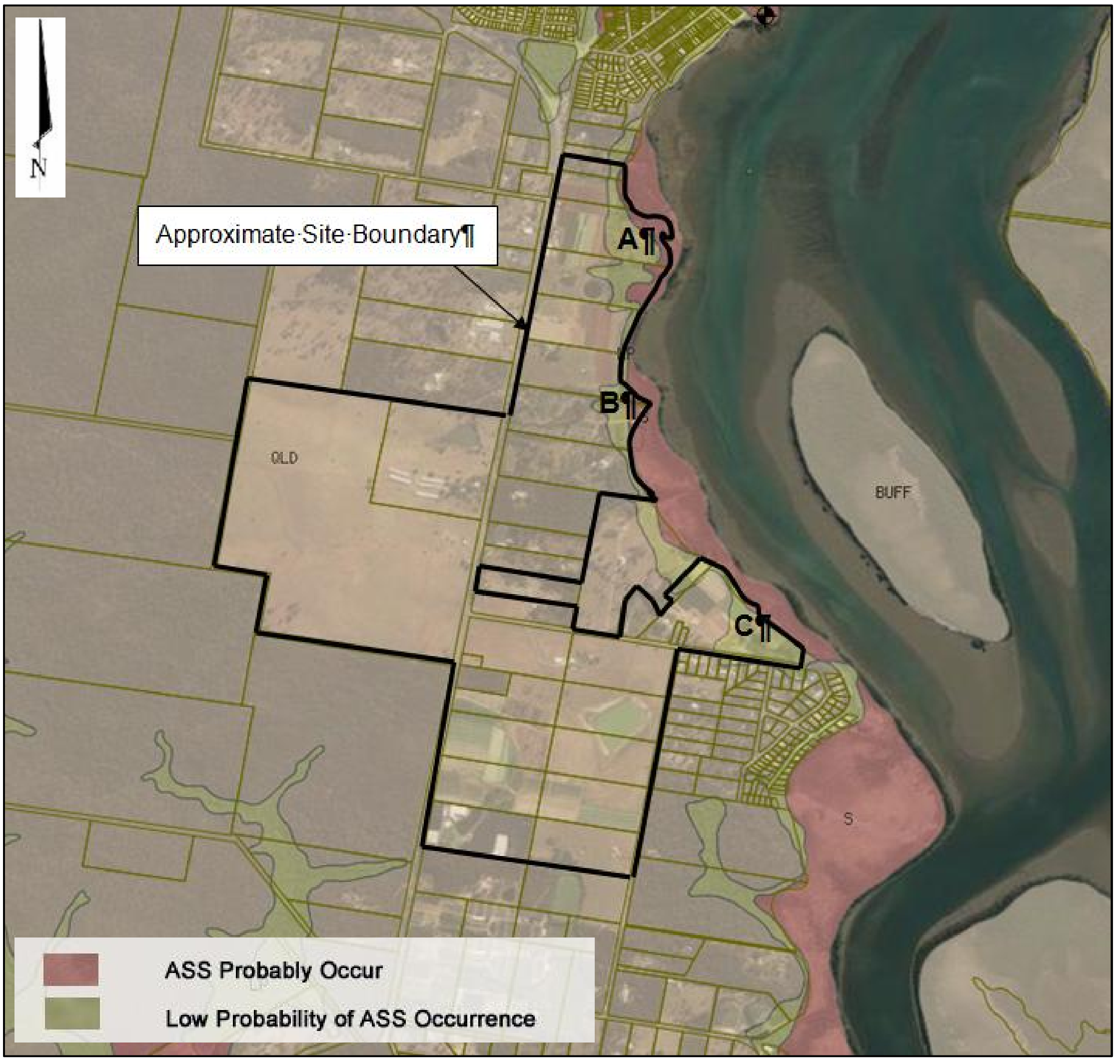

Figure 5: Extract from Acid Sulfate Soils, Tweed Heads to Redcliffe, Map 1.

3. Environmental Risk to Moreton Bay

The ASS risk to Moreton Bay associated with this development is considered to be the discharge or leachate of acidic water into Moreton Bay. Although sea water has a moderate buffering capacity, all water would need to be treated in accordance with Section 7 below before discharging either on land (for recharging the groundwater) or within Moreton Bay.

Referenced to Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines v4.0 (Ref 2) indicates that when acidic waters are discharged or leached into a marine environment, a depletion of carbonate can occur. While the effects of carbonate depletion are not known, 'it may stress near-shore marine and estuarine organisms and may lead to unacceptable and possibly irreversible changes to tidal and marine ecosystems, particularly those already under stress' (Ref 2).

4. Acid Sulfate Soils Investigation

4.1 Field Work Methods

The field work for the ASS sampling was carried out between 6 and 8 March 2017 and comprised the drilling and sampling of 40 bores (designated Bores 1 to 28, 24B and 31 to 42). The approximate locations of the tests are indicated on Drawings 2 to 4 in Appendix B. It should be noted that Bores 29 and 30 were also proposed, however were unable to be drilled due to restricted access to the southern portion of Area B.

The bores were drilled using a utility mounted drill rig with solid flight augers. Bores 21, 22, 24B, 28 and 42 were drilled to 4 m depth, while the remaining bores were drilled to 2 m depth. ASS sampling was undertaken at 0.25 m intervals to the termination depth of all bores.

Slotted PVC standpipes were installed in Bores 22, 24B and 42 to 4 m depth for groundwater monitoring. A groundwater sample was taken from Bore 24B for subsequent laboratory analysis.

All ASS samples were placed in sealable plastic bags and stored on ice prior to delivery to the laboratory. The bores were set out and logged by experienced geotechnical personnel, who also collected samples for laboratory testing and identification purposes.

The bores were positioned in areas mapped as 'Land <5m AHD with low probability of ASS occurrence' and 'Potential or actual ASS occur within 5m of the surface' by a geotechnical engineer relative to existing site features. Following completion of the field work, the UTM coordinates of the bores were recorded using a hand-held GPS accurate to approximately 5 m. Surface levels at the test locations were inferred from the client-supplied contour and detail survey plan.

4.2 Field Work Results

Details of subsurface conditions encountered in the test bores are given in the borehole logs in Appendix C. The logs should be read in conjunction with the notes entitled 'About this Report' in Appendix A as well as other explanatory notes which comment on the sampling methods, soil descriptions, and symbols and abbreviations used in their preparation.

4.2.1 Area A

In summary, the subsurface conditions at Area A generally comprised localised **filling,** over **alluvial soils.** The subsurface conditions encountered are further described below:

- **Filling** – red-brown silty clay filling was encountered to 0.3 m depth in Bore 3 and brown mottled light grey sandy clay filling was encountered to 1.1 m depth in Bore 8.

  In the absence of documentation to confirm the filling was controlled and placed under engineering supervision and testing, it should be considered as 'uncontrolled'.

  Alluvial Soil - alluvial soils generally comprising silty sand, and silty and sandy clay were also encountered in all bores to termination at depths of 2 m and 4 m.

4.2.2 Area B

In summary, the subsurface conditions at Area B generally comprised localised **filling,** over **alluvial soils.** The subsurface conditions encountered are further described below:

- **Filling** – red-brown mottled grey silty clay filling was encountered to 0.6 m depth in Bore 26 and light grey-brown silty sand filling with some angular gravel was encountered to 0.3 m depth in Bore 27.

  In the absence of documentation to confirm the filling was controlled and placed under engineering supervision and testing, it should be considered as 'uncontrolled'.

  Alluvial Soils – alluvial soils generally comprising silty sand, clayey sand, and silty clay were also encountered in all bores to termination at depths of 2 m and 4 m.

4.2.3 Area C

In summary, the subsurface conditions at Area C generally comprised localised **filling,** over **alluvial soils.** The subsurface conditions encountered are further described below:

- **Filling** – silty clay filling was encountered to depths of 0.8 m and 0.2 m in Bores 35 and 36 respectively. The silty clay filling was underlain by silty sand filling to 1 m depth in Bore 36.

  In the absence of documentation to confirm the filling was controlled and placed under engineering supervision and testing, it should be considered as 'uncontrolled'.

- **Alluvial Soils** – alluvial soils generally comprising silty sand, silty clay, sandy clay and sand were also encountered in all bores to termination at depths of 2 m and 4 m.

4.2.4 Groundwater

Groundwater was observed at 3.2 m depth in Bore 24B (Area B), however it was not observed in any of the other bores. It should be noted, however, that groundwater depths and ground moistures are affected by climatic conditions (including tidal conditions at this location) and soil permeability, and will therefore vary with time.

4.3 Laboratory Testing

Screening and analytical testing for oxidisable sulfur arising from actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) were carried out with reference to the QASSIT Guidelines (Ref. 1), the Soil Management Guidelines (Ref. 2) and the Laboratory Methods Guidelines (Ref. 3).

325 samples recovered from the bores were screened by measurement of pH after the addition of distilled water (pH_F) and peroxide (pH_{FOX}). The pH_F tests provide a preliminary indication of past oxidation of sulfides resulting in the presence of AASS. The pH_{FOX} tests provide a preliminary indication of unoxidised sulfides and therefore PASS. Based on the results of the screening tests and visual inspection of the samples, selected samples were subjected to more rigorous chromium suite testing, carried out by ALS Environmental Pty Ltd (ALS) in Brisbane.

A groundwater sample was collected from Bore 24B and was screened by ASS groundwater suite testing.

The results of the screening tests (pH_F and pH_{FOX}), and a summary of the chromium suite testing and groundwater suite testing are summarised in Table D1 in Appendix D, followed by the complete ALS laboratory results.

5. Comments

5.1 Acid Sulfate Soil Assessment and Laboratory Results Summary

The criteria used to assess the results of the screening tests (pH_F and pH_{FOX}) as possibly indicative of actual acid sulfate soils (AASS) or potential acid sulfate soils (PASS) were based on the QASSIT Guidelines (Ref. 3) as follows:

- $pH_F < 4$ indicates oxidation has occurred in the past and that AASS is present; and
- $pH_{FOX} < 3$, plus a pH_{FOX} reading at least one pH unit below pH_F, plus a strong reaction with peroxide, strongly indicates the presence of PASS.

The lowest pH_F test result recorded (refer Table D1 in Appendix D) during the screening tests was 4.3 (1.75 m depth in Bore 16). A pH_{FOX} condition less than pH 3 was encountered in 38 samples, while a pH_{FOX} reading at least one pH unit below pH_F was encountered in 315 samples.

Regardless of the indicative screening results, 45 samples were selected for more rigorous and quantitative chromium suite testing to determine more definitively if AASS or PASS are present.

The action criterion to assess the presence of ASS and requirement for an acid sulfate soils management plan (ASSMP) is based on the Soil Management Guidelines (Ref. 3) and the Laboratory Methods Guidelines (Ref. 4) as follows:

Existing plus potential acidity (S_{CR} + TAA + S_{NAS}) of greater than or equal to 0.03%S (sulfur trail) or 18 mol H^+/tonne (acid trail).

Where: S_{CR} = Chromium Reducible Sulfur
TAA = Titratable Actual Acidity
S_{NAS} = Net Acid Soluble Sulfur (retained acidity)

The existing plus potential acidity was calculated to be equal to or higher than the laboratory's limit of reporting (i.e. 0.02 %S) for 44 of the 45 samples tested and 28 of these samples returned an existing plus potential acidity of at least 0.03%S. The elevated chromium suite results are summarised in Table 1 below.

Table 1: Chromium suite results with elevated existing plus potential acidity.

Bore	Depth (m)	RL (mAHD)	Chromium Reducible Sulfur (S_{CR}) (%S)	Titratable Actual Acidity (TAA) (%S)	Net Acid Soluble Sulfur (S_{NAS})	Existing plus Potential Acidity (%S)	Liming Rate (kg $CaCO_3$/t)
AREA A							
1	0.25	1.75	0.010	0.06	-	0.07	3
2	0.75	3.75	0.008	0.11	<0.02	0.13	6
3	0.5	2.50	0.01	<0.02	-	0.03	1
	1.75	1.25	<0.005	0.06	<0.02	0.06	3
5	0.25	2.25	0.007	0.05	-	0.06	3
6	0.5	1.50	0.009	0.05	-	0.06	3
8	2.0	1.50	<0.005	0.06	<0.02	0.07	3
13	0.25	3.75	0.008	0.04	-	0.04	2
	1.0	3.00	0.007	0.04	-	0.05	2
14	1.75	1.25	0.005	0.05	-	0.05	2
17	0.25	1.75	0.006	0.05	-	0.06	3
	1.25	0.75	<0.005	0.03	<0.02	0.03	2
18	0.25	5.25	0.006	0.05	-	0.06	3
19	0.75	5.25	<0.005	0.02	-	0.02	1
20	0.25	4.75	0.005	0.04	-	0.05	2
21	3.00	1.00	<0.005	0.03	-	0.03	1
22	1.5	3.50	0.006	0.04	-	0.05	2
AREA B							
24B	0.75	1.75	0.008	0.08	<0.02	0.09	4
25	0.5	4.50	0.006	0.03	-	0.04	2
26	0.25	1.75	0.009	0.03	-	0.05	2
28	0.5	2.00	0.010	0.16	<0.02	0.19	9
	1.5	1.00	0.005	0.04	-	0.05	2

Table 1: Chromium suite results with elevated existing plus potential acidity *(cont.)*

Bore	Depth (m)	RL (mAHD)	Chromium Reducible Sulfur (S_{CR}) (%S)	Titratable Actual Acidity (TAA) (%S)	Net Acid Soluble Sulfur (S_{NAS})	Existing plus Potential Acidity (%S)	Liming Rate (kg $CaCO_3$/t)
AREA C							
31	1.75	3.25	0.005	0.11	<0.02	0.12	6
34	1.25	2.25	0.007	0.05	-	0.06	3
35	1.0	1.50	0.732	0.04	-	0.77	36
35	1.75	0.75	0.014	0.07	<0.02	0.09	4
37	2.0	2.00	0.063	0.05	<0.02	0.12	6
38	0.50	1.50	0.010	0.02	-	0.04	2
39	1.0	2.00	0.012	0.07	<0.02	0.08	4
41	0.5	2.00	0.012	0.10	<0.02	0.11	5
42	0.25	2.00	0.010	0.03	-	0.04	2

Table 2: Groundwater suite results

Bore	Depth (m)	RL (mAHD)	pH	Acidity $CaCO_3$ (mg/L)	Dissolved Metals (mg/L)		Total Dissolved Solids at 180°C (mg/L)
					Aluminium	Iron	
24B	3.2	-0.70	6.17	100	0.03	0.12	1400

The existing plus potential acidity was generally calculated to be between 0.02%S and 0.13%S and locally up to 0.19%S (Bore 28 at 0.5 m depth) and 0.77%S (Bore 35 at 1.0 m depth).

Although the groundwater sample testing is indicated to be slightly acidic, it is not indicative of highly ASS conditions.

While the existing plus potential acidity action criterion of 0.03%S was exceeded in 28 of the 45 samples tested, this could only be primarily attributed to the S_{CR} component for two samples tested from Area C (Bore 35 at 1 m depth and Bore 37 at 2.0 m depth).

With the exception of the two samples tested from Area C (Bore 35 at 1 m depth and Bore 37 at 2.0 m depth), all other elevated results were due to actual or retained acidity, rather than potential acidity as implied by chromium reducible (oxidisable) sulfur (S_{cr}) results of below 0.03% sulfur or below the laboratory's practical quantification limit (0.005% sulfur). The low retained acidity (S_{NAS}) results in these samples indicate no jarosite or similar iron or aluminium hydroxyl sulfate minerals are present. On this basis, it is considered that the elevated net acidity results in Areas A and B are probably largely due to naturally occurring acidic soils rather than ASS.

5.2 Areas A and B

Based on results of this testing, an ASSMP is probably not required for Areas A and B. However, Ref. 2 suggests a neutralising agent (such as ag-lime) should be applied during site works in Areas A and B (refer below). The TAA results can be used to guide liming rates to achieve desired pH levels. Thorough mixing, a safety factor and a fully contained treatment pad would generally not be necessary. Instead, neutralising agent may be:

- spread in key areas as part of the filling operations to intercept any acidic leachate flow;
- added to truckloads of disturbed material while being moved, thus achieving a degree of mixing during transport and placement;
- spread as a guard layer under any temporary or permanent stockpiles or treatment areas;
- incorporated as lime-enriched perimeters around temporary or permanent stockpiles or treatment areas; and
- positioned in drains and areas most likely to experience flow.

Using the highest reported level of soil acidity (i.e. existing plus potential) determined by the laboratory test results in Areas A and B, a preliminary neutralisation rates of 6 kg and 9 kg of lime per tonne of soil is required in Areas A and B respectively.

5.3 Area C

Based on results of this testing, an ASSMP is considered necessary for Area C. This is because two samples tested from Area C (Bore 35 at 1 m depth and Bore 37 at 2.0 m depth) exceeded the action criterion due to chromium reducible sulfur, indicating the presence of PASS in this vicinity. There were no discernible features associated with these elevated results, and given the limited nature of testing carried out to date, it is possible that elevated potential acidity may occur in other areas not tested.

As mentioned above, the anticipated bulk earthworks plans were not provided for the preparation of this report. If excavation is required in Area C, it is recommended that further investigation is undertaken to determine the extent and severity of the ASS in this area.

The following acid sulfate soil management plan is provisional only and applies to the treatment of Area C under the assumption that the PASS in the vicinity of Bores 35, 36 and 37 will not be widespread.

6. Provisional Acid Sulfate Soil Management Plan

6.1 Management Strategy

6.1.1 Overview

As noted above, some soils excavated in Area C will require neutralisation to address the presence of ASS.

For the excavation of soils below RL 5 m in Area C, liming will be carried out as excavation progresses. Without additional testing to determine more accurate liming rate across the site, it is recommended that a rate of 6 kg of lime per tonne of material to be disturbed, should be adopted.

It follows that where lime neutralisation treatment is undertaken, it should be managed in a controlled environment, in a bunded and lined pad with perimeter drainage and a sump. This is to enable the collection and separate treatment of any acid leachate formed during the soil drying and liming process.

Saturated and cohesive soil cannot be neutralised effectively with lime, without significant reworking. This is because the lime must be well mixed into the soil and this cannot be performed when the soil is overly wet and 'sticky'. Hence, the excavated soil must be dried back on a limed pad, before effective mixing can take place with earthmoving machinery.

All water draining from the soil, once it is removed from the excavation, should be considered as potentially acidic and should be separated in a controlled area, such as the above referred bunded and lined pad. The water should not be allowed to flow into any waterways or drains, until it has been tested for pH and for any other environmental tests required by the regulatory authority.

If soil is to be removed from site, to be dried and neutralised off-site, it should be transported in trucks appropriately lined to prevent leakage of wet soil, slurry or drainage water during its transportation.

The soil and water contained within the treatment bunds should not be removed until the target values have been achieved as presented in Table 3 below. Similarly, additional layers of soil should not be added to the bunded stockpile for treatment until the underlying layers have been validated.

6.1.2 Neutralisation Pads

If neutralisation of ASS is to be carried out on-site, works should be as follows:

- Prepare a liming pad/stockpile site of appropriate area for the volume of soil to be treated. The pad should be prepared on relatively level or gently sloping ground to minimise the risk of any potential instability issues, with a natural (or shaped) fall to the local drainage sump;
- Line the surface of the pad with selected approved compacted clay (at least two layers to a combined compacted thickness of 0.5 m) or an impermeable geosynthetic liner, where the subgrade soils are other than low permeability clays. The subgrade soils in some areas of the site comprise silty clay, therefore additional clay filling or a geosynthetic lining will probably not be required where treatment can be carried out in these areas;

- Apply a guard layer of fine agricultural lime ('ag-lime') over the clay subgrade or compacted clay liner, to neutralise downward seepage. This is not required if an impermeable geosynthetic liner is used. The guard layer of lime should be applied at a rate of approximately 5 kg lime/m^2 of surface area for every 1 m height of stockpiled soil;
- Spread the excavated soil onto the guard layer in layers of 200 mm to 300 mm thickness, leaving a 1 m flat area between the toe of the spread soil and the containment bund or drain. When spreading the first soil layer, care should be taken not to churn up the lime guard layer;
- Let the soil dry back to facilitate lime mixing (if too wet, then adequate mixing of lime cannot be undertaken);
- Apply ag-lime to the recently spread soil at the designated liming rate of about 6 kg ag-lime per tonne (assuming a neutralising value (NV) of 95% for ag-lime);
- Use a disc harrow or rotary hoe to thoroughly mix the lime with the existing soil layer, prior to spreading the next layer of soil; and
- Continue the spreading/liming/mixing cycle until construction works are finished.

When testing indicates that lime neutralisation is complete (refer to Section 6.1.5), then the stockpiled soil may be removed from the liming/neutralisation pad.

Liming pads should be bunded off, and a circumference drain excavated to collect and contain leachate. The drain and inner bund slopes should be covered with a layer of fine lime applied to neutralise any possible leachate migrating from the stockpiled material.

Liming should be pre-planned and appropriate liming pads constructed, allowing for other construction activities at the site. Leachate collection location, lining and construction should be similarly pre-planned.

Construction of excavations below the filling should also include the placement of a guard layer of fine 'ag-lime' over the exposed surfaces, to neutralise any exposed acid sulfate soils. This guard layer would also serve to mitigate against low pH conditions which may be aggressive to concrete pipes and footings. A liming rate of 5 kg lime/m^2 is suggested in this regard.

6.1.3 Neutralisation Materials

Ag-lime should be used as the preferred neutralisation material for the management of ASS as it is usually the cheapest and most readily available product available for soil neutralisation. This material is mildly alkaline (pH of 8.5 to 9), of low solubility, and does not present any handling problems. The ag-lime comprises calcium carbonate typically made from limestone that has been finely ground and sieved to a fine powder.

It is generally preferable if an ag-lime with a purity of 95% or better is used (i.e. NV >95, where NV is the neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine calcium carbonate which is designated NV = 100).

Due to its low solubility in water, ag-lime is not suitable for the neutralisation of leachate, which requires a product with a very quick reaction and high solubility. The most suitable neutralising agent for leachate and stockpile drainage water is slaked lime or quicklime (calcium hydroxide). This is made by treating burnt lime with water (slaking) and comes as a fine white powder. It has a typical NV of about 135%. Due to its high alkalinity (pH of about 12.5 to 13), slaked lime or quicklime should not be allowed to come into contact with the skin or be inhaled.

6.1.4 Risk Categorisation

On the basis that up to 1000 tonnes of ASS is disturbed during bulk earthworks at Area C and an average liming rate of 6 kg ag-lime is used, approximately 6 tonnes of ag-lime would be required and hence the treatment level stipulated in Table 2 of Ref 2 is "Category VH" (very high level of treatment). No alteration of permanent groundwater levels is proposed. Ref 2 confirms that a formal ASSMP is required as part of the development application for "Category VH" treatment, and that the following practices are included:

- submitting more detailed plans of disturbance and an ASS investigation report (noting the comments in Section 5.3 above)
- treatment of soils to their existing plus potential acidity with an appropriate amount of neutralising agent;
- ensuring that the ASS have been appropriately treated and that ag-lime has been thoroughly mixed with the soil;
- undertaking laboratory testing to verify that ASS have been properly treated and the neutralising agent has been thoroughly mixed with the soil;
- bunding of the treatment area using non-ASS material (refer Section 8.1.2 above);
- monitoring of pH (refer Section 6.1.5 below) of any pools of water collected within the bund (particularly after rain) and treating water (refer Section 6.1.3) to keep pH in an appropriate range for the site;
- preventing infiltration passing through ASS to groundwater and apply an extra guard layer of ag-lime to intercept any infiltration from ASS (refer Section 6.1.2 above);
- providing a simple but thorough environmental management plan that meets the requirements of assessing authorities; and
- documenting of ASS management activities in the form of a simple closure report (refer Section 6.1.6 below).

7. Monitoring and Validation Testing

Based on a "Category VH" treatment level (refer Section 6.1.4 above), validation testing of the soil is specifically required.

Testing on any water collected from the treatment pad/s should also be conducted after the addition of lime and mixing to assess if mixing has been adequate, and to reduce the risk of acidic water being returned to the drainage channel and nearby lakes/watercourses.

Based on the amount of soil to be treated (assumed to be about 1000 tonnes), a frequency of one validation sample per 250 m^3 neutralised bunded soil would require four samples of soil to be collected and tested for field pH screening and chromium suite. However, from a practicality perspective, it is suggested that at least two validation samples per 200 mm to 300 mm deep soil layer per bunded area be collected for testing.

In addition so soil validation testing, the pH of all ponded stormwater around the confines of the treatment bunds should be measured daily.

The criteria for water quality are dependent upon the final discharge point. Based on 'Water Types and Aquatic Ecosystems Protection Levels in South East Queensland, Figure 3.1.1a' (Ref 4) the setting of the site and its proximity to Southern Moreton Bay, water quality guidelines have been chosen based upon discharge into enclosed coastal waters, lower estuary ecosystem. Recommended performance water quality guidelines have been adopted from the QWQG 2009 (Ref. 4).

Table 3: Target Levels of Neutralised Soil and Water

Test	Component	Target Level
Monitoring of water (refer also to Section 6.2)	pH	$8.0 < pH < 8.4^{(1)}$
	Turbidity	$6^{(1)}$
	Aluminium (Al) and Iron (Fe)	Established local water quality data prior to site disturbance and ensure that these values are not exceeded
	Dissolved Oxygen	90% to 105% saturation$^{(1)}$
Field screening of soil	pH_F	$5.5 < pH_F \leq 8.5$
Acid based accounting of soil (sPOCAS or chromium suite test method)	Existing + potential acidity	Zero or negative
	pH_{KCl}	$pH_{KCl} \geq 8.5$
	TAA	Zero
	TPA	Zero

Note: $^{(1)}$ Recommended threshold limits from Table 3.1.1 of Ref 4.

It is recommended that dewatering management strategies are re-evaluated early in the treatment process to ensure the proposed management system performs adequately.

Before discharge of any groundwater, the pH should be carefully monitored to indicate any potential oxidation of PASS by groundwater drawdown (if any). Furthermore, ferrous iron (Fe2+) should be measured prior to discharge using colourmetric test strips. Where ferrous iron is detected, groundwater should be held, treated and re-tested prior to discharge.

DP should be contacted to collect and test soil and water validation samples during construction at the frequencies mentioned above, and to assess the treatment effectiveness. If validation testing confirms that the ASS have not been sufficiently neutralised, then DP will provide liming rates for re-treatment.

Implementation of the ASSMP is the responsibility of the head contractor.

8. Closure Report

Based on a “Category VH” treatment level (refer Section 6.1.4 above), a “simple” closure report must be prepared and submitted to the assessment manager to demonstrate that residual risks to the environment, stakeholders and land users are ‘low’. Ref 2 provides mandatory information for a detailed closure report, but very limited guidance on a simple report. Detailed closure reports should include the following, but a lesser extent of reporting would probably be relevant for the site if further investigation indicates the extent of elevated PASS is limited:

- total final volumes and dimensions of disturbed ASS;
- where localised dewatering within the perimeter shoring was carried out, final location, extent and duration of dewatering and details of groundwater management strategies applied;
- details of soil management strategies undertaken at the site (including evidence of specific management measures such as waste tracking, photographic evidence of neutralisation and of bunded treatment pads);
- details of water management strategies undertaken at the site;
- location of off-site treatment and/or disposal of ASS and evidence of treatment off-site;
- summary of verification testing results for material treated (either on or off-site);
- summary of monitoring results for surface water and groundwater (with an emphasis on trends in water quality);
- full results of monitoring and verification testing regimes in appendices,
- a discussion of the effectiveness of management strategies employed at the site;
- details of any incidence of nonconformity with the ASSMP and corrective actions taken;
- a discussion of any potential risks to the environment or human health;
- proposed future monitoring and/or reporting programs; and
- proposed remediation measures, if needed.

9. Limitations

Douglas Partners (DP) has prepared this acid sulfate soils management plan for a proposed subdivision development at Serpentine Creek Road, Redland Bay in general accordance with DP’s Proposal BNE170194 dated 27 February 2017 The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of Shoreline Redland Bay Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any ensuing liability resulting from the use of the report by any third parties cannot be transferred to DP. In preparing this report, DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

10. References

1. Ahern, CR, Ahern, MR, and Powell, B, "Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998," QASSIT, Department of Natural Resources, Resource Sciences Centre, Indooroopilly, October 1998.
2. Dear, S E, Ahern, C R, O'Brien, L E, Dobos, S K, McElnea, A E, Moore, N G and Watling, K M, "Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines", Department of Science, Information Technology, Innovation and the Arts, Qld Government, June 2014.
3. Ahern, CR, McElnea, AE and Sullivan, LA, "Acid Sulfate Soils Laboratory Methods Guidelines", Department of Natural Resources , Mines and Energy, Indooroopilly, November 2004.
4. Department of Environment and Resource Management, "Queensland Water Quality Guidelines", Version 3, September 2009.

Douglas Partners Pty Ltd

Appendix A

About This Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

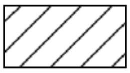
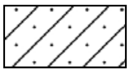
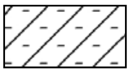
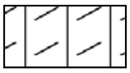
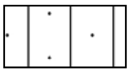
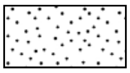
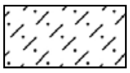
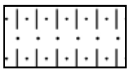
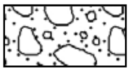
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

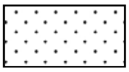
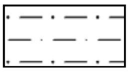
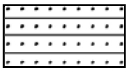
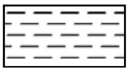
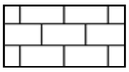
General

■	Asphalt
	Road base
	Concrete
	Filling

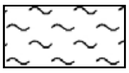
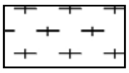
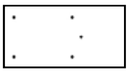
Soils

	Topsoil
	Peat
	Clay
	Silty clay
	Sandy clay
	Gravelly clay
	Shaly clay
	Silt
	Clayey silt
	Sandy silt
	Sand
	Clayey sand
	Silty sand
	Gravel
	Sandy gravel
	Cobbles, boulders
	Talus

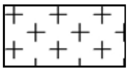
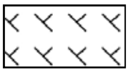
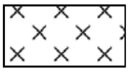
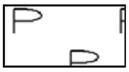
Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
■	Coal
	Limestone

Metamorphic Rocks

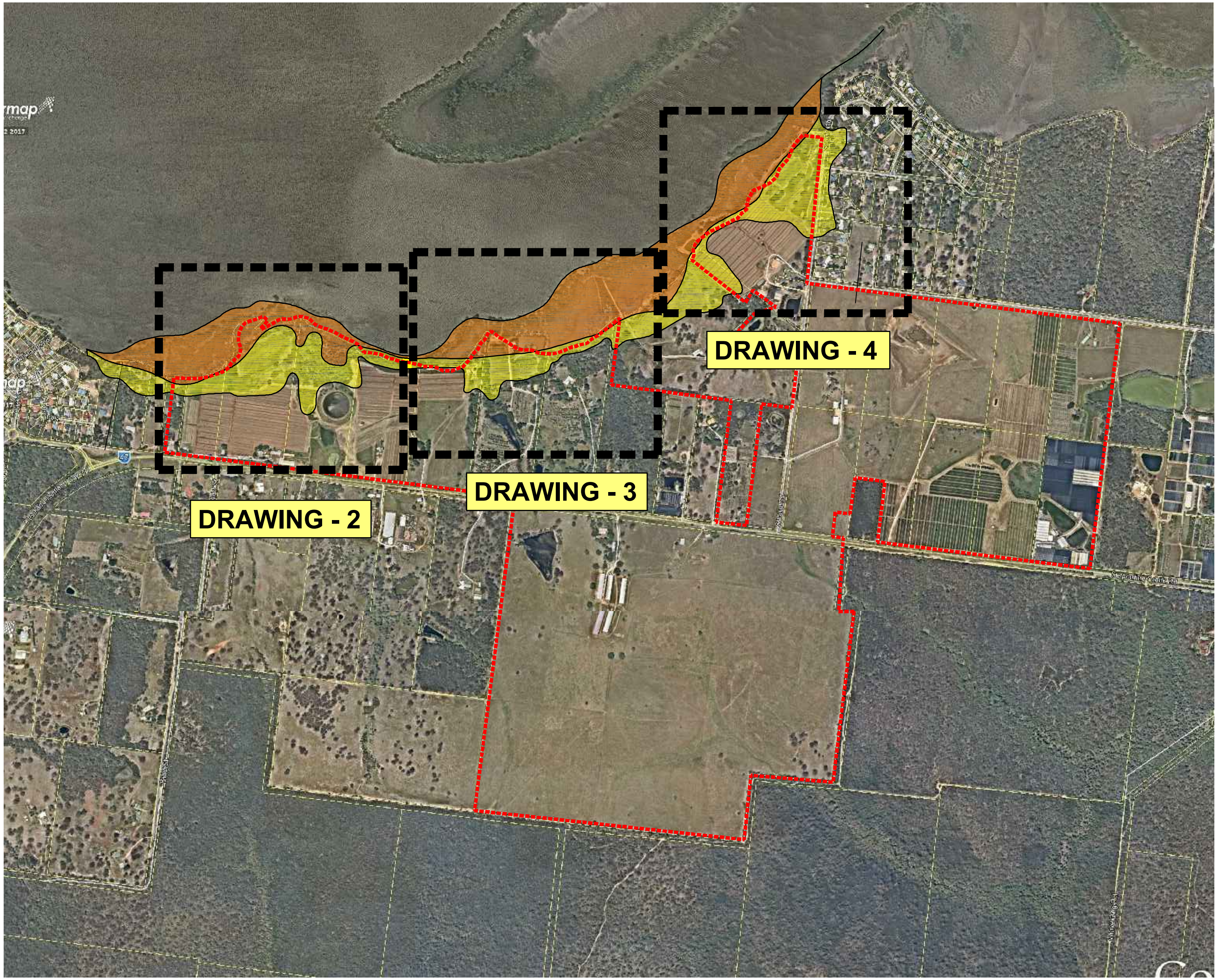
	Slate, phyllite, schist
	Gneiss
	Quartzite

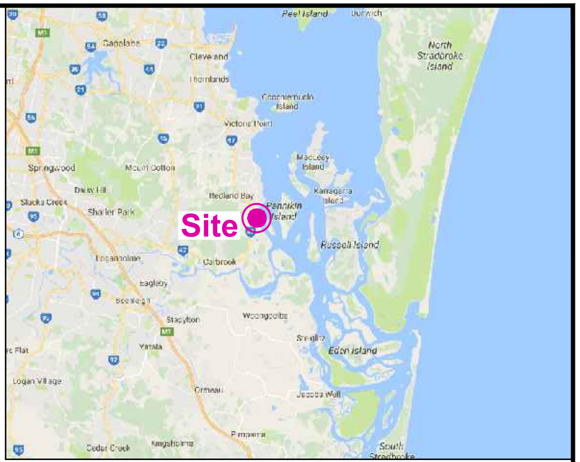
Igneous Rocks

	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

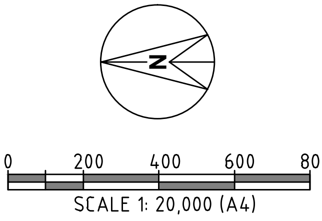
Appendix B

Drawings 1 to 4 – Test Location Plan





Location Plan



LEGEND:-

■■■■	Site Boundary
🟧	ASS Probably Occur
🟨	Low Probability of ASS Occurrence

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Image obtained from Google Earth Pro. and Near Map. Date of imagery 24-01-2017.
3. ASS Mapping obbtained from QLD SE ASS Risk Mapping.

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Shoreline Redland Bay Pty Ltd

OFFICE: Brisbane

DRAWN BY: JST

DATE: 3 April 2017

SCALE: As shown

Site Location Plan

Proposed Subdivision Development

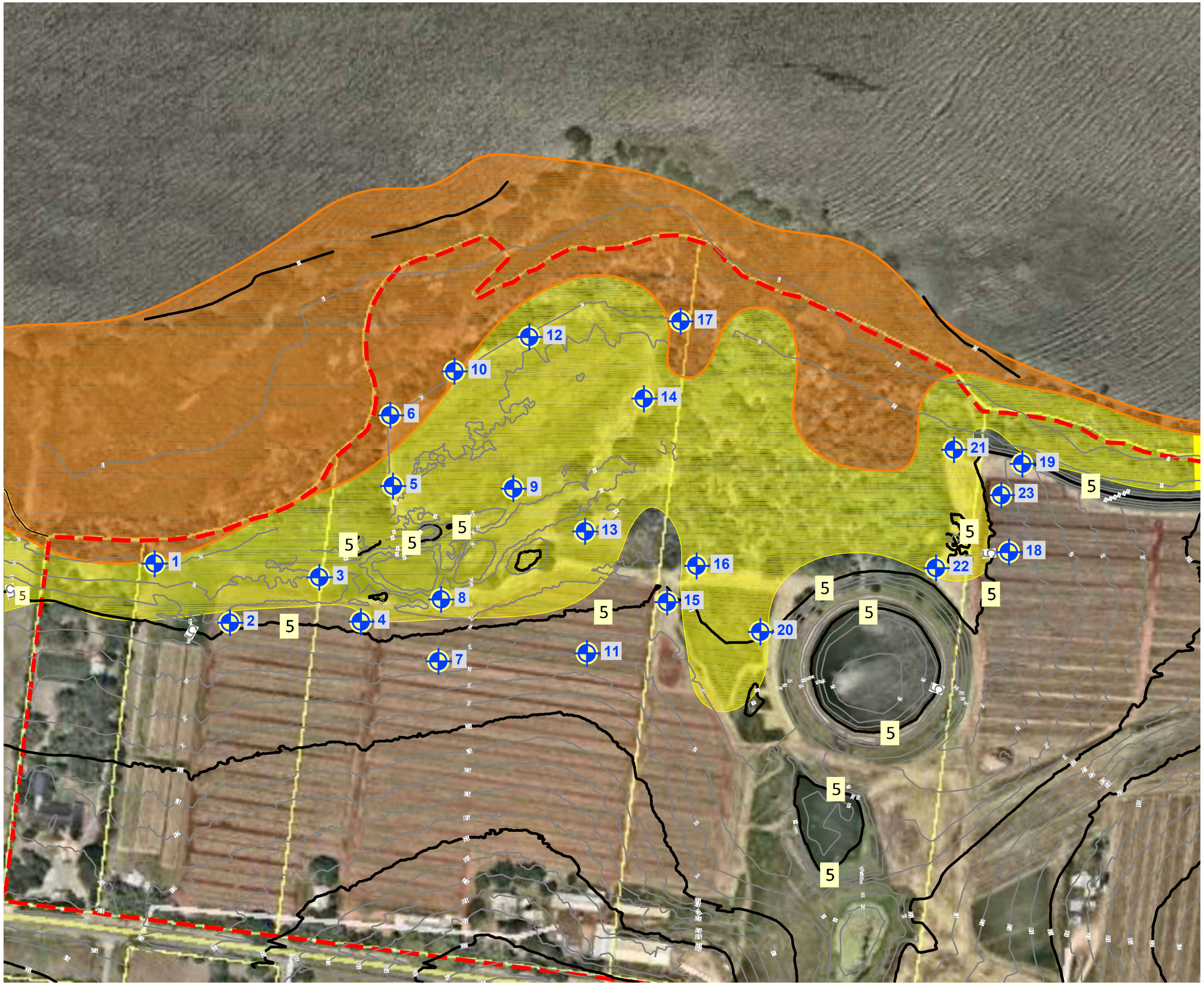
218 Serpentine Creek Road, Redland Bay

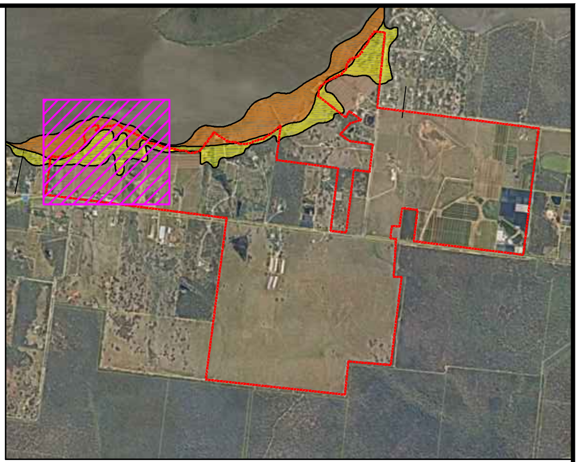
PROJECT No: 92838.00

DRAWING No: 1

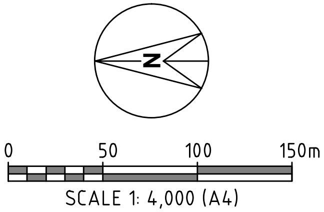
REVISION: 0

P:\92838.00 - REDLAND BAY - Proposed Subdivision Devel\7.0 Drawings\7.2 Out\92838.00.D.001.Rev0.dwg





Location Plan



SCALE 1: 4,000 (A4)

LEGEND:-

⊕	Test Bore Location and Number
▬ ▬	Site Boundary
🟧	ASS Probably Occur
🟨	Low Probability of ASS Occurrence

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Image obtained from Google Earth Pro. and Near Map. Date of imagery 24-01-2017.
3. ASS Mapping obbtained from QLD SE ASS Risk Mapping.

Douglas Partners
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CLIENT: Shoreline Redland Bay Pty Ltd

OFFICE: Brisbane

DRAWN BY: JST

DATE: 3 April 2017

SCALE: As shown

Test Location Plan
Proposed Subdivision Development
218 Serpentine Creek Road, Redland Bay

PROJECT No: 92838.00

DRAWING No: 2

REVISION: 0

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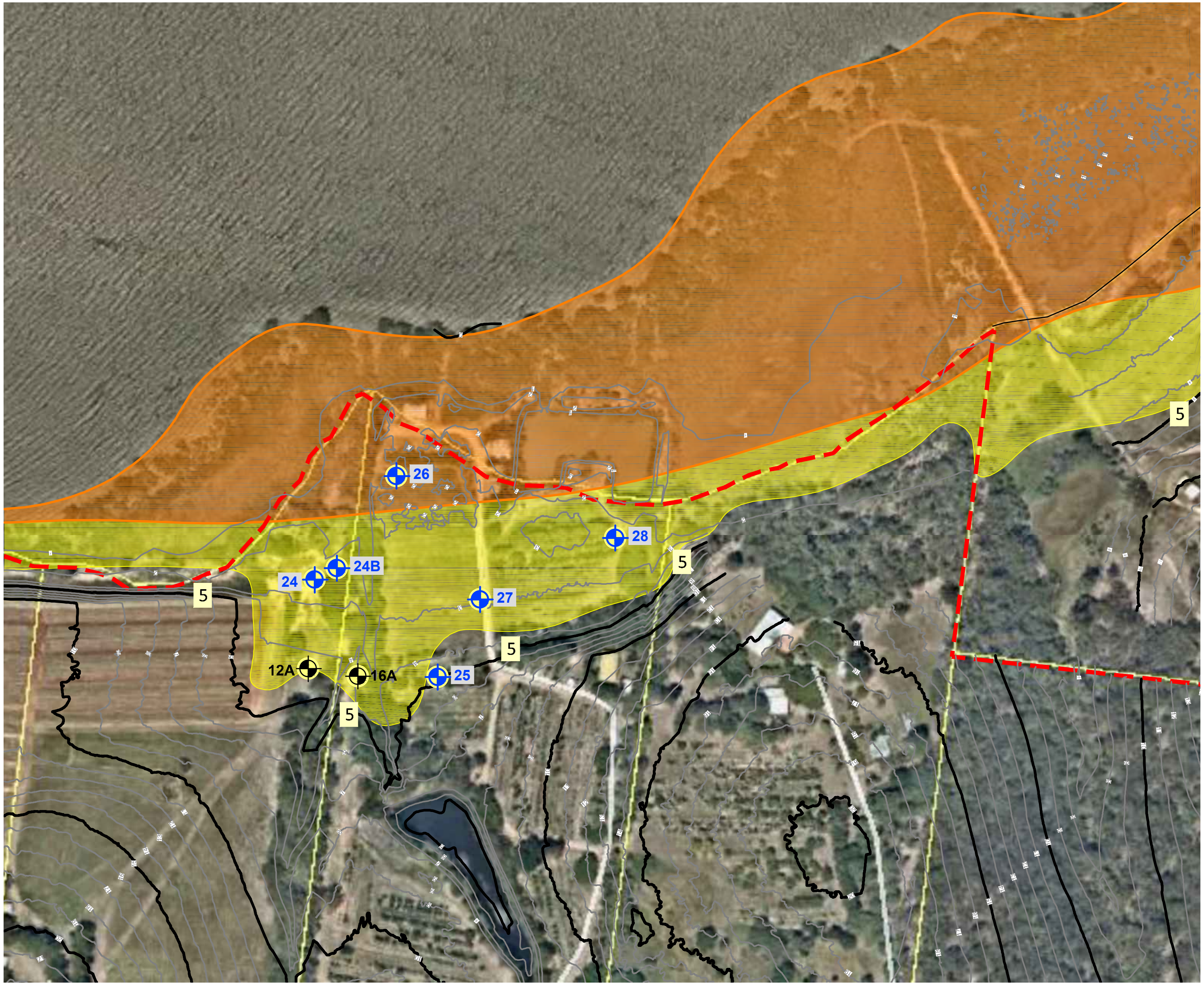
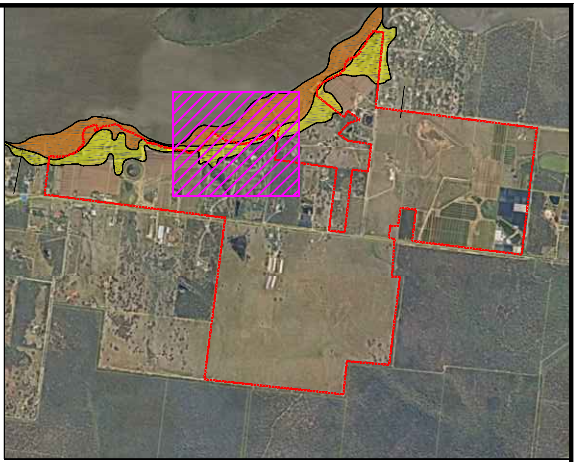
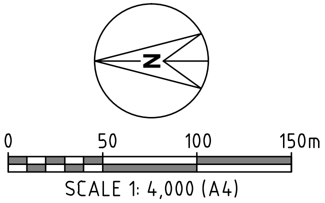




Location Plan



SCALE 1: 4,000 (A4)

LEGEND:-

⊕	Test Bore Location and Number
⊕	Previous Bore Location and Number
▪▪▪▪	Site Boundary
🟧	ASS Probably Occur
🟨	Low Probability of ASS Occurrence

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Image obtained from Google Earth Pro. and Near Map. Date of imagery 24-01-2017.
3. ASS Mapping obbtained from QLD SE ASS Risk Mapping.

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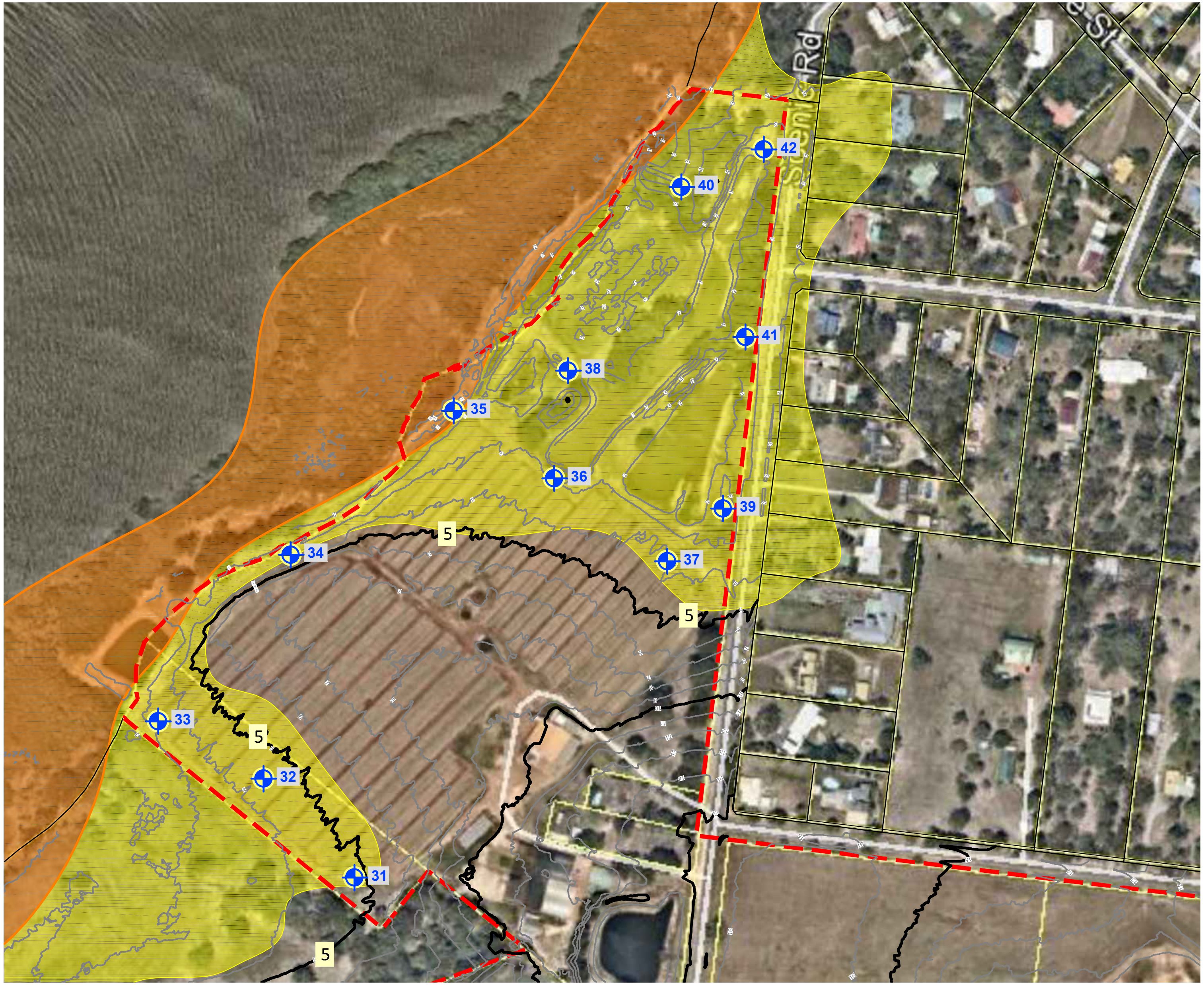
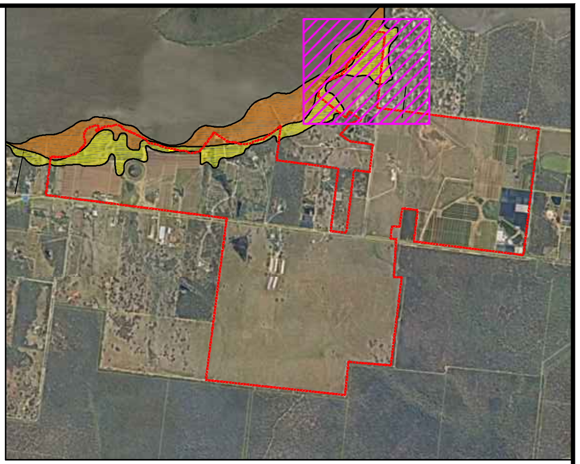
CLIENT: Shoreline Redland Bay Pty Ltd	
OFFICE: Brisbane	DRAWN BY: JST
DATE: 3 April 2017	SCALE: As shown

Test Location Plan
Proposed Subdivision Development
218 Serpentine Creek Road, Redland Bay

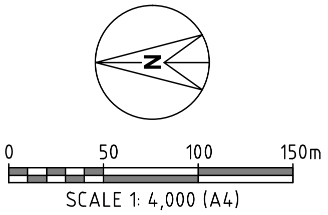
PROJECT No:	92838.00
DRAWING No:	3
REVISION:	0

P:\92838.00 - REDLAND BAY - Proposed Subdivision Devel\7.0 Drawings\7.2 Out\92838.00.D.001.Rev0.dwg





Location Plan



LEGEND:-

⊕	Test Bore Location and Number
▪▪▪▪	Site Boundary
🟧	ASS Probably Occur
▨	Low Probability of ASS Occurrence

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Image obtained from Google Earth Pro. and Near Map. Date of imagery 24-01-2017.
3. ASS Mapping obbtained from QLD SE ASS Risk Mapping.

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CLIENT: Shoreline Redland Bay Pty Ltd		**Test Location Plan**	PROJECT No:	92838.00
OFFICE: Brisbane	DRAWN BY: JST	**Proposed Subdivision Development**	DRAWING No:	4
DATE: 3 April 2017	SCALE: As shown	**218 Serpentine Creek Road, Redland Bay**	REVISION:	0

P:\92838.00 - REDLAND BAY - Proposed Subdivision Devel\7.0 Drawings\7.2 Out\92838.00.D.001.Rev0.dwg

Appendix C

Borehole Logs

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2 AHD
EASTING: 530348
NORTHING: 6941574
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm)
				Type	Depth	Sample	Results & Comments		5 10 15 20
2		SILTY SAND (SM) - brown, silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.3	SILTY CAY (CI-CH) - light grey-orange, silty clay with a trace of medium sand, moist - grey red and orange							
1	1								1
0	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
-1	3								3
-2	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 4.5 AHD
EASTING: 530306
NORTHING: 6941526
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm)
				Type	Depth	Sample	Results & Comments		5 10 15 20
		SANDY CLAY (CI) - brown-grey and red, sandy clay with some fine gravel, moist		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
4	0.4	SILTY CLAY (CH) - dark grey, silty clay with some fine gravel, moist - grey and red							
	1								1
3	1.4	SILTY CLAY (CI-CH) - grey red and orange, silty clay with some sand and fine gravel, moist							
	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
2									
	3								3
1									
	4								4
0									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3 AHD
EASTING: 530333
NORTHING: 6941465
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
3		FILLING (CI) - red-brown, sandy clay filling, fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.3	SILTY SAND (SM) - dark grey, silty fine sand, dry - grey (lighter with depth) - light brown-grey, fine to coarse sand							
2	1								
	1.2	SANDY CLAY (CI-CH) - light grey mottled orange and red, slightly silty sandy clay, fine to coarse sand, moist							
	1.6	SILTY CLAY (CH) - grey mottled red and orange, silty clay with some sand, moist							
1	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							
0	3								
-1	4								

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 4.5 AHD
EASTING: 530302
NORTHING: 6941439
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
		SILTY SAND (SM) - red, silty fine sand, dry							
	0.2	SANDY CLAY (CI) - red-brown, slightly silty sandy clay, moist; (possible fill)		D	0.2		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
4	0.6	SILTY CLAY (CI) - dark brown, slightly sandy silty clay, very moist							
	1.1	SANDY CLAY (CI) - grey, slightly silty sandy clay, very moist - light grey							
3	1.6	SILTY CLAY (CH) - light grey mottled orange, silty clay with a trace of sand, moist to very moist; (possible jarosite)							
	2.0	Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2.5 AHD
EASTING: 530391
NORTHING: 6941413
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
	SILTY SAND (SM) - brown, silty fine sand, dry	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
0.6	SAND (SP) - light grey, medium sand, dry						
1.1	SILTY CLAY (CI) - grey orange and red, silty clay with some fine sand, moist						
1.4	SILTY CLAY (CI-CH) - grey orange, silty clay with some fine sand, moist						
2.0	Bore discontinued at 2.0m depth - Limit of investigation						

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2 AHD
EASTING: 530438
NORTHING: 6941412
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm)
				Type	Depth	Sample	Results & Comments		5 10 15 20
2		SILTY SAND (SM) - brown, silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.3	CLAYEY SAND (SC) - dark brown, low plasticity clayey medium sand, moist - grey with red and orange							
1	1								1
	1.3	SILTY CLAY (CI) - grey, silty clay with fine sand, moist							
0	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
-1	3								3
-2	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 6.5 AHD
EASTING: 530273
NORTHING: 6941389
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
	0.1	SILTY SAND (SM) - brown, silty fine sand, dry							
	2.0	SILTY CLAY (CI) - red, silty clay with occasional fine round gravel, moist - red-brown with occasional round gravel		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
		Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3.5 AHD
EASTING: 530314
NORTHING: 6941385
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
		FILLING (CI) - brown mottled light grey, sandy clay, fine to coarse sand, moist; some sandy layers	▩	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	1.1	SILTY CLAY (CH) - light grey mottled orange, silty clay, moist; (possible jarosite)	▧						
	2.0	Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3.25 AHD
EASTING: 530385
NORTHING: 6941333
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
3		SILTY SAND (SM) - brown, silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.6	SANDY CLAY (CL) - brown-grey and red, sandy clay, medium sand, moist							
2	1								1
		- grey and red, medium plasticity							
		- grey							
1	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
0	3								3
-1	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2 AHD
EASTING: 530465
NORTHING: 6941368
DIP/AZIMUTH: 90°/--

BORE No: 10
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
2		SILTY SAND (SM) - dark grey, silty fine sand with a trace of gravel and rootlets							
	0.2	SILTY SAND (SM) - orange, slightly gravelly silty fine to coarse sand, fine to coarse gravel - light grey		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.5	SANDY CLAY (CI) - light grey mottled red and orange, sandy clay with some fine to medium gravel, fine to coarse sand, moist							
	0.7	SILTY CLAY (CH) - light grey mottled orange and red, slightly sandy silty clay, moist to very moist							
1	1								1
	1.5	SANDY CLAY (CI) - light grey, sandy clay with some organic material, fine to coarse sand, very moist							
0	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
-1	3								3
-2	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 7 AHD
EASTING: 530273
NORTHING: 6941290
DIP/AZIMUTH: 90°/--

BORE No: 11
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
7		SILTY SAND (SM) - brown, silty fine sand, dry							
	0.2	SILTY CLAY (CI) - red, silty clay, moist		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
		- red-brown with round gravel							
5	2.0	Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2 AHD
EASTING: 530485
NORTHING: 6941317
DIP/AZIMUTH: 90°/--

BORE No: 12
PROJECT No: 92838.00
DATE: 8/3/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
2		SILTY SAND (SM) - dark grey, silty fine sand with a trace of gravel and rootlets - slightly gravelly - brown - light brown		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.7	SANDY CLAY (CI) - light brown-orange mottled grey and red, slightly gravelly sandy clay, fine gravel, fine to coarse sand, moist							
1	1 1.0	SANDY CLAY (CH) - light grey, sandy clay with some organic material, fine to coarse sand, very moist - light grey mottled orange							1
	1.7	SILTY CLAY (CH) - light grey mottled orange and red, slightly sandy silty clay, moist to very moist							
0	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
-1	3								3
-2	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 4 AHD
EASTING: 530354
NORTHING: 6941287
DIP/AZIMUTH: 90°/--

BORE No: 13
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
4		SILTY SAND (SM) - dark brown, silty fine sand with rootlets, dry							
	0.2	SILTY SAND (SM) - brown, silty fine to coarse sand with a trace of clay, moist		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.4	CLAYEY SAND (SC) - clayey fine to coarse sand with a trace of fine gravel, moist							
	0.6	SANDY CLAY (CI) - brown, sandy clay with a trace of fine gravel, fine to coarse sand, moist - light grey mottled orange							
3	1								1
2	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
1	3								3
0	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3 AHD
EASTING: 530440
NORTHING: 6941243
DIP/AZIMUTH: 90°/--

BORE No: 14
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
	0.2	SILTY SAND (SM) - brown, silty fine sand with rootlets, dry							
	0.4	CLAYEY SAND (SC) - red-brown, clayey fine to medium sand, moist		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	2.0	SANDY CLAY (CI) - brown mottled red, sandy clay with a trace of fine gravel, fine to coarse sand, moist							
		Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 5.25 AHD
EASTING: 530304
NORTHING: 6941235
DIP/AZIMUTH: 90°/--

BORE No: 15
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
5		SILTY SAND (SM) - brown, silty fine sand, dry - red-brown		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
4	1.0	SILTY CLAY (CI) - light grey and orange, silty clay, moist - light grey and red							
3	2.0	Bore discontinued at 2.0m depth - Limit of investigation							
2	3								
1	4								

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 4.75 AHD
EASTING: 530327
NORTHING: 6941214
DIP/AZIMUTH: 90°/--

BORE No: 16
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
		SILTY SAND (SM) - brown, silty fine sand, dry - grey	⁝	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.8	SILTY CLAY (CL) - light grey and orange, silty clay, dry - light grey and red, medium plasticity, moist	▨						
	2.0	Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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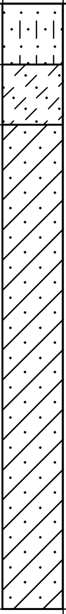
BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2 AHD
EASTING: 530490
NORTHING: 6941216
DIP/AZIMUTH: 90°/--

BORE No: 17
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
2		SILTY SAND (SM) - dark brown, silty fine sand with rootlets, dry						
	0.2	CLAYEY SAND (SC) - brown, clayey fine to coarse sand, moist	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.4	SANDY CLAY (CI-CH) - light grey mottled orange and red, slightly silty sandy clay, fine to coarse sand, moist						
1	1							1
0	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation						2
-1	3							3
-2	4							4



RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 5.5 AHD
EASTING: 530325
NORTHING: 6941006
DIP/AZIMUTH: 90°/--

BORE No: 18
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm)
				Type	Depth	Sample	Results & Comments		5 10 15 20
		SILTY CLAY (CL) - red, silty clay, dry							
	0.2	SILTY CLAY (CL-CI) - red, silty clay, moist		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	2.0	Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 6 AHD
EASTING: 530383
NORTHING: 6940994
DIP/AZIMUTH: 90°/--

BORE No: 19
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
6		SILTY CLAY (CL) - red, silty clay, dry - moist - low to medium plasticity		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
5	1								1
4	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
3	3								3
2	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 5 AHD
EASTING: 530281
NORTHING: 6941174
DIP/AZIMUTH: 90°/--

BORE No: 20
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
5		SILTY SAND (SM) - dark brown, silty fine sand with rootlets, dry							
	0.2	SILTY SAND (SM) - grey, slightly clayey silty fine sand, moist		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.7	SANDY CLAY (CI-CL) - light grey mottled orange, slightly silty sandy clay, moist							
4	1								1
		- light grey mottled red, medium plasticity							
3	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
2	3								3
1	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 4 AHD
EASTING: 530395
NORTHING: 6941039
DIP/AZIMUTH: 90°/--

BORE No: 21
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Sampling & In Situ Testing Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
4		SILTY SAND (SM) - red, silty fine sand, dry							
	0.2	SANDY CLAY (CI) - red, slightly silty sandy clay, moist							
3	1	- with a trace of fine gravel							1
2	2	- red mottled light brown-grey							2
1	3								3
	3.2	SILTY CLAY (CH) - light grey mottled red, silty clay, moist							
0	4 4.0	Bore discontinued at 4.0m depth - Limit of investigation							4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

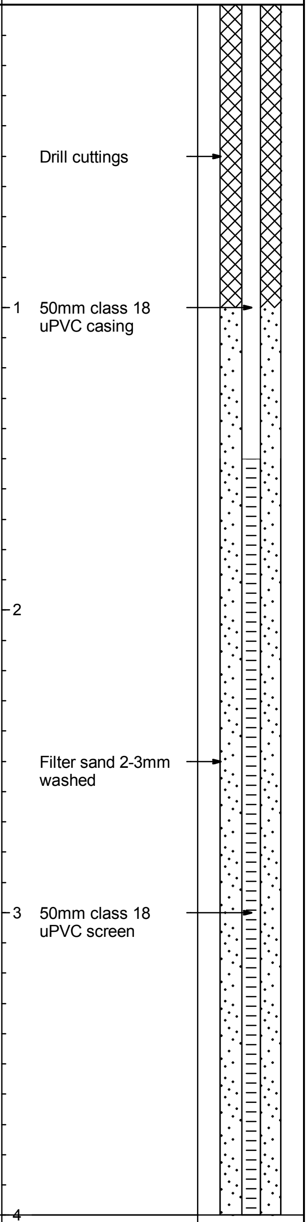
CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 5 AHD
EASTING: 530317
NORTHING: 6941055
DIP/AZIMUTH: 90°/--

BORE No: 22
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
5		SILTY SAND (SM) - dark brown, silty fine sand with rootlets, dry						
	0.2	SILTY SAND (SM) - light grey, slightly clayey silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 4.0m for ASS sampling	
	0.7	SANDY CLAY (CI-CL) - light grey mottled orange, slightly silty sandy clay, moist						
4	1	- light grey mottled red, medium plasticity						
3	2							
	2.1	SANDY CLAY (CI-CL) - light grey mottled red, slightly silty sandy clay, moist						
	2.8	SILTY CLAY (CI-CH) - light grey mottled red, slightly sandy silty clay, moist						
2	3							
1	4 / 4.0	Bore discontinued at 4.0m depth - Limit of investigation						

Well Construction Details



RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 5.5 AHD
EASTING: 530363
NORTHING: 6941009
DIP/AZIMUTH: 90°/--

BORE No: 23
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm)
				Type	Depth	Sample	Results & Comments		5 10 15 20
		SILTY CLAY (CL) - red, silty clay, dry - moist - low to medium plasticity	▨	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	2.0	Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2.5 AHD
EASTING: 530363
NORTHING: 6941009
DIP/AZIMUTH: 90°/--

BORE No: 24
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - light brown mottled grey and oragne, silty clay filling with sime fine sand and gravel, moist	▨						
2			▨						
	1		▨						1
1		- very moist	▨						
	1.7	Bore discontinued at 1.7mdepth - Limit of investigation							
	2								2
0									
	3								3
-1									
	4								4
-2									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

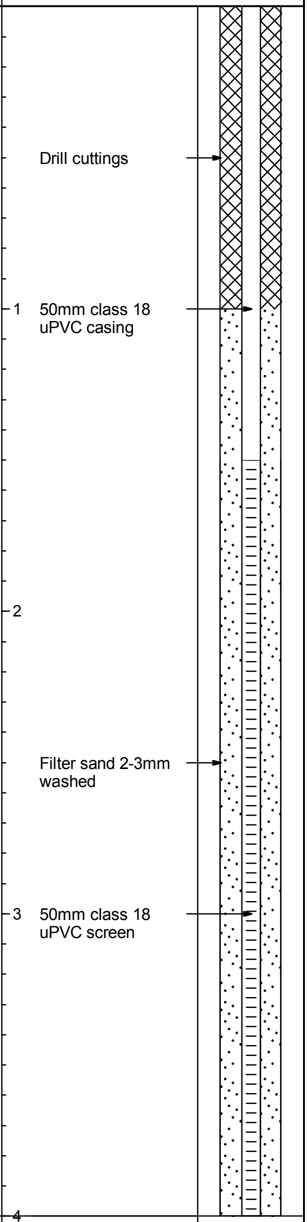
CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2.5 AHD
EASTING: 530351
NORTHING: 6940626
DIP/AZIMUTH: 90°/--

BORE No: 24 B
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SILTY SAND - dark grey, silty fine sand, moist						
		- slightly clayey						
	1.1	SILTY SAND - light grey, fine to coarse silty sand, moist						
	1.3	SILTY CLAY - light grey mottled orange, slightly sandy silty clay, moist						
		- light grey mottled red-orange						
		- very moist						▼
	4.0	Bore discontinued at 4.0mdepth - Limit of investigation						

Well Construction Details



RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater observed at 3.2 m depth
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 5 AHD
EASTING: 530275
NORTHING: 6940563
DIP/AZIMUTH: 90°/--

BORE No: 25
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
5		SILTY SAND (SM) - grey, silty fine sand with occasional gravel, dry - no gravel - grey-brown		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
4	0.9	SILTY CLAY (CL-CI) - light grey-brown, silty clay with some fine sand, moist - grey-brown mottled red, medium plasticity							
3	2.0	Bore discontinued at 2.0m depth - Limit of investigation							

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2 AHD
EASTING: 530410
NORTHING: 6940583
DIP/AZIMUTH: 90°/--

BORE No: 26
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
2		FILLING (CI) - red mottled grey and orange, silty clay with some sand and gravel, dry; (plastic in fill)		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.6	SILTY SAND (SM) - orange, slightly gravelly silty fine to coarse sand, fine to coarse gravel							
1	0.9 1	SILTY CLAY (CH) - light grey mottled orange and red, silty clay with a trace of sand, moist - slightly sandy, very moist							1
0	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
-1	3								3
-2	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3 AHD
EASTING: 530325
NORTHING: 6940532
DIP/AZIMUTH: 90°/--

BORE No: 27
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
3		FILLING (SM) - light grey-brown, silty fine sand filling with angular gravel, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.3	SILTY SAND (SM) - brown, silty medium sand, dry							
2	0.9 1	CLAYEY SAND (SC) - light grey-brown, clayey course sand, moist							1
	1.3	SILTY CLAY (CI) - grey, silty clay with some fine sand, moist - grey mottled orange							
1	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
0	3								3
-1	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2.5 AHD
EASTING: 530361
NORTHING: 6940440
DIP/AZIMUTH: 90°/--

BORE No: 28
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
		SILTY SAND (SM) - brown, silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 4.0m for ASS sampling		
	0.3	CLAYEY SAND (SC) - dark brown, low plasticity clayey medium sand, moist							
2									
	0.7	SILTY CLAY (CI-CH) - light grey mottled red and orange, silty clay, moist							
	1								1
		- grey mottled red							
1									
	2								2
0									
	3								3
-1									
	4 4.0	Bore discontinued at 4.0m depth - Limit of investigation							4
-2									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 5 AHD
EASTING: 530552
NORTHING: 6939781
DIP/AZIMUTH: 90°/--

BORE No: 31
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
5		SILTY SAND (SM) - brown, silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.6	SILTY CLAY (CI) - brown mottled orange and red, silty fine sand							
4	1								1
3	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
2	3								3
1	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 4.5 AHD
EASTING: 530621
NORTHING: 6939838
DIP/AZIMUTH: 90°/--

BORE No: 32
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Sampling & In Situ Testing Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
		SILTY SAND (SM) - brown, silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
4	0.3	SILTY CLAY (CI) - brown mottled orange and red, silty fine sand							
	1								1
3		- red mottled grey							
	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
2									
	3								3
1									
	4								4
0									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3.25 AHD
EASTING: 530663
NORTHING: 6939906
DIP/AZIMUTH: 90°/--

BORE No: 33
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
		SILTY SAND (SM) - brown, silty fine sand, dry							
3	0.3	SILTY CLAY (CI) - red-brown, silty fine sand		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	1								1
2		- brown mottled red, medium to high plasticity							
	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
1									
	3								3
0									
	4								4
-1									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3.5 AHD
EASTING: 530781
NORTHING: 6939818
DIP/AZIMUTH: 90°/--

BORE No: 34
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
	0.2	CLAYEY SAND (SC) - dark brown, clayey fine sand with rootlets, dry							
3		SILTY CLAY (CH) - dark grey, silty clay with some organic material, dry - light grey mottled red and orange - moist							
	1								1
2									
	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
1									
	3								3
0									
	4								4
-1									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2.5 AHD
EASTING: 530839
NORTHING: 6939731
DIP/AZIMUTH: 90°/--

BORE No: 35
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
		FILLING (CH) - brown, silty clay filling, highly organic, very moist		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.3	FILLING (CI) - light grey, sandy clay filling with a trace of gravel, very moist							
2									
	0.8	SILTY CLAY (CH) - light grey mottled red and orange, silty clay, very moist							
	1								1
		- moist to very moist							
1									
	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
0									
	3								3
-1									
	4								4
-2									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2.5 AHD
EASTING: 530810
NORTHING: 6939634
DIP/AZIMUTH: 90°/--

BORE No: 36
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING (CI) - dark brown, silty clay filling with rootlets, moist					
	0.2	FILLING (SM) - grey, silty fine sand, dry	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling	
2		- grey-brown, fine to coarse sand, moist					
	1 1.0	SILTY SAND (SM) - grey, silty fine sand, moist					
	1.2	SANDY CLAY (CI) - grey, sandy clay with some organic material, fine to coarse sand, moist					
1	1.5	SILTY CLAY (CH) - grey mottled orange, silty clay, moist					
		- light brown mottled orange					
	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation					
0							
	3						
-1							
	4						
-2							

Dynamic Penetrometer Test (blows per 0mm)
5 10 15 20

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 4 AHD
EASTING: 30744
NORTHING: 6939582
DIP/AZIMUTH: 90°/--

BORE No: 37
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
4		SILTY SAND (SM) - brown, silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
	0.3	SILTY CLAY (CI) - red mottled brown, silty fine sand							
3	1								1
		- light grey mottled red							
2	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
1	3								3
0	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2 AHD
EASTING: 530881
NORTHING: 6939621
DIP/AZIMUTH: 90°/--

BORE No: 38
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
2		SILTY SAND (SM) - grey, silty fine sand, dry	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
		- light grey with some gravel						
1	1							1
		- light grey mottled orange						
	1.6	SAND (SP) - light grey mottled orange, coarse sand with subangular gravel, moist						
	1.9	SANDY CLAY (CL) - grey, sandy clay, medium sand, moist						
0	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation						2
-1	3							3
-2	4							4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3 AHD
EASTING: 530784
NORTHING: 6939523
DIP/AZIMUTH: 90°/--

BORE No: 39
PROJECT No: 92838.00
DATE: 8/3/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
3		SILTY CLAY (CH) - light grey mottled red and orange, silty clay with a trace of sand and some rootlets, dry	▨	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
		- moist	▨						
2	1		▨						1
		- very moist	▨						
1	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
0	3								3
-1	4								4

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 3.5 AHD
EASTING: 530999
NORTHING: 6939539
DIP/AZIMUTH: 90°/--

BORE No: 40
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm)
				Type	Depth	Sample	Results & Comments		5 10 15 20
		SILTY SAND (SM) - dark grey, silty fine sand, dry		D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
3		- light grey with occasional gravel							
	1.4	SILTY CLAY (CI) - grey, silty clay with some fine sand, moist							
2	1.7	CLAYEY SAND (SC) - grey, low plasticity clayey sand, moist							
	2.0	Bore discontinued at 2.0m depth - Limit of investigation							
1	3								
0	4								
-1									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2.5 AHD
EASTING: 530897
NORTHING: 6939502
DIP/AZIMUTH: 90°/--

BORE No: 41
PROJECT No: 92838.00
DATE: 8/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
		SANDY CLAY (CI) - dark brown mottled orange, sandy clay with a trace of fine gravel and root zone, fine sand, dry - dark grey mottled orange, slightly silty	▨	D	0.25		Samples taken at 0.25m intervals down to 2.0m for ASS sampling		
2		- light grey mottled orange	▨						
	1 1.0	SILTY CLAY (CH) - light grey mottled red and orange, silty clay with some fine to coarse sand and fine gravel, moist	▨						1
1									
	2 2.0	Bore discontinued at 2.0m depth - Limit of investigation							2
0									
	3								3
-1									
	4								4
-2									

RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

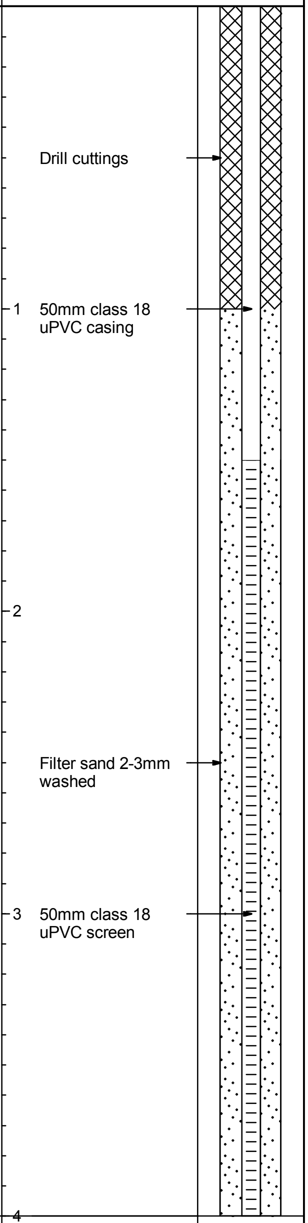
CLIENT: Shoreline Redland
PROJECT: Proposed Residential Subdivision
LOCATION: Serpentine Creek Road, Redland Bay

SURFACE LEVEL: 2.25 AHD
EASTING: 531021
NORTHING: 6939484
DIP/AZIMUTH: 90°/--

BORE No: 42
PROJECT No: 92838.00
DATE: 6/3/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Sampling & In Situ Testing Results & Comments	Water
		SILTY SAND (SM) - grey, silty fine sand with rootlets, dry						
				D	0.25		Samples taken at 0.25m intervals down to 4.0m for ASS sampling	
		- light brown						
	0.7	SANDY CLAY (CI) - light brown mottled red, sandy clay, fine to coarse sand, moist						
		- red						
		- red mottled light grey and orange						
		- grey mottled orange and red, with some fine quartz gravel						
		- interbedded extremely weathered sandstone/cemented sand						
		- moist to very moist						
	4.0	Bore discontinued at 4.0m depth - Limit of investigation						

Well Construction Details



RIG: Christie Soil Rig **DRILLER:** Geo-Serve **LOGGED:** JS **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix D

Table D1
Results of Laboratory Testing

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H^+/t	%S							
Bore 1	0.25	Silty sand	6.1	2.2	3.9	3	5	40	0.06	0.01	-	-	-	0.07	0.07	3
	0.50	Silty clay	5	3.4	1.6	3										
	0.75	Silty clay	5.2	3.1	2.1	3										
	1.00	Silty clay	5.3	3.6	1.7	3										
	1.25	Silty clay	5.2	3.6	1.6	3										
	1.50	Silty clay	5.4	3.8	1.6	3										
	1.75	Silty clay	5.60	4.1	1.5	3										
	2.00	Silty clay	5.3	4	1.3	3										
Bore 2	0.25	Sandy clay	6.4	3.2	3.2	3										
	0.50	Silty clay	6.5	3.5	3.0	3										
	0.75	Silty clay	5.1	3.4	1.7	3	4.2	70	0.11	0.01	-	<0.02	-	0.13	0.13	6
	1.00	Silty clay	4.8	3.9	0.9	4										
	1.25	Silty clay	4.9	3.8	1.1	4										
	1.50	Silty clay	5	3.2	1.8	2										
	1.75	Silty clay	5.6	3.4	2.2	2										
	2.00	Silty clay	5.1	3.7	1.4	2										
Bore 3	0.25	Filling	6.3	2.9	3.4	3										
	0.50	Silty sand	6.5	2.9	3.6	3	5.4	10	<0.02	0.01	-	-	-	0.03	0.03	1
	0.75	Silty sand	6.4	3.2	3.2	3										
	1.00	Silty sand	6.6	3.7	2.9	3										
	1.25	Sandy clay	5.7	3.4	2.3	2										
	1.50	Sandy clay	5.6	3.4	2.2	2										
	1.75	Silty clay	5.3	3.3	2.0	2	4.4	36	0.06	<0.005	<0.02	<0.02	-	0.06	0.06	3
	2.00	Silty clay	5	3.3	1.7	2										
Bore 4	0.25	Sandy clay	6.2	3.6	2.6	3										
	0.50	Sandy clay	5.8	3.8	2.0	4										
	0.75	Silty clay	5.3	3.5	1.8	4										
	1.00	Silty clay	5.3	5.6	0.3	4										
	1.25	Sandy clay	5.4	2.5	2.9	3	5.2	10	<0.02	0.01	-	-	-	0.02	0.02	1

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity		Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)			
								mole H^+/t	%S							
Bore4	1.50	Sandy clay	6	3.8	2.2	2										
	1.75	Silty clay	5.6	3.4	2.2	2										
	2.00	Silty clay	5.7	3.5	2.2	2										
Bore 5	0.25	Silty sand	5.4	2.1	3.3	3	4.6	32	0.05	0.007	-	-	-	0.06	0.06	3
	0.50	Silty sand	5.7	2.9	2.8	2										
	0.75	Sand	6.1	4.1	2.0	2										
	1.00	Sand	6.5	4.7	1.8	2										
	1.25	Silty clay	5.5	3.8	1.7	2										
	1.50	Silty clay	5.8	3.9	1.9	2										
	1.75	Silty clay	5.5	3.8	1.7	2										
	2.00	Silty clay	5.5	3.4	2.1	2										
Bore 6	0.25	Silty sand	5.6	2.5	3.1	3										
	0.50	Clayey sand	5.2	2.3	2.9	3	5	32	0.05	0.009	-	-	-	0.06	0.06	3
	0.75	Clayey sand	5.2	2.5	2.7	3										
	1.00	Clayey sand	5.1	2.7	2.4	2										
	1.25	Clayey sand	5.4	2.9	2.5	2										
	1.50	Silty clay	5.8	3.4	2.4	2										
	1.75	Silty clay	4.7	2.9	1.8	2										
	2.00	Silty clay	4.7	2.8	1.9	2	4.5	21	0.03	<0.005	-	-	-	0.03	0.03	2
Bore 7	0.25	Silty clay	6.2	3.9	2.3	3										
	0.50	Silty clay	6.5	4.5	2.0	3										
	0.75	Silty clay	6.4	4.5	1.9	2	5.8	11	<0.02	<0.005	-	-	-	<0.02	<0.02	<1
	1.00	Silty clay	6.2	4.4	1.8	2										
	1.25	Silty clay	6.3	4.4	1.9	2										
	1.50	Silty clay	6.3	4.5	1.8	2										
	1.75	Silty clay	6.2	4.3	1.9	2										
	2.00	Silty clay	6.3	4.4	1.9	2										
Bore 8	0.25	Filling	6.2	3.2	3.0	2										
	0.50	Filling	6.6	3.0	3.6	2										
	0.75	Filling	6.4	3.1	3.3	2										
	1.00	Filling	6.6	3.0	3.6	3										

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH$_F$	pH$_{FOX}$	ΔpH	Reaction Intensity (1,2,3,4)*	pH$_{KCl}$	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S$_{Cr}$, %S)	Sulfur in KCl extract (S$_{KCl}$, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H$^+$/t	%S							
Bore 8	1.25	Silty clay	6.2	3.6	2.6	3										
	1.50	Silty clay	5.7	3.6	2.1	2										
	1.75	Silty clay	5.3	3.1	2.2	2										
	2.00	Silty clay	4.9	3.7	1.2	2	4.4	37	0.06	<0.005	<0.02	<0.02	-	0.07	0.07	3
Bore 9	0.25	Silty sand	6.5	3.5	3.0	3										
	0.50	Silty sand	6.8	3.5	3.3	3										
	0.75	Sandy clay	6.6	4.2	2.4	2										
	1.00	Sandy clay	5.9	4.2	1.7	2	5.4	9	<0.02	0.005	-	-	-	<0.02	<0.02	<1
	1.25	Sandy clay	5.7	3.8	1.9	2										
	1.50	Sandy clay	5.8	3.7	2.1	2										
	1.75	Sandy clay	5.7	3.2	2.5	2										
	2.00	Sandy clay	5.4	3.2	2.2	2										
Bore 10	0.25	Silty sand	6.0	3.7	2.3	3										
	0.50	Sandy clay	6.0	3.5	2.5	2										
	0.75	Silty sand	6.3	4.3	2.0	2										
	1.00	Silty sand	6.1	4.6	1.5	2										
	1.25	Silty sand	6.4	4.0	2.4	2										
	1.50	Sandy clay	6.0	4.2	1.8	2										
	1.75	Sandy clay	5.1	3.1	2.0	2	5	7	<0.02	<0.005	-	-	-	<0.02	<0.02	<1
	2.00	Sandy clay	5.0	3.4	1.6	2										
Bore 11	0.25	Silty clay	6.3	4.2	2.1	3										
	0.50	Silty clay	6.6	4.6	2.0	2										
	0.75	Silty clay	6.4	4.2	2.2	3	5.6	10	<0.02	0.01	-	-	-	0.02	0.02	1
	1.00	Silty clay	5.9	4.5	1.4	2										
	1.25	Silty clay	6.1	4.5	1.6	2										
	1.50	Silty clay	6.3	4.5	1.8	1										
	1.75	Silty clay	6.4	4.5	1.9	1										
	2.00	Silty clay	6.5	4.4	2.1	1										
Bore 12	0.25	Silty sand	6.3	3.4	2.9	2										
	0.50	Silty sand	6.0	3.5	2.5	2										
	0.75	Sandy clay	6.0	3.6	2.4	2										
	1.00	Sandy clay	6.2	3.4	2.8	1										

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H^+/t	%S							
Bore 12	1.00	Sandy clay	6.2	3.4	2.8	1										
	1.25	Sandy clay	5.3	3.7	1.6	1										
	1.50	Sandy clay	4.6	2.9	1.7	1	4.9	9	<0.02	<0.005	-	-	-	<0.02	<0.02	<1
	1.75	Silty clay	4.3	3	1.3	1										
Bore 13	0.25	Silty sand	4.9	2.3	2.6	3	4.7	22	0.04	0.008	-	-	-	0.04	0.04	2
	0.50	Clayey sand	5.2	3.0	2.2	2										
	0.75	Sandy clay	4.8	2.7	2.1	2										
	1.00	Sandy clay	4.8	2.7	2.1	2	4.5	26	0.04	0.01	-	-	-	0.05	0.05	2
	1.25	Sandy clay	5.3	4.0	1.3	2										
	1.50	Sandy clay	5.0	3.5	1.5	2										
	1.75	Sandy clay	5.2	3.1	2.1	2										
	2.00	Sandy clay	5.2	3.5	1.7	2										
Bore 14	0.25	clayey sand	6.6	3.6	3.0	3										
	0.50	Sandy clay	6.7	4.5	2.2	2										
	0.75	Sandy clay	5.5	3.5	2.0	2										
	1.00	Sandy clay	5.8	3.7	2.1	2										
	1.25	Sandy clay	5.8	3.6	2.2	2										
	1.50	Sandy clay	6.3	3.4	2.9	2										
	1.75	Sandy clay	5.4	3.9	1.5	2	4.5	30	0.05	0.01	-	-	-	0.05	0.05	2
	2.00	Sandy clay	5.2	3.7	1.5	2										
Bore 15	0.25	Silty sand	6.0	2.7	3.3	3										
	0.50	Silty sand	5.9	3.9	2.0	3										
	0.75	Silty sand	6.2	3.6	2.6	3										
	1.00	Silty clay	6.1	3.3	2.8	3										
	1.25	Silty clay	5.7	3.4	2.3	2										
	1.50	Silty clay	5.6	3.6	2.0	2										
	1.75	Silty clay	6.0	3.7	2.3	3										
	2.00	Silty clay	5.8	3.7	2.1	3										
Bore 16	0.25	Silty sand	7.0	4.2	2.8	3	6.4	<2	<0.02	0.007	-	-	-	<0.02	<0.02	<1
	0.50	Silty sand	7.5	4.9	2.6	3										
	0.75	Silty sand	7.6	5.5	2.1	2										
	1.00	Silty clay	7.5	5.6	1.9	2										

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Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H^+/t	%S							
Bore 16	1.25	Silty clay	7.1	5.4	1.7	2										
	1.50	Silty clay	5.7	4.7	1.0	2										
	1.75	Silty clay	5.3	4.5	0.8	2										
	2.00	Silty clay	4.9	3.8	1.1	2										
Bore 17	0.25	clayey sand	5.4	2.7	2.7	3	4.6	33	0.05	0.01	-	-	-	0.06	0.06	3
	0.50	Sandy clay	5.0	3.8	1.2	2										
	0.75	Sandy clay	4.7	3.9	0.8	2										
	1.00	Sandy clay	5.1	4.1	1.0	2										
	1.25	Sandy clay	4.8	3.6	1.2	2	4.4	22	0.03	<0.005	<0.02	<0.02	-	0.03	0.03	2
	1.50	Sandy clay	4.8	3.9	0.9	2										
	1.75	Sandy clay	4.9	4.2	0.7	2										
	2.00	Sandy clay	4.9	4.2	0.7	2										
Bore 18	0.25	Silty clay	5.4	4.3	1.1	3	4.8	32	0.05	0.006	-	-	-	0.06	0.06	3
	0.50	Silty clay	5.6	4.8	0.8	3										
	0.75	Silty clay	6.2	4.7	1.5	2										
	1.00	Silty clay	6.1	4.8	1.3	2										
	1.25	Silty clay	6.0	4.9	1.1	2										
	1.50	Silty clay	5.9	4.7	1.2	2										
	1.75	Silty clay	5.8	4.5	1.3	2										
	2.00	Silty clay	5.9	4.5	1.4	2										
Bore 19	0.25	Silty clay	6.0	4.6	1.4	3										
	0.50	Silty clay	5.6	5.2	0.4	3										
	0.75	Silty clay	5.8	4.7	1.1	2	5.2	15	0.02	<0.005	-	-	-	0.02	0.02	1
	1.00	Silty clay	5.9	4.6	1.3	2										
	1.25	Silty clay	6.0	5.0	1.0	2										
	1.50	Silty clay	6.0	4.9	1.1	2										
	1.75	Silty clay	6.2	5.0	1.2	2										
	2.00	Silty clay	6.2	4.9	1.3	2										
Bore 20	0.25	Silty sand	5.9	2.7	3.2	3	4.6	27	0.04	0.01	-	-	-	0.05	0.05	2
	0.50	Silty sand	6.1	3.0	3.1	3										
	0.75	Sandy clay	6.4	4.5	1.9	2										
	1.00	Sandy clay	6.0	4.8	1.2	2										

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H^+/t	%S							
Bore 20	1.25	Sandy clay	6	4.8	1.2	2										
	1.50	Sandy clay	5.9	5	0.9	2										
	1.75	Sandy clay	5.7	4.8	0.9	2										
	2.00	Sandy clay	5.6	4.7	0.9	2										
Bore 21	0.25	Sandy clay	5.6	4.1	1.5	3										
	0.50	Sandy clay	5.5	4.8	0.7	3										
	0.75	Sandy clay	5.6	4.7	0.9	3										
	1.00	Sandy clay	5.6	4.6	1.0	3										
	1.25	Sandy clay	5.9	4.6	1.3	3										
	1.50	Sandy clay	6.1	4.5	1.6	3	5.2	16	0.02	<0.005	-	-	-	0.02	0.02	1
	1.75	Sandy clay	6.2	4.7	1.5	3										
	2.00	Sandy clay	6.2	4.9	1.3	3										
	2.25	Sandy clay	6.1	4.7	1.4	3										
	2.50	Sandy clay	5.6	4.7	0.9	3										
	2.75	Sandy clay	5.7	4.5	1.2	3										
	3.00	Sandy clay	5.7	4.6	1.1	3	5.2	17	0.03	<0.005	-	-	-	0.03	0.03	1
	3.25	Silty clay	5.7	4.5	1.2	3										
	3.50	Silty clay	5.7	4.6	1.1	3										
	3.75	Silty clay	5.2	4.5	0.7	3										
	4.00	Silty clay	5.7	4.8	0.9	3										
Bore 22	0.25	Silty sand	5.9	3.2	2.7	3										
	0.50	Silty sand	6.0	3.0	3.0	3	5	11	<0.02	0.005	-	-	-	0.02	0.02	1
	0.75	Sandy clay	5.9	3.5	2.4	3										
	1.00	Sandy clay	5.7	4.6	1.1	3										
	1.25	Sandy clay	5.8	4.9	0.9	3										
	1.50	Sandy clay	5.4	4.7	0.7	3	4.5	28	0.04	0.006	-	-	-	0.05	0.05	2
	1.75	Sandy clay	5.5	4.3	1.2	3										
	2.00	Sandy clay	5.8	4.7	1.1	3										
	2.25	Sandy clay	5.6	4.1	1.5	3										
	2.50	Sandy clay	5.8	4.2	1.6	3										
	2.75	Sandy clay	5.4	4.6	0.8	3										
	3.00	Silty clay	5.5	3.8	1.7	3										

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Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H^+/t	%S							
Bore 22	3.25	Silty clay	5.4	4.1	1.3	3										
	3.50	Silty clay	5.5	3.9	1.6	3										
	3.75	Silty clay	5.4	3.9	1.5	3										
	4.00	Silty clay	5.3	4.2	1.1	3										
Bore 23	0.25	Silty clay	5.7	4.5	1.2	3										
	0.50	Silty clay	6.0	4.7	1.3	2										
	0.75	Silty clay	6.1	4.9	1.2	2										
	1.00	Silty clay	6.2	4.8	1.4	2										
	1.25	Silty clay	6.2	5.0	1.2	2										
	1.50	Silty clay	6.3	4.8	1.5	2										
	1.75	Silty clay	6.2	4.7	1.5	2										
	2.00	Silty clay	6.2	4.7	1.5	2										
Bore 24B	0.25	Silty sand	4.5	2.3	2.2	2										
	0.50	Silty sand	5.0	2.6	2.4	2										
	0.75	Silty sand	4.6	2.4	2.2	2	4.4	52	0.08	0.008	<0.02	<0.02	-	0.09	0.09	4
	1.00	Silty sand	4.7	2.5	2.2	2										
	1.25	Silty sand	4.8	3.3	1.5	2										
	1.50	Silty clay	4.6	3.4	1.2	2										
	1.75	Silty clay	4.8	3.5	1.3	2										
	2.00	Silty clay	4.8	3.6	1.2	2										
	2.25	Silty clay	4.8	4.1	0.7	2										
	2.75	Silty clay	4.8	3.7	1.1	2										
	3.00	Silty clay	4.8	4.1	0.7	2										
	3.25	Silty clay	5.4	4.8	0.6	2										
	3.50	Silty clay	5.5	4.4	1.1	2										
	3.75	Silty clay	5.4	4.1	1.3	2										
	4.00	Silty clay	5.6	4.5	1.1	2										
Bore 25	0.25	Silty sand	5.6	2.2	3.4	2										
	0.50	Silty sand	6.0	2.9	3.1	2	4.8	20	0.03	0.006	-	-	-	0.04	0.04	2
	0.75	Silty sand	6.0	3.4	2.6	2										
	1.00	Silty clay	5.4	4.4	1.0	2										
	1.25	Silty clay	5.3	4.1	1.2	2										

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H^+/t	%S							
Bore 25	1.50	Silty clay	5.5	4.2	1.3	2										
	1.75	Silty clay	5.3	4.1	1.2	2										
	2.00	Silty clay	5.2	4.5	0.7	2										
Bore 26	0.25	Filling	5.7	3.5	2.2	3	5	21	0.03	0.009	-	-	-	0.04	0.04	2
	0.50	Filling	4.9	3.0	1.9	2										
	0.75	Silty sand	5.3	3.6	1.7	2										
	1.00	Silty clay	5.7	4.7	1.0	2										
	1.25	Silty clay	5.7	4.7	1.0	2										
	1.50	Silty clay	5.2	4.0	1.2	2										
	1.75	Silty clay	6.2	4.5	1.7	2										
	2.00	Silty clay	6.3	4.9	1.4	2										
Bore 27	0.25	Filling	5.6	3.9	1.7	2										
	0.50	Silty sand	6.4	3.1	3.3	2										
	0.75	Silty sand	6.2	4.3	1.9	2										
	1.00	Clayey sand	6.2	5.1	1.1	2										
	1.25	Clayey sand	5.3	4.9	0.4	2										
	1.50	Silty clay	5.0	4.3	0.7	2										
	1.75	Silty clay	5.2	4.1	1.1	2										
	2.00	Silty clay	5.0	4.1	0.9	2										
Bore 28	0.25	Silty sand	6.1	3.1	3.0	3										
	0.50	Clayey sand	5.5	2.8	2.7	3	4.3	102	0.16	0.01	<0.02	<0.02	-	0.19	0.19	9
	0.75	Silty clay	4.5	3.4	1.1	1										
	1.00	Silty clay	4.4	3.0	1.4	2										
	1.25	Silty clay	4.7	3.8	0.9	1										
	1.50	Silty clay	4.6	3.1	1.5	1	4.6	26	0.04	0.01	-	-	-	0.05	0.05	2
	1.75	Silty clay	4.5	3.4	1.1	2										
	2.00	Silty clay	4.6	3.4	1.2	1										
	2.25	Silty clay	4.5	3.3	1.2	2										
	2.50	Silty clay	4.9	3.4	1.5	2										
	2.75	Silty clay	5.5	4.1	1.4	2										
	3.00	Silty clay	5.7	4.2	1.5	2										
	3.25	Silty clay	6.1	5.8	0.3	3										

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH$_F$	pH$_{FOX}$	ΔpH	Reaction Intensity (1,2,3,4)*	pH$_{KCl}$	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S$_{Cr}$, %S)	Sulfur in KCl extract (S$_{KCl}$, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H$^+$/t	%S							
Bore 28	3.50	Silty clay	6.1	5	1.1	3										
	3.75	Silty clay	5.9	4.9	1.0	3										
	4.00	Silty clay	6	4.9	1.1	3	4.8	18	0.03	0.006	-	-	-	0.03	0.03	2
Bore 31	0.25	Silty sand	7.2	5.4	1.8	3										
	0.50	Silty sand	7.6	4.7	2.9	3	6.7	<2	<0.02	0.01	-	-	1	<0.02	<0.02	<1
	0.75	Silty clay	5.5	4.4	1.1	2										
	1.00	Silty clay	5.3	3.8	1.5	1										
	1.25	Silty clay	4.9	3.4	1.5	2										
	1.50	Silty clay	4.7	3.5	1.2	2										
	1.75	Silty clay	4.6	3.4	1.2	2	4	71	0.11	0.01	0.07	<0.02	-	0.12	0.12	6
	2.00	Silty clay	4.6	3.3	1.3	2										
Bore 32	0.25	Silty sand	7.1	5.4	1.7	3										
	0.50	Silty clay	6.8	5.3	1.5	3										
	0.75	Silty clay	6.5	4.8	1.7	2										
	1.00	Silty clay	6.6	4.8	1.8	1										
	1.25	Silty clay	6.6	4.9	1.7	2										
	1.50	Silty clay	6.5	4.9	1.6	2										
	1.75	Silty clay	6.3	4.6	1.7	2										
	2.00	Silty clay	6.2	4.6	1.6	2										
Bore 33	0.25	Silty sand	7.1	5.4	1.7	3										
	0.50	Silty clay	7.1	5.4	1.7	3	6.7	<2	<0.02	0.01	-	-	2	<0.02	<0.02	<1
	0.75	Silty clay	6.9	5.4	1.5	2										
	1.00	Silty clay	6.5	4.8	1.7	2										
	1.25	Silty clay	6.5	4.5	2.0	2										
	1.50	Silty clay	6.4	4.5	1.9	2										
	1.75	Silty clay	6.2	4.6	1.6	2										
	2.00	Silty clay	6.2	4.5	1.7	2										
Bore 34	0.25	Silty clay	6.6	5.2	1.4	2										
	0.50	Silty clay	6.7	5.0	1.7	2										
	0.75	Silty clay	5.3	4.4	0.9	2										
	1.00	Silty clay	5.0	3.6	1.4	1										
	1.25	Silty clay	4.7	3.6	1.1	1	4.5	32	0.05	0.007	-	-	-	0.06	0.06	3

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity				
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)	Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
								mole H^+/t	%S							
Bore 34	1.50	Silty clay	5.8	4.1	1.7	2										
	1.75	Silty clay	6.7	3.3	3.4	2										
	2.00	Silty clay	6.1	5.2	0.9	2										
Bore 35	0.25	Filling	6.1	3.4	2.7	3										
	0.50	Filling	6.2	3.4	2.8	2										
	0.75	Filling	7.1	3.9	3.2	2										
	1.00	Silty clay	6.7	1.8	4.9	4	4.6	25	0.04	0.732	-	-	-	0.77	0.77	36
	1.25	Silty clay	6.2	4.2	2.0	2										
	1.50	Silty clay	6.0	1.8	4.2	2										
	1.75	Silty clay	6.1	1.9	4.2	4	4.4	46	0.07	0.014	<0.02	<0.02	-	0.09	0.09	4
	2.00	Silty clay	6.3	2.2	4.1	2										
Bore 36	0.25	Filling	6.6	4.3	2.3	2										
	0.50	Filling	6.6	4.5	2.1	1										
	0.75	Filling	6.5	4.9	1.6	1										
	1.00	Silty sand	6.3	4.5	1.8	2										
	1.25	Sandy clay	5.4	4.0	1.4	2										
	1.50	Silty clay	5.2	3.5	1.7	2										
	1.75	Silty clay	5.1	3.4	1.7	2										
	2.00	Silty clay	4.7	3.6	1.1	1										
Bore 37	0.25	Silty sand	7.1	5.4	1.7	2										
	0.50	Silty clay	6.8	5.7	1.1	2										
	0.75	Silty clay	6.4	4.6	1.8	2										
	1.00	Silty clay	6.0	4.4	1.6	2										
	1.25	Silty clay	6.1	4.5	1.6	2										
	1.50	Silty clay	5.0	3.7	1.3	2										
	1.75	Silty clay	4.5	3.7	0.8	2										
	2.00	Silty clay	4.4	3.2	1.2	2	4.4	34	0.05	0.063	0.08	<0.02	-	0.12	0.12	6
Bore 38	0.25	Silty sand	6.0	3.9	2.1	2										
	0.50	Silty sand	6.0	2.8	3.2	3	5	15	0.02	0.01	-	-	-	0.04	0.04	2
	0.75	Silty sand	6.3	4.6	1.7	3										
	1.00	Silty sand	6.2	4.5	1.7	3										
	1.25	Silty sand	6.2	4.8	1.4	1										

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	Actual Acidity			Potential Acidity		Retained Acidity		Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
							pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)			
								mole H^+/t	%S							
Bore 38	1.50	Silty sand	6.2	4.8	1.4	1										
	1.75	Sand	6.2	5.1	1.1	1										
Bore 39	0.25	Silty clay	6	4.5	1.5	2										
	0.50	Silty clay	4.9	3.6	1.3	1										
	0.75	Silty clay	5.2	3.9	1.3	2										
	1.00	Silty clay	4.9	2.8	2.1	2	4.2	46	0.07	0.012	<0.02	<0.020	-	0.08	0.08	4
	1.25	Silty clay	5.5	3.2	2.3	2										
	1.50	Silty clay	5.0	3.0	2.0	2										
	1.75	Silty clay	4.9	2.8	2.1	2										
	2.00	Silty clay	4.9	3.2	1.7	2										
Bore 40	0.25	Silty sand	6.1	3.3	2.8	2										
	0.50	Silty sand	5.6	2.8	2.8	2	4.9	12	<0.02	0.01	-	-	-	0.03	0.03	1
	0.75	Silty sand	5.4	3.2	2.2	2										
	1.00	Silty sand	6.1	3.3	2.8	2										
	1.25	Silty sand	6.2	4.5	1.7	1										
	1.50	Silty clay	4.7	3.6	1.1	2										
	1.75	Clayey sand	5.2	3.1	2.1	2										
	2.00	Clayey sand	5.1	4.4	0.7	2										
Bore 41	0.25	Sandy clay	5.0	2.4	2.6	3										
	0.50	Sandy clay	5.2	2.4	2.8	3	4.3	64	0.1	0.012	<0.02	<0.02	-	0.11	0.11	5
	0.75	Sandy clay	5.4	3.2	2.2	3										
	1.00	Silty clay	4.6	3.2	1.4	2										
	1.25	Silty clay	4.5	3.3	1.2	2										
	1.50	Silty clay	4.9	3.5	1.4	2										
	1.75	Silty clay	4.7	3.7	1.0	2										
	2.00	Silty clay	4.8	4.2	0.6	2										
Bore 42	0.25	Silty sand	5.3	2.8	2.5	2	4.8	18	0.03	0.01	-	-	-	0.04	0.04	2
	0.50	Silty sand	5.8	3.0	2.8	2										
	0.75	Sandy clay	5.3	3.8	1.5	2										
	1.00	Sandy clay	5.0	3.8	1.2	2										
	1.25	Sandy clay	4.7	3.4	1.3	2										
	1.50	Sandy clay	4.9	3.7	1.2	2										

Table D1: Summary of Acid Sulfate Soil Results

Sample ID	Depth (mbGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results									Liming Rate (kg Ag Lime/t)
							Actual Acidity			Potential Acidity		Retained Acidity		Net Acidity (%S)	Net Acidity, excl. ANC (%S)	
			pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pH_{KCl}	Titratable Actual Acidity (TAA)		Chromium Reducible Sulfur (S_{Cr}, %S)	Sulfur in KCl extract (S_{KCl}, %S)	Net Acid-Soluble Sulfur (NASS, %S)	Acid Neutralising Capacity (ANC, %S)			
								mole H^+/t	%S							
Bore 42	1.75	Sandy clay	5.4	4.5	0.9	2										
	2.00	Sandy clay	5.2	4.5	0.7	2										
	2.25	Sandy clay	5.4	4.4	1.0	2										
	2.50	Sandy clay	5.5	4.7	0.8	2										
	2.75	Sandy clay	5.6	4.7	0.9	2										
	3.00	Sandy clay	5.5	4.8	0.7	2										
	3.25	Sandy clay	5.3	4.4	0.9	2										
	3.75	Sandy clay	5.3	4.4	0.9	2										
Assessment Criteria																
Sands to loamy sands			<4	<3	~	~	~	~	~	~	~	~	~	0.03	~	~
Sandy loams to light clays					~	~	~	~	~	~	~	~	~	$0.06^a/0.03^b$	~	~
Medium to heavy clays & silty clays					~	~	~	~	~	~	~	~	~	$0.1^a/0.03^b$	~	~

Notes:

mbGL	metres below ground level
-	Not tested
~	No guideline available at time of investigation
*	Reaction Intensity: 1 = no reaction, 2 = mild reaction, 3 = vigorous reaction, 4 = violent reaction, F = effervescence
a	Action Criteria for disturbance of 1-1000 tonnes of material
b	Action Criteria for disturbance of more than 1000 tonnes of material
Yellow	cells indicate a net acidity greater than or equal to the guideline level of 0.03% S
	If pH_F <4, this indicates that Actual Acid Sulfate Soils may be present
	If pH_{FOX} <3, this is a strong indication that Potential Acid Sulfate Soils may be present
	The greater the difference between pH_F and pH_{FOX}, the stronger the indication that Potential Acid Sulfate Soils are present

CERTIFICATE OF ANALYSIS

Work Order	: **EB1704688**	Page	: 1 of 27
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: EMMA MAXWELL	Contact	: John Pickering
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 32378900	Telephone	: +61-7-3243 7222
Project	: 92838 Redland Bay	Date Samples Received	: 09-Mar-2017 16:05
Order number	: 92838 Redland Bay	Date Analysis Commenced	: 13-Mar-2017
C-O-C number	: ----	Issue Date	: 16-Mar-2017 15:10
Sampler	: ----		
Site	: ----		
Quote number	: EN/093/15		
No. of samples received	: 121		
No. of samples analysed	: 121		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris		Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 1 -0.25**	**BORE 1 -0.5**	**BORE 1 -0.75**	**BORE 1 -1**	**BORE 1 -1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-001**	**EB1704688-002**	**EB1704688-003**	**EB1704688-004**	**EB1704688-005**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.1**	**5.0**	**5.2**	**5.3**	**5.2**
ø **pH (Fox)**	----	0.1	pH Unit	**2.2**	**3.4**	**3.1**	**3.6**	**3.6**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 1 -1.5**	**BORE 1 -1.75**	**BORE 1 -2**	**BORE 2 - 0.25**	**BORE 2 - 0.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-006**	**EB1704688-007**	**EB1704688-008**	**EB1704688-009**	**EB1704688-010**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.4**	**5.6**	**5.3**	**6.4**	**6.5**
ø **pH (Fox)**	----	0.1	pH Unit	**3.8**	**4.1**	**4.0**	**3.2**	**3.5**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 2 - 0.75**	**BORE 2 - 1**	**BORE 2 - 1.25**	**BORE 2 - 1.5**	**BORE 2 - 1.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-011**	**EB1704688-012**	**EB1704688-013**	**EB1704688-014**	**EB1704688-015**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.1**	**4.8**	**4.9**	**5.0**	**5.6**
ø **pH (Fox)**	----	0.1	pH Unit	**3.4**	**3.9**	**3.8**	**3.2**	**3.4**
ø **Reaction Rate**	----	1	-	**3**	**4**	**4**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 2 - 2**	**BORE 3 - 0.25**	**BORE 3 - 0.5**	**BORE 3 - 0.75**	**BORE 3 - 1**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-016**	**EB1704688-017**	**EB1704688-018**	**EB1704688-019**	**EB1704688-020**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.1**	**6.3**	**6.5**	**6.4**	**6.6**
ø **pH (Fox)**	----	0.1	pH Unit	**3.7**	**2.9**	**2.9**	**3.2**	**3.7**
ø **Reaction Rate**	----	1	-	**2**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 3 - 1.25**	**BORE 3 - 1.5**	**BORE 3 - 1.75**	**BORE 3 - 2**	**BORE 4 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-021**	**EB1704688-022**	**EB1704688-023**	**EB1704688-024**	**EB1704688-025**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.7**	**5.6**	**5.3**	**5.0**	**6.2**
ø **pH (Fox)**	----	0.1	pH Unit	**3.4**	**3.4**	**3.3**	**3.3**	**3.6**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 4 - 0.5**	**BORE 4 - 0.75**	**BORE 4 - 1**	**BORE 4 - 1.25**	**BORE 4 - 1.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-026**	**EB1704688-027**	**EB1704688-028**	**EB1704688-029**	**EB1704688-030**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.8**	**5.3**	**5.3**	**5.4**	**6.0**
ø **pH (Fox)**	----	0.1	pH Unit	**3.8**	**3.5**	**5.6**	**2.5**	**3.8**
ø **Reaction Rate**	----	1	-	**4**	**4**	**4**	**3**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 4 - 1.75**	**BORE 4 - 2**	**BORE 5 - 0.25**	**BORE 5 - 0.5**	**BORE 5 - 0.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-031**	**EB1704688-032**	**EB1704688-033**	**EB1704688-034**	**EB1704688-035**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.6**	**5.7**	**5.4**	**5.7**	**6.1**
ø **pH (Fox)**	----	0.1	pH Unit	**3.4**	**3.5**	**2.1**	**2.9**	**4.1**
ø **Reaction Rate**	----	1	-	**2**	**2**	**3**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 5 - 1**	**BORE 5 - 1.25**	**BORE 5 - 1.5**	**BORE 5 - 1.75**	**BORE 5 - 2**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-036**	**EB1704688-037**	**EB1704688-038**	**EB1704688-039**	**EB1704688-040**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.5**	**5.5**	**5.8**	**5.5**	**5.5**
ø **pH (Fox)**	----	0.1	pH Unit	**4.7**	**3.8**	**3.9**	**3.8**	**3.4**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 6 - 0.25**	**BORE 6 - 0.5**	**BORE 6 - 0.75**	**BORE 6 - 1**	**BORE 6 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-041**	**EB1704688-042**	**EB1704688-043**	**EB1704688-044**	**EB1704688-045**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.6**	**5.2**	**5.2**	**5.1**	**5.4**
ø **pH (Fox)**	----	0.1	pH Unit	**2.5**	**2.3**	**2.5**	**2.7**	**2.9**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 6 - 1.5**	**BORE 6 - 1.75**	**BORE 6 - 2**	**BORE 7 - 0.25**	**BORE 7 - 0.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-046**	**EB1704688-047**	**EB1704688-048**	**EB1704688-049**	**EB1704688-050**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.8**	**4.7**	**4.7**	**6.2**	**6.5**
ø **pH (Fox)**	----	0.1	pH Unit	**3.4**	**2.9**	**2.8**	**3.9**	**4.5**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 7 - 0.75**	**BORE 7 - 1**	**BORE 7 - 1.25**	**BORE 7 - 1.5**	**BORE 7 - 1.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-051**	**EB1704688-052**	**EB1704688-053**	**EB1704688-054**	**EB1704688-055**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø pH (F)	----	0.1	pH Unit	**6.4**	**6.2**	**6.3**	**6.3**	**6.2**
ø pH (Fox)	----	0.1	pH Unit	**4.5**	**4.4**	**4.4**	**4.5**	**4.3**
ø Reaction Rate	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 7 - 2**	**BORE 8 - 0.25**	**BORE 8 - 0.5**	**BORE 8 - 0.75**	**BORE 8 - 1**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-056**	**EB1704688-057**	**EB1704688-058**	**EB1704688-059**	**EB1704688-060**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.3**	**6.2**	**6.6**	**6.4**	**6.6**
ø **pH (Fox)**	----	0.1	pH Unit	**4.4**	**3.2**	**3.0**	**3.1**	**3.0**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 8 - 1.25**	**BORE 8 - 1.5**	**BORE 8 - 1.75**	**BORE 8 - 2**	**BORE 9 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-061**	**EB1704688-062**	**EB1704688-063**	**EB1704688-064**	**EB1704688-065**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.2**	**5.7**	**5.3**	**4.9**	**6.5**
ø **pH (Fox)**	----	0.1	pH Unit	**3.6**	**3.6**	**3.1**	**3.7**	**3.5**
ø **Reaction Rate**	----	1	-	**3**	**2**	**2**	**2**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 9 - 0.5**	**BORE 9 - 0.75**	**BORE 9 - 1**	**BORE 9 - 1.25**	**BORE 9 - 1.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-066**	**EB1704688-067**	**EB1704688-068**	**EB1704688-069**	**EB1704688-070**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.8**	**6.6**	**5.9**	**5.7**	**5.8**
ø **pH (Fox)**	----	0.1	pH Unit	**3.5**	**4.2**	**4.2**	**3.8**	**3.7**
ø **Reaction Rate**	----	1	-	**3**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 9 - 1.75**	**BORE 9 - 2**	**BORE 10 - 0.25**	**BORE 10 - 0.5**	**BORE 10 - 0.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-071**	**EB1704688-072**	**EB1704688-073**	**EB1704688-074**	**EB1704688-075**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.7**	**5.4**	**6.0**	**6.0**	**6.3**
ø **pH (Fox)**	----	0.1	pH Unit	**3.2**	**3.2**	**3.7**	**3.5**	**4.3**
ø **Reaction Rate**	----	1	-	**2**	**2**	**3**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 10 - 1**	**BORE 10 - 1.25**	**BORE 10 - 1.5**	**BORE 10 - 1.75**	**BORE 10 - 2**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-076**	**EB1704688-077**	**EB1704688-078**	**EB1704688-079**	**EB1704688-080**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.1**	**6.4**	**6.0**	**5.1**	**5.0**
ø **pH (Fox)**	----	0.1	pH Unit	**4.6**	**4.0**	**4.2**	**3.1**	**3.4**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 11 - 0.25**	**BORE 11 - 0.5**	**BORE 11 - 0.75**	**BORE 11 - 1**	**BORE 11 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-081**	**EB1704688-082**	**EB1704688-083**	**EB1704688-084**	**EB1704688-085**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.3**	**6.6**	**6.4**	**5.9**	**6.1**
ø **pH (Fox)**	----	0.1	pH Unit	**4.2**	**4.6**	**4.2**	**4.5**	**4.5**
ø **Reaction Rate**	----	1	-	**3**	**2**	**3**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 11 - 1.5**	**BORE 11 - 1.75**	**BORE 11 - 2**	**BORE 12 - 0.25**	**BORE 12 - 0.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-086**	**EB1704688-087**	**EB1704688-088**	**EB1704688-089**	**EB1704688-090**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.3**	**6.4**	**6.5**	**6.3**	**6.0**
ø **pH (Fox)**	----	0.1	pH Unit	**4.5**	**4.5**	**4.4**	**3.4**	**3.5**
ø **Reaction Rate**	----	1	-	**1**	**1**	**1**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 12 - 0.75**	**BORE 12 - 1**	**BORE 12 - 1.25**	**BORE 12 - 1.5**	**BORE 12 - 1.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-091**	**EB1704688-092**	**EB1704688-093**	**EB1704688-094**	**EB1704688-095**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.0**	**6.2**	**5.3**	**4.6**	**4.3**
ø **pH (Fox)**	----	0.1	pH Unit	**3.6**	**3.4**	**3.7**	**2.9**	**3.0**
ø **Reaction Rate**	----	1	-	**2**	**1**	**1**	**1**	**1**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 12 - 2**	**BORE 13 - 0.25**	**BORE 13 - 0.5**	**BORE 13 - 0.75**	**BORE 13 - 1**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-096**	**EB1704688-097**	**EB1704688-098**	**EB1704688-099**	**EB1704688-100**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.5**	**4.9**	**5.2**	**4.8**	**4.8**
ø **pH (Fox)**	----	0.1	pH Unit	**3.5**	**2.3**	**3.0**	**2.7**	**2.7**
ø **Reaction Rate**	----	1	-	**1**	**3**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 13 - 1.25**	**BORE 13 - 1.5**	**BORE 13 - 1.75**	**BORE 13 - 2**	**BORE 14 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-101**	**EB1704688-102**	**EB1704688-103**	**EB1704688-104**	**EB1704688-105**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.3**	**5.0**	**5.2**	**5.2**	**6.6**
ø **pH (Fox)**	----	0.1	pH Unit	**4.0**	**3.5**	**3.1**	**3.5**	**3.6**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 14 - 0.5**	**BORE 14 - 0.75**	**BORE 14 - 1**	**BORE 14 - 1.25**	**BORE 14 - 1.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-106**	**EB1704688-107**	**EB1704688-108**	**EB1704688-109**	**EB1704688-110**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.7**	**5.5**	**5.8**	**5.8**	**6.3**
ø **pH (Fox)**	----	0.1	pH Unit	**4.5**	**3.5**	**3.7**	**3.6**	**3.4**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 14 - 1.75**	**BORE 14 - 2**	**BORE 15 - 0.25**	**BORE 15 - 0.5**	**BORE 15 - 0.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704688-111**	**EB1704688-112**	**EB1704688-113**	**EB1704688-114**	**EB1704688-115**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.4**	**5.2**	**6.0**	**5.9**	**6.2**
ø **pH (Fox)**	----	0.1	pH Unit	**3.9**	**3.7**	**2.7**	**3.9**	**3.6**
ø **Reaction Rate**	----	1	-	**2**	**2**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 15 - 1**	**BORE 15 - 1.25**	**BORE 15 - 1.5**	**BORE 15 - 1.75**	**BORE 15 - 2**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-116**	**EB1704688-117**	**EB1704688-118**	**EB1704688-119**	**EB1704688-120**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.1**	**5.7**	**5.6**	**6.0**	**5.8**
ø **pH (Fox)**	----	0.1	pH Unit	**3.3**	**3.4**	**3.6**	**3.7**	**3.7**
ø **Reaction Rate**	----	1	-	**3**	**2**	**2**	**3**	**3**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**Bore 24**	----	----	----	----
			Client sampling date / time	06-Mar-2017 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704688-121**	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.17**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**2920**	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**1400**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**55**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**55**	----	----	----	----
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	**100**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**25**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**868**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**62**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**78**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**363**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**22**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.323**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.12**	----	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**26.1**	----	----	----	----
Total Cations	----	0.01	meq/L	**25.9**	----	----	----	----
Ionic Balance	----	0.01	%	**0.46**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order : **EB1704691**
Client : **DOUGLAS PARTNERS PTY LTD**
Contact : EMMA MAXWELL
Address : 439 MONTAGUE ROAD
WEST END QLD, AUSTRALIA 4101
Telephone : +61 07 32378900
Project : 92838 Redland Bay
Order number : 92838 Redland Bay
C-O-C number : ----
Sampler : EMMA MAXWELL
Site : ----
Quote number : EN/093/15
No. of samples received : 120
No. of samples analysed : 119

Page : 1 of 26
Laboratory : Environmental Division Brisbane
Contact : John Pickering
Address : 2 Byth Street Stafford QLD Australia 4053
Telephone : +61-7-3243 7222
Date Samples Received : 09-Mar-2017 16:05
Date Analysis Commenced : 13-Mar-2017
Issue Date : 13-Mar-2017 11:19

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris		Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BORE 16 - 0.25**	**BORE 16 - 0.5**	**BORE 16 - 0.75**	**BORE 16 - 1**	**BORE 16 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-001**	**EB1704691-002**	**EB1704691-003**	**EB1704691-004**	**EB1704691-005**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**7.0**	**7.5**	**7.6**	**7.5**	**7.1**
ø **pH (Fox)**	----	0.1	pH Unit	**4.2**	**4.9**	**5.5**	**5.6**	**5.4**
ø **Reaction Rate**	----	1	-	**3**	**3**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 16 - 1.5**	**BORE 16 - 1.75**	**BORE 16 - 2**	**BORE 17 - 0.25**	**BORE 17 - 0.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-006**	**EB1704691-007**	**EB1704691-008**	**EB1704691-009**	**EB1704691-010**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.7**	**5.3**	**4.9**	**5.4**	**5.0**
ø **pH (Fox)**	----	0.1	pH Unit	**4.7**	**4.5**	**3.8**	**2.7**	**3.8**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**3**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 17 - 0.75**	**BORE 17 - 1**	**BORE 17 - 1.25**	**BORE 17 - 1.5**	**BORE 17 - 1.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-011**	**EB1704691-012**	**EB1704691-013**	**EB1704691-014**	**EB1704691-015**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.7**	**5.1**	**4.8**	**4.8**	**4.9**
ø **pH (Fox)**	----	0.1	pH Unit	**3.9**	**4.1**	**3.6**	**3.9**	**4.2**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 17 - 2**	**BORE 18 - 0.25**	**BORE 18 - 0.5**	**BORE 18 - 0.75**	**BORE 18 - 1**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-016**	**EB1704691-017**	**EB1704691-018**	**EB1704691-019**	**EB1704691-020**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.9**	**5.4**	**5.6**	**6.2**	**6.1**
ø **pH (Fox)**	----	0.1	pH Unit	**4.2**	**4.3**	**4.8**	**4.7**	**4.8**
ø **Reaction Rate**	----	1	-	**2**	**3**	**3**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 18 - 1.25**	**BORE 18 - 1.5**	**BORE 18 - 1.75**	**BORE 18 - 2**	**BORE 19 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-021**	**EB1704691-022**	**EB1704691-023**	**EB1704691-024**	**EB1704691-025**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.0**	**5.9**	**5.8**	**5.9**	**6.0**
ø **pH (Fox)**	----	0.1	pH Unit	**4.9**	**4.7**	**4.5**	**4.5**	**4.6**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 19 - 0.5**	**BORE 19 - 0.75**	**BORE 19 - 1**	**BORE 19 - 1.25**	**BORE 19 - 1.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-026**	**EB1704691-027**	**EB1704691-028**	**EB1704691-029**	**EB1704691-030**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.6**	**5.8**	**5.9**	**6.0**	**6.0**
ø **pH (Fox)**	----	0.1	pH Unit	**5.2**	**4.7**	**4.6**	**5.0**	**4.9**
ø **Reaction Rate**	----	1	-	**3**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL)**

			Client sample ID	**BORE 19 - 1.75**	**BORE 19 - 2**	**BORE 20 - 0.25**	**BORE 20 - 0.5**	**BORE 20 - 0.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-031**	**EB1704691-032**	**EB1704691-033**	**EB1704691-034**	**EB1704691-035**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.2**	**6.2**	**5.9**	**6.1**	**6.4**
ø **pH (Fox)**	----	0.1	pH Unit	**5.0**	**4.9**	**2.7**	**3.0**	**4.5**
ø **Reaction Rate**	----	1	-	**2**	**2**	**3**	**3**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 20 - 1**	**BORE 20 - 1.25**	**BORE 20 - 1.5**	**BORE 20 - 1.75**	**BORE 20 - 2**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-036**	**EB1704691-037**	**EB1704691-038**	**EB1704691-039**	**EB1704691-040**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.0**	**6.0**	**5.9**	**5.7**	**5.6**
ø **pH (Fox)**	----	0.1	pH Unit	**4.8**	**4.8**	**5.0**	**4.8**	**4.7**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 21 - 0.25**	**BORE 21 - 0.5**	**BORE 21 - 0.75**	**BORE 21 - 1**	**BORE 21 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-041**	**EB1704691-042**	**EB1704691-043**	**EB1704691-044**	**EB1704691-045**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.6**	**5.5**	**5.6**	**5.6**	**5.9**
ø **pH (Fox)**	----	0.1	pH Unit	**4.1**	**4.8**	**4.7**	**4.6**	**4.6**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 21 - 1.5**	**BORE 21 - 1.75**	**BORE 21 - 2**	**BORE 21 - 2.25**	**BORE 21 - 2.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-046**	**EB1704691-047**	**EB1704691-048**	**EB1704691-049**	**EB1704691-050**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.1**	**6.2**	**6.2**	**6.1**	**5.6**
ø **pH (Fox)**	----	0.1	pH Unit	**4.5**	**4.7**	**4.9**	**4.7**	**4.7**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BORE 21 - 2.75**	**BORE 21 - 3**	**BORE 21 - 3.25**	**BORE 21 - 3.5**	**BORE 21 - 3.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-051**	**EB1704691-052**	**EB1704691-053**	**EB1704691-054**	**EB1704691-055**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.7**	**5.7**	**5.7**	**5.7**	**5.2**
ø **pH (Fox)**	----	0.1	pH Unit	**4.5**	**4.6**	**4.5**	**4.6**	**4.5**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 21 - 4**	**BORE 22 - 0.25**	**BORE 22 - 0.5**	**BORE 22 - 0.75**	**BORE 22 - 1**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-056**	**EB1704691-057**	**EB1704691-058**	**EB1704691-059**	**EB1704691-060**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.7**	**5.9**	**6.0**	**5.9**	**5.7**
ø **pH (Fox)**	----	0.1	pH Unit	**4.8**	**3.2**	**3.0**	**3.5**	**4.6**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 22 - 1.25**	**BORE 22 - 1.5**	**BORE 22 - 1.75**	**BORE 22 - 2**	**BORE 22 - 2.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-061**	**EB1704691-062**	**EB1704691-063**	**EB1704691-064**	**EB1704691-065**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.8**	**5.4**	**5.5**	**5.8**	**5.6**
ø **pH (Fox)**	----	0.1	pH Unit	**4.9**	**4.7**	**4.3**	**4.7**	**4.1**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 22 - 2.5**	**BORE 22 - 2.75**	**BORE 22 - 3**	**BORE 22 - 3.25**	**BORE 22 - 3.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-066**	**EB1704691-067**	**EB1704691-068**	**EB1704691-069**	**EB1704691-070**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.8**	**5.4**	**5.5**	**5.4**	**5.5**
ø **pH (Fox)**	----	0.1	pH Unit	**4.2**	**4.6**	**3.8**	**4.1**	**3.9**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 22 - 3.75**	**BORE 22 - 4**	**BORE 23 -0.25**	**BORE 23 -0.5**	**BORE 23 -0.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-071**	**EB1704691-072**	**EB1704691-073**	**EB1704691-074**	**EB1704691-075**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø pH (F)	----	0.1	pH Unit	**5.4**	**5.3**	**5.7**	**6.0**	**6.1**
ø pH (Fox)	----	0.1	pH Unit	**3.9**	**4.2**	**4.5**	**4.7**	**4.9**
ø Reaction Rate	----	1	-	**3**	**3**	**3**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 23 -1**	**BORE 23 -1.25**	**BORE 23 -1.5**	**BORE 23 -1.75**	**BORE 23 -2**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-076**	**EB1704691-077**	**EB1704691-078**	**EB1704691-079**	**EB1704691-080**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.2**	**6.2**	**6.3**	**6.2**	**6.2**
ø **pH (Fox)**	----	0.1	pH Unit	**4.8**	**5.0**	**4.8**	**4.7**	**4.7**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 24 - 0.25**	**BORE 24 - 0.5**	**BORE 24 - 0.75**	**BORE 24 - 1**	**BORE 24 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-081**	**EB1704691-082**	**EB1704691-083**	**EB1704691-084**	**EB1704691-085**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.5**	**5.0**	**4.6**	**4.7**	**4.8**
ø **pH (Fox)**	----	0.1	pH Unit	**2.3**	**2.6**	**2.4**	**2.5**	**3.3**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BORE 24 - 1.5**	**BORE 24 - 1.75**	**BORE 24 - 2**	**BORE 24 - 2.25**	**BORE 24 - 2.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-086**	**EB1704691-087**	**EB1704691-088**	**EB1704691-089**	**EB1704691-091**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.6**	**4.8**	**4.8**	**4.8**	**4.8**
ø **pH (Fox)**	----	0.1	pH Unit	**3.4**	**3.5**	**3.6**	**4.1**	**3.7**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 24 - 3**	**BORE 24 - 3.25**	**BORE 24 - 3.5**	**BORE 24 - 3.75**	**BORE 24 - 4**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-092**	**EB1704691-093**	**EB1704691-094**	**EB1704691-095**	**EB1704691-096**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.8**	**5.4**	**5.5**	**5.4**	**5.6**
ø **pH (Fox)**	----	0.1	pH Unit	**4.1**	**4.8**	**4.4**	**4.1**	**4.5**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 25 - 0.25**	**BORE 25 - 0.5**	**BORE 25 - 0.75**	**BORE 25 - 1**	**BORE 25 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-097**	**EB1704691-098**	**EB1704691-099**	**EB1704691-100**	**EB1704691-101**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.6**	**6.0**	**6.0**	**5.4**	**5.3**
ø **pH (Fox)**	----	0.1	pH Unit	**2.2**	**2.9**	**3.4**	**4.4**	**4.1**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 25 - 1.5**	**BORE 25 - 1.75**	**BORE 25 - 2**	**BORE 26 - 0.25**	**BORE 26 - 0.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-102**	**EB1704691-103**	**EB1704691-104**	**EB1704691-105**	**EB1704691-106**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.5**	**5.3**	**5.2**	**5.7**	**4.9**
ø **pH (Fox)**	----	0.1	pH Unit	**4.2**	**4.1**	**4.5**	**3.5**	**3.0**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**3**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 26 - 0.75**	**BORE 26 - 1**	**BORE 26 - 1.25**	**BORE 26 - 1.5**	**BORE 26 - 1.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704691-107**	**EB1704691-108**	**EB1704691-109**	**EB1704691-110**	**EB1704691-111**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø pH (F)	----	0.1	pH Unit	**5.3**	**5.7**	**5.7**	**5.2**	**6.2**
ø pH (Fox)	----	0.1	pH Unit	**3.6**	**4.7**	**4.7**	**4.0**	**4.5**
ø Reaction Rate	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 26 - 2**	**BORE 27 - 0.25**	**BORE 27 - 0.5**	**BORE 27 - 0.75**	**BORE 27 - 1**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-112**	**EB1704691-113**	**EB1704691-114**	**EB1704691-115**	**EB1704691-116**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.3**	**5.6**	**6.4**	**6.2**	**6.2**
ø **pH (Fox)**	----	0.1	pH Unit	**4.9**	**3.9**	**3.1**	**4.3**	**5.1**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 27 - 1.25**	**BORE 27 - 1.5**	**BORE 27 - 1.75**	**BORE 27 - 2**	**----**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704691-117**	**EB1704691-118**	**EB1704691-119**	**EB1704691-120**	**--------**
				Result	Result	Result	Result	----
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.3**	**5.0**	**5.2**	**5.0**	**----**
ø **pH (Fox)**	----	0.1	pH Unit	**4.9**	**4.3**	**4.1**	**4.1**	**----**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**----**

CERTIFICATE OF ANALYSIS

Work Order	: **EB1704694**	Page	: 1 of 26
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: EMMA MAXWELL	Contact	: John Pickering
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 32378900	Telephone	: +61-7-3243 7222
Project	: 92838 Redland Bay	Date Samples Received	: 09-Mar-2017 16:05
Order number	: 92838 Redland Bay	Date Analysis Commenced	: 16-Mar-2017
C-O-C number	: ----	Issue Date	: 16-Mar-2017 17:01
Sampler	: EMMA MAXWELL		
Site	: ----		
Quote number	: EN/093/15		
No. of samples received	: 119		
No. of samples analysed	: 118		

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Satishkumar Trivedi	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 28 - 0.25**	**BORE 28 - 0.5**	**BORE 28 - 0.75**	**BORE 28 - 1**	**BORE 28 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-001**	**EB1704694-002**	**EB1704694-003**	**EB1704694-004**	**EB1704694-005**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.1**	**5.5**	**4.5**	**4.4**	**4.7**
ø **pH (Fox)**	----	0.1	pH Unit	**3.1**	**2.8**	**3.4**	**3.0**	**3.8**
ø **Reaction Rate**	----	1	-	**3**	**3**	**1**	**2**	**1**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 28 - 1.5**	**BORE 28 - 1.75**	**BORE 28 - 2**	**BORE 28 - 2.25**	**BORE 28 - 2.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-006**	**EB1704694-007**	**EB1704694-008**	**EB1704694-009**	**EB1704694-010**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.6**	**4.5**	**4.6**	**4.5**	**4.9**
ø **pH (Fox)**	----	0.1	pH Unit	**3.1**	**3.4**	**3.4**	**3.3**	**3.4**
ø **Reaction Rate**	----	1	-	**1**	**2**	**1**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 28 - 2.75**	**BORE 28 - 3**	**BORE 28 - 3.25**	**BORE 28 - 3.5**	**BORE 28 - 3.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-011**	**EB1704694-012**	**EB1704694-013**	**EB1704694-014**	**EB1704694-015**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.5**	**5.7**	**6.1**	**6.1**	**5.9**
ø **pH (Fox)**	----	0.1	pH Unit	**4.1**	**4.2**	**5.8**	**5.0**	**4.9**
ø **Reaction Rate**	----	1	-	**2**	**2**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 28 - 4**	**BORE 31 - 0.25**	**BORE 31 - 0.5**	**BORE 31 - 0.75**	**BORE 31 - 1**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-016**	**EB1704694-017**	**EB1704694-018**	**EB1704694-019**	**EB1704694-020**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.0**	**7.2**	**7.6**	**5.5**	**5.3**
ø **pH (Fox)**	----	0.1	pH Unit	**4.9**	**5.4**	**4.7**	**4.4**	**3.8**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**2**	**1**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 31 - 1.25**	**BORE 31 - 1.5**	**BORE 31 - 1.75**	**BORE 31 - 2**	**BORE 32 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-021**	**EB1704694-022**	**EB1704694-023**	**EB1704694-024**	**EB1704694-025**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.9**	**4.7**	**4.6**	**4.6**	**7.1**
ø **pH (Fox)**	----	0.1	pH Unit	**3.4**	**3.5**	**3.4**	**3.3**	**5.4**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 32 - 0.5**	**BORE 32 - 0.75**	**BORE 32 - 1**	**BORE 32 - 1.25**	**BORE 32 - 1.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-026**	**EB1704694-027**	**EB1704694-028**	**EB1704694-029**	**EB1704694-030**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.8**	**6.5**	**6.6**	**6.6**	**6.5**
ø **pH (Fox)**	----	0.1	pH Unit	**5.3**	**4.8**	**4.8**	**4.9**	**4.9**
ø **Reaction Rate**	----	1	-	**3**	**2**	**1**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 32 - 1.75**	**BORE 32 - 2**	**BORE 33 - 0.25**	**BORE 33 - 0.5**	**BORE 33 - 0.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-031**	**EB1704694-032**	**EB1704694-033**	**EB1704694-034**	**EB1704694-035**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.3**	**6.2**	**7.1**	**7.1**	**6.9**
ø **pH (Fox)**	----	0.1	pH Unit	**4.6**	**4.6**	**5.4**	**5.4**	**5.4**
ø **Reaction Rate**	----	1	-	**2**	**2**	**3**	**3**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 33 - 1**	**BORE 33 - 1.25**	**BORE 33 - 1.5**	**BORE 33 - 1.75**	**BORE 33 - 2**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-036**	**EB1704694-037**	**EB1704694-038**	**EB1704694-039**	**EB1704694-040**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.5**	**6.5**	**6.4**	**6.2**	**6.2**
ø **pH (Fox)**	----	0.1	pH Unit	**4.8**	**4.5**	**4.5**	**4.6**	**4.5**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 34 - 0.25**	**BORE 34 - 0.5**	**BORE 34 - 0.75**	**BORE 34 - 1**	**BORE 34 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-041**	**EB1704694-042**	**EB1704694-043**	**EB1704694-044**	**EB1704694-045**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.6**	**6.7**	**5.3**	**5.0**	**4.7**
ø **pH (Fox)**	----	0.1	pH Unit	**5.2**	**5.0**	**4.4**	**3.6**	**3.6**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**1**	**1**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 34 - 1.5**	**BORE 34 - 1.75**	**BORE 34 - 2**	**BORE 35 - 0.25**	**BORE 35 - 0.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-046**	**EB1704694-047**	**EB1704694-048**	**EB1704694-049**	**EB1704694-050**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.8**	**6.7**	**6.1**	**6.1**	**6.2**
ø **pH (Fox)**	----	0.1	pH Unit	**4.1**	**3.3**	**5.2**	**3.4**	**3.4**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**3**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BORE 35 - 0.75**	**BORE 35 - 1**	**BORE 35 - 1.25**	**BORE 35 - 1.5**	**BORE 35 - 1.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-051**	**EB1704694-052**	**EB1704694-053**	**EB1704694-054**	**EB1704694-055**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**7.1**	**6.7**	**6.2**	**6.0**	**6.1**
ø **pH (Fox)**	----	0.1	pH Unit	**3.9**	**1.8**	**4.2**	**1.8**	**1.9**
ø **Reaction Rate**	----	1	-	**2**	**4**	**2**	**2**	**4**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 35 - 2**	**BORE 36 - 0.25**	**BORE 36 - 0.5**	**BORE 36 - 0.75**	**BORE 36 - 1**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-056**	**EB1704694-057**	**EB1704694-058**	**EB1704694-059**	**EB1704694-060**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.3**	**6.6**	**6.6**	**6.5**	**6.3**
ø **pH (Fox)**	----	0.1	pH Unit	**2.2**	**4.3**	**4.5**	**4.9**	**4.5**
ø **Reaction Rate**	----	1	-	**2**	**2**	**1**	**1**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 36 - 1.25**	**BORE 36 - 1.5**	**BORE 36 - 1.75**	**BORE 36 - 2**	**BORE 37 -0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-061**	**EB1704694-062**	**EB1704694-063**	**EB1704694-064**	**EB1704694-065**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø pH (F)	----	0.1	pH Unit	**5.4**	**5.2**	**5.1**	**4.7**	**7.1**
ø pH (Fox)	----	0.1	pH Unit	**4.0**	**3.5**	**3.4**	**3.6**	**5.4**
ø Reaction Rate	----	1	-	**2**	**2**	**2**	**1**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 37 -0.5**	**BORE 37 -0.75**	**BORE 37 -1**	**BORE 37 -1.25**	**BORE 37 -1.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-066**	**EB1704694-067**	**EB1704694-068**	**EB1704694-069**	**EB1704694-070**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.8**	**6.4**	**6.0**	**6.1**	**5.0**
ø **pH (Fox)**	----	0.1	pH Unit	**5.7**	**4.6**	**4.4**	**4.5**	**3.7**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 37 -1.75**	**BORE 37 -2**	**BORE 38 - 0.25**	**BORE 38 - 0.5**	**BORE 38 - 0.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-071**	**EB1704694-072**	**EB1704694-073**	**EB1704694-074**	**EB1704694-075**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø pH (F)	----	0.1	pH Unit	**4.5**	**4.4**	**6.0**	**6.0**	**6.3**
ø pH (Fox)	----	0.1	pH Unit	**3.7**	**3.2**	**3.9**	**2.8**	**4.6**
ø Reaction Rate	----	1	-	**2**	**2**	**2**	**3**	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 38 - 1**	**BORE 38 - 1.25**	**BORE 38 - 1.5**	**BORE 38 - 1.75**	**BORE 39 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-076**	**EB1704694-077**	**EB1704694-078**	**EB1704694-079**	**EB1704694-080**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.2**	**6.2**	**6.2**	**6.2**	**6.0**
ø **pH (Fox)**	----	0.1	pH Unit	**4.5**	**4.8**	**4.8**	**5.1**	**4.5**
ø **Reaction Rate**	----	1	-	**3**	**1**	**1**	**1**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 39 - 0.5**	**BORE 39 - 0.75**	**BORE 39 - 1**	**BORE 39 - 1.25**	**BORE 39 - 1.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-081**	**EB1704694-082**	**EB1704694-083**	**EB1704694-084**	**EB1704694-085**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.9**	**5.2**	**4.9**	**5.5**	**5.0**
ø **pH (Fox)**	----	0.1	pH Unit	**3.6**	**3.9**	**2.8**	**3.2**	**3.0**
ø **Reaction Rate**	----	1	-	**1**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 39 - 1.75**	**BORE 39 - 2**	**BORE 40 -0.25**	**BORE 40 -0.5**	**BORE 40 -0.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-086**	**EB1704694-087**	**EB1704694-088**	**EB1704694-089**	**EB1704694-090**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.9**	**4.9**	**6.1**	**5.6**	**5.4**
ø **pH (Fox)**	----	0.1	pH Unit	**2.8**	**3.2**	**3.3**	**2.8**	**3.2**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 40 -1**	**BORE 40 -1.25**	**BORE 40 -1.5**	**BORE 40 -1.75**	**BORE 40 -2**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-091**	**EB1704694-092**	**EB1704694-093**	**EB1704694-094**	**EB1704694-095**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**6.1**	**6.2**	**4.7**	**5.2**	**5.1**
ø **pH (Fox)**	----	0.1	pH Unit	**3.3**	**4.5**	**3.6**	**3.1**	**4.4**
ø **Reaction Rate**	----	1	-	**2**	**1**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 41 - 0.25**	**BORE 41 - 0.5**	**BORE 41 - 0.75**	**BORE 41 - 1**	**BORE 41 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-096**	**EB1704694-097**	**EB1704694-098**	**EB1704694-099**	**EB1704694-100**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.0**	**5.2**	**5.4**	**4.6**	**4.5**
ø **pH (Fox)**	----	0.1	pH Unit	**2.4**	**2.4**	**3.2**	**3.2**	**3.3**
ø **Reaction Rate**	----	1	-	**3**	**3**	**3**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Client sample ID	**BORE 41 - 1.5**	**BORE 41 - 1.75**	**BORE 41 - 2**	**BORE 42 - 0.25**	**BORE 42 - 0.5**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1704694-101**	**EB1704694-102**	**EB1704694-103**	**EB1704694-104**	**EB1704694-105**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**4.9**	**4.7**	**4.8**	**5.3**	**5.8**
ø **pH (Fox)**	----	0.1	pH Unit	**3.5**	**3.7**	**4.2**	**2.8**	**3.0**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**BORE 42 - 0.75**	**BORE 42 - 1**	**BORE 42 - 1.25**	**BORE 42 - 1.5**	**BORE 42 - 1.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-106**	**EB1704694-107**	**EB1704694-108**	**EB1704694-109**	**EB1704694-110**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.3**	**5.0**	**4.7**	**4.9**	**5.4**
ø **pH (Fox)**	----	0.1	pH Unit	**3.8**	**3.8**	**3.4**	**3.7**	**4.5**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**BORE 42 - 2**	**BORE 42 - 2.25**	**BORE 42 - 2.5**	**BORE 42 - 2.75**	**BORE 42 - 3**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1704694-111**	**EB1704694-112**	**EB1704694-113**	**EB1704694-114**	**EB1704694-115**
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
ø pH (F)	----	0.1	pH Unit	**5.2**	**5.4**	**5.5**	**5.6**	**5.5**
ø pH (Fox)	----	0.1	pH Unit	**4.5**	**4.4**	**4.7**	**4.7**	**4.8**
ø Reaction Rate	----	1	-	**2**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BORE 42 - 3.25**	**BORE 42 - 3.75**	**BORE 42 - 4**	**----**	**----**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	----	----
Compound	CAS Number	LOR	Unit	**EB1704694-116**	**EB1704694-118**	**EB1704694-119**	**--------**	**--------**
				Result	Result	Result	----	----
EA037: Ass Field Screening Analysis								
ø **pH (F)**	----	0.1	pH Unit	**5.3**	**5.3**	**5.4**	**----**	**----**
ø **pH (Fox)**	----	0.1	pH Unit	**4.4**	**4.8**	**4.5**	**----**	**----**
ø **Reaction Rate**	----	1	-	**2**	**2**	**2**	**----**	**----**

Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1705388**	Page	: 1 of 11
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR RYAN KEMP	Contact	: John Pickering
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 32378900	Telephone	: +61-7-3243 7222
Project	: 92838 Redland Bay	Date Samples Received	: 17-Mar-2017 12:54
Order number	: 92838 Redland Bay	Date Analysis Commenced	: 23-Mar-2017
C-O-C number	: ----	Issue Date	: 24-Mar-2017 16:34
Sampler	: EMMA MAXWELL		
Site	: ----		
Quote number	: EN/093/15		
No. of samples received	: 45		
No. of samples analysed	: 45		

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Satishkumar Trivedi	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**Bore 1 -0.25**	**Bore 2 - 0.75**	**Bore 3 - 0.5**	**1.75**	**Bore 4 - 1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1705388-001**	**EB1705388-002**	**EB1705388-003**	**EB1705388-004**	**EB1705388-005**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**5.0**	**4.2**	**5.4**	**4.4**	**5.2**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**40**	**70**	**10**	**36**	**10**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.06**	**0.11**	<0.02	**0.06**	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.010**	**0.008**	**0.010**	<0.005	**0.007**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	**0.02**	----	<0.02	----
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	**0.04**	----	<0.02	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	<0.02	----	<0.02	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	<10	----	<10	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.07**	**0.13**	**0.03**	**0.06**	**0.02**
Net Acidity (acidity units)	----	10	mole H+ / t	**46**	**81**	**17**	**36**	**14**
Liming Rate	----	1	kg CaCO3/t	**3**	**6**	**1**	**3**	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.07**	**0.13**	**0.03**	**0.06**	**0.02**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**46**	**81**	**17**	**36**	**14**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**3**	**6**	**1**	**3**	**1**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**Bore 5 - 0.25**	**Bore 6 - 0.5**	**2**	**Bore 7 - 0.75**	**Bore 8 - 2.0**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1705388-006**	**EB1705388-007**	**EB1705388-008**	**EB1705388-009**	**EB1705388-010**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.6**	**5.0**	**4.5**	**5.8**	**4.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**32**	**32**	**21**	**11**	**37**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.05**	**0.05**	**0.03**	<0.02	**0.06**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.007**	**0.009**	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	----	<0.02
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	----	----	**0.03**
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	----	----	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	----	----	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	----	----	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.06**	**0.06**	**0.03**	<0.02	**0.07**
Net Acidity (acidity units)	----	10	mole H+ / t	**36**	**37**	**21**	**11**	**45**
Liming Rate	----	1	kg CaCO3/t	**3**	**3**	**2**	<1	**3**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.06**	**0.06**	**0.03**	<0.02	**0.07**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**36**	**37**	**21**	**11**	**45**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**3**	**3**	**2**	<1	**3**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**Bore 9 - 1.0**	**Bore 10 - 1.75**	**Bore 11 - 0.75**	**Bore 12 - 1.5**	**Bore 13 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1705388-011**	**EB1705388-012**	**EB1705388-013**	**EB1705388-014**	**EB1705388-015**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**5.4**	**5.0**	**5.6**	**4.9**	**4.7**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**9**	**7**	**10**	**9**	**22**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	**0.04**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.005**	<0.005	**0.005**	<0.005	**0.008**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	**0.02**	<0.02	**0.04**
Net Acidity (acidity units)	----	10	mole H+ / t	**12**	<10	**13**	<10	**27**
Liming Rate	----	1	kg CaCO3/t	<1	<1	**1**	<1	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	**0.02**	<0.02	**0.04**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**12**	<10	**13**	<10	**27**
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	**1**	<1	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**1**	**Bore 14 - 1.75**	**Bore 16 - 0.25**	**Bore 17 - 0.25**	**1.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1705388-016**	**EB1705388-017**	**EB1705388-018**	**EB1705388-019**	**EB1705388-020**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.5**	**4.5**	**6.4**	**4.6**	**4.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**26**	**30**	<2	**33**	**22**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.04**	**0.05**	<0.02	**0.05**	**0.03**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.007**	**0.005**	**0.007**	**0.006**	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	----	<0.02
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	----	----	<0.02
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	----	----	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	----	----	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	----	----	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.05**	**0.05**	<0.02	**0.06**	**0.03**
Net Acidity (acidity units)	----	10	mole H+ / t	**30**	**34**	<10	**36**	**22**
Liming Rate	----	1	kg CaCO3/t	**2**	**2**	<1	**3**	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.05**	**0.05**	<0.02	**0.06**	**0.03**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**30**	**34**	<10	**36**	**22**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	**2**	<1	**3**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**Bore 18 - 0.25**	**Bore 19 - 0.75**	**Bore 20 - 0.25**	**Bore 21 - 1.5**	**3**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1705388-021**	**EB1705388-022**	**EB1705388-023**	**EB1705388-024**	**EB1705388-025**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.8**	**5.2**	**4.6**	**5.2**	**5.2**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**32**	**15**	**27**	**16**	**17**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.05**	**0.02**	**0.04**	**0.02**	**0.03**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.006**	<0.005	**0.005**	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.06**	**0.02**	**0.05**	**0.02**	**0.03**
Net Acidity (acidity units)	----	10	mole H+ / t	**36**	**15**	**31**	**16**	**17**
Liming Rate	----	1	kg CaCO3/t	**3**	**1**	**2**	**1**	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.06**	**0.02**	**0.05**	**0.02**	**0.03**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**36**	**15**	**31**	**16**	**17**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**3**	**1**	**2**	**1**	**1**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**Bore 22 - 0.5**	**1.5**	**Bore 24 - 0.75**	**Bore 25 - 0.5**	**Bore 26 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	CAS Number	LOR	Unit	**EB1705388-026**	**EB1705388-027**	**EB1705388-028**	**EB1705388-029**	**EB1705388-030**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**5.0**	**4.5**	**4.4**	**4.8**	**5.0**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**11**	**28**	**52**	**20**	**21**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.04**	**0.08**	**0.03**	**0.03**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.005**	**0.006**	**0.008**	**0.006**	**0.009**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	<0.02	----	----
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	<0.02	----	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	<0.02	----	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	<10	----	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	<0.02	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.02**	**0.05**	**0.09**	**0.04**	**0.04**
Net Acidity (acidity units)	----	10	mole H+ / t	**14**	**32**	**57**	**23**	**27**
Liming Rate	----	1	kg CaCO3/t	**1**	**2**	**4**	**2**	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.02**	**0.05**	**0.09**	**0.04**	**0.04**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**14**	**32**	**57**	**23**	**27**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**1**	**2**	**4**	**2**	**2**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**Boire 28 - 0.5**	**1.5**	**4**	**Bore 31 - 0.5**	**1.75**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1705388-031**	**EB1705388-032**	**EB1705388-033**	**EB1705388-034**	**EB1705388-035**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.3**	**4.6**	**4.8**	**6.7**	**4.2**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**102**	**26**	**18**	<2	**71**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.16**	**0.04**	**0.03**	<0.02	**0.11**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.010**	**0.005**	**0.006**	**0.008**	**0.005**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	----	----	**1.14**	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	----	----	**227**	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	----	----	**0.36**	----
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	**0.07**
HCl Extractable Sulfur (20Be)	----	0.02	% S	**0.04**	----	----	----	**0.07**
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	----	----	----	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	----	----	----	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.19**	**0.05**	**0.03**	<0.02	**0.12**
Net Acidity (acidity units)	----	10	mole H+ / t	**117**	**29**	**22**	<10	**75**
Liming Rate	----	1	kg CaCO3/t	**9**	**2**	**2**	<1	**6**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.19**	**0.05**	**0.03**	<0.02	**0.12**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**117**	**29**	**22**	<10	**75**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**9**	**2**	**2**	<1	**6**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**Bore 33 - 0.5**	**Bore 34 - 1.25**	**Bore 35 - 1**	**1.75**	**Bore 37 - 2**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1705388-036**	**EB1705388-037**	**EB1705388-038**	**EB1705388-039**	**EB1705388-040**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**6.7**	**4.5**	**4.6**	**4.4**	**4.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	**32**	**25**	**46**	**34**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.05**	**0.04**	**0.07**	**0.05**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.010**	**0.007**	**0.732**	**0.014**	**0.063**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	**456**	<10	**39**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**1.89**	----	----	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**378**	----	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**0.60**	----	----	----	----
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	<0.02	**0.08**
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	----	**0.02**	**0.08**
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	----	<0.02	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	----	<10	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	----	<0.02	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.06**	**0.77**	**0.09**	**0.12**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**36**	**482**	**59**	**75**
Liming Rate	----	1	kg CaCO3/t	<1	**3**	**36**	**4**	**6**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	**0.06**	**0.77**	**0.09**	**0.12**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	**36**	**482**	**59**	**75**
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	**3**	**36**	**4**	**6**

Analytical Results

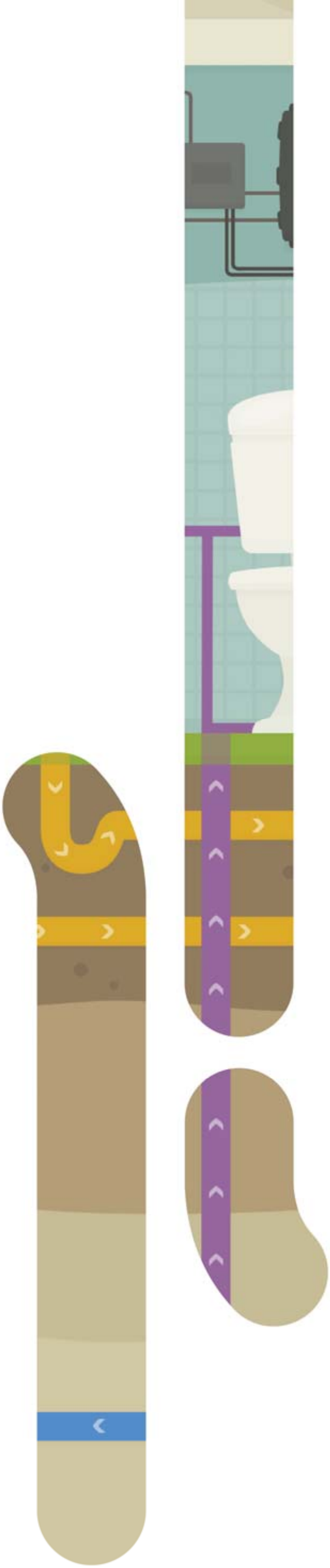
Sub-Matrix: **SOIL** (Matrix: **SOIL)**			*Client sample ID*	**Bore 38 - 0.5**	**Bore 39 - 1**	**Bore 40 - 0.5**	**Bore 41 - 0.5**	**Bore 42 - 0.25**
			Client sampling date / time	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]	[06-Mar-2017]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1705388-041**	**EB1705388-042**	**EB1705388-043**	**EB1705388-044**	**EB1705388-045**
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**5.0**	**4.2**	**4.9**	**4.3**	**4.8**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**15**	**46**	**12**	**64**	**18**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.02**	**0.07**	<0.02	**0.10**	**0.03**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.010**	**0.012**	**0.010**	**0.012**	**0.010**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	<0.02	----
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	<0.02	----	<0.02	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	<10	----	<10	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.04**	**0.08**	**0.03**	**0.11**	**0.04**
Net Acidity (acidity units)	----	10	mole H+ / t	**22**	**54**	**18**	**71**	**25**
Liming Rate	----	1	kg CaCO3/t	**2**	**4**	**1**	**5**	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.04**	**0.08**	**0.03**	**0.11**	**0.04**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**22**	**54**	**18**	**71**	**25**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	**4**	**1**	**5**	**2**

ATTACHMENT 3

Pressure Sewer FAQ

flow
systems

Pressure sewer FAQ



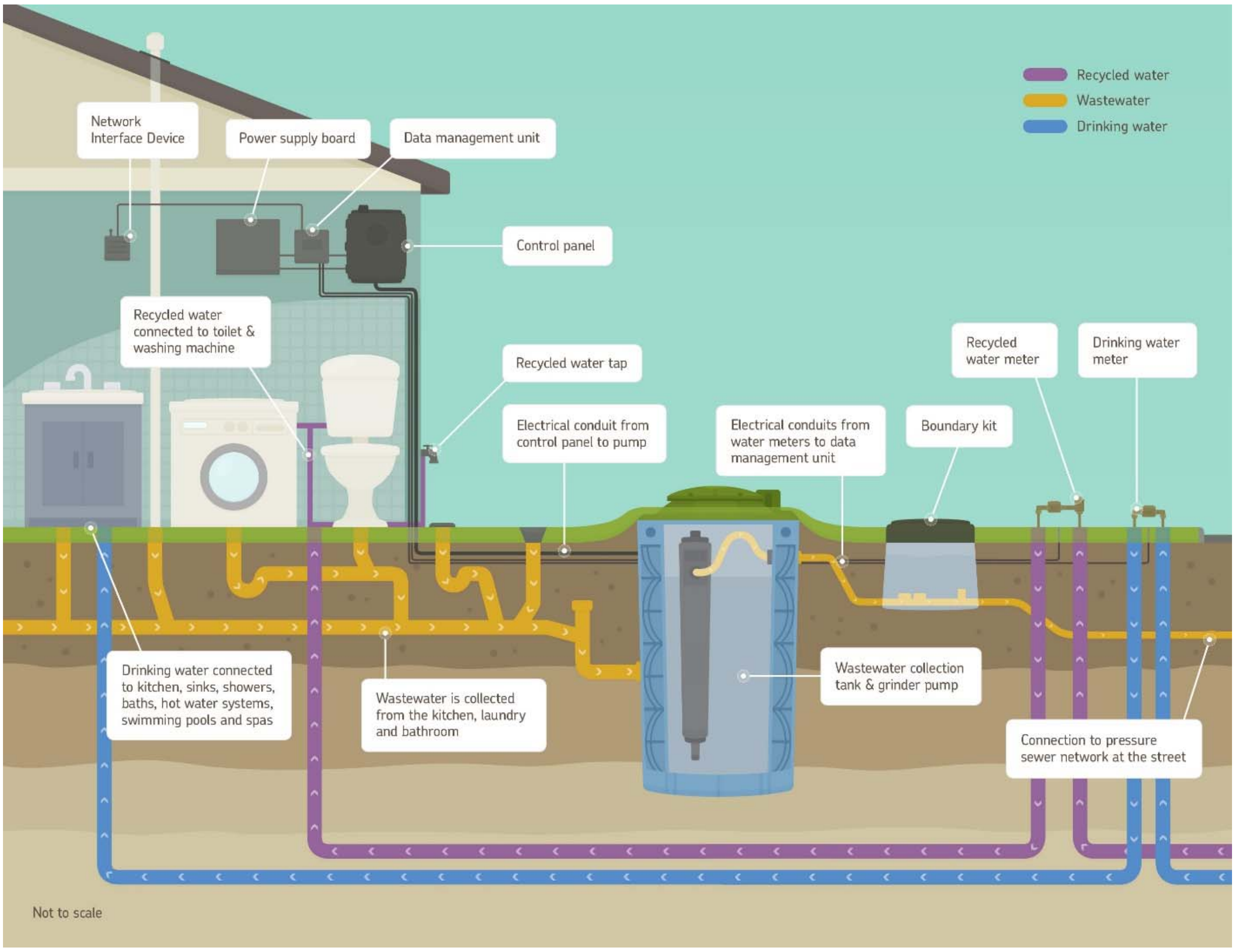
November 2015

Pressure sewer

This document provides information about pressure sewer, which is a central component of the sustainable water network offering from Flow Systems (Flow). There are more than 27,000 properties currently being serviced using pressure sewer in Australia and many more are under construction.

What is pressure sewer?

Pressure sewer is a method of collecting wastewater from households to send it for treatment. It uses proven technology and engineering. The diagram below shows how pressure sewer is linked to homes in relation to other water services. For more information about how pressure sewer works in homes, you can also look at the video available at http://www.inviziq.com/video/index.html by the company that supplies components of the household pressure sewer equipment to Flow Systems.



What are the benefits of a pressure sewer system?

There are many benefits of a pressure sewer system, which can most easily be described in comparison with traditional gravity sewer networks. They include smaller infrastructure impacts, a reliable and tested solution and one that has no discharge into the environment, resulting in a smaller environmental impact.

Environmental benefits

A significant benefit is that there are no wet weather overflows to the environment. This is because a pressure sewer network is a closed, pressurised system and therefore does not attract wet weather inflow. This has many benefits. It results in sewerage networks, pumping stations, storage and treatment facilities that are six to eight times smaller than a traditional centralised gravity sewer network. In addition to a smaller infrastructure footprint, no sewage overflow into the local environment or waterways means no potential to release viruses and pathogens into the environment from the sewer network.

Service benefits

Flow owns and maintains the sewer infrastructure from the point where the home's gravity sewer joins the pressure sewer network at the collection tank. In the instance of faults and emergencies, if a householder is serviced by a public utility, they need to source their own plumber at their own cost. This is an unregulated charge. However, if they are a Flow customer, this service is provided by qualified specialists for a clearly disclosed charge upfront. If the fault is found to be Flow's, even if it is on the customer's property, then Flow covers the cost.

Infrastructure benefits

A pressure sewer networks requires much smaller infrastructure than a traditional gravity sewer and because it doesn't have to be laid to grade like a gravity sewer, it can be laid at shallower depths. Access chambers and pump stations that typically make up part of the gravity sewer network are not required and pre-fabricated wastewater collection tanks with proprietary pumps can be easily installed. Because of this, pressure sewer is suited to difficult ground conditions, such as rock and high water tables.

Construction is faster and has less impact.

Smaller infrastructure also means it is more easily repaired in the instance of a fault or emergency.

The Local Water Centre, the part of the network where wastewater is treated, is also smaller and low impact due to the elimination of wet weather inflow.

Pressure sewer is a well-established alternative to gravity sewer and uses proven, reliable technology and engineering.

Water efficiency benefits

Sustainable management of water resources is at the heart of Flow's offering. Pressure sewer is a central element to the solution that Flow provides. Residents in neighbourhoods serviced by Flow have a dual water supply – drinking water, sourced from the incumbent public water utility, and a recycled water supply for flushing toilets, irrigation and to use in the cold water inlet of washing machines. It is the smaller footprint of the local water centre, made possible by the pressure sewer, that makes the provision of recycled water technically feasible and economically viable within new communities. In addition to its environmental benefits, the dual water supply makes communities highly water efficient, creating a more secure water supply, extending the life of water infrastructure to the existing community and reducing the increase in demand for potable water supplies.

How is it different to traditional sewer infrastructure?

Traditional sewer infrastructure in Australia is transported by gravity. The engineering of a gravity sewer network means it is inherently open to groundwater and stormwater, which dramatically increases the volume of water and types of waste the network needs to be able to accommodate. Another feature of gravity sewer networks is that they discharge untreated sewage into the environment if the network overflows with additional wet weather inflow. These overflows are uncontrolled and concentrated. And because gravity sewer networks have to manage the water from rainfall and stormwater, as well as wastewater, treatment facilities have to be much larger, creating a greater impact on the community and environment. Pumping stations are also required to transport wastewater to centralised treatment facilities in a centralised gravity sewer network.

How does a pressure sewer network link to incumbent public water utilities?

Flow provides a decentralised wastewater solution, which means it does not need to link to a public utility's network to transport wastewater to another community for treatment. However, Flow sometimes has a commercial agreement in place with the incumbent public water utility to discharge wastewater to their trunk main as a contingency or as an interim arrangement while a community is being built and new houses being connected to the network.

Given that the piping systems are under pressure, does that mean that they can leak wastewater or water into the soil?

It is universal industry practice to use pressure pipes to supply water and the same principles apply for pressure sewer. Flow meets industry standards in the design and installation of pipes to prevent leaking. For pressure sewer we use industry standard thick-walled high density polyethylene (HDPE) pipes and fusion welded joints. This method means leaks are less likely than in traditional gravity sewer systems which are typically joined with rubber seals, which can deteriorate over time and attract tree roots.

How long does your piping last?

Our water and wastewater networks, including the pipes, are designed and constructed to Australian Standards and design guidelines published by the Water Services Association of Australia (WSAA), the peak industry body for the Australian urban water sector.

The pipes we use for pressure sewer are made from HDPE as specified by WSAA. This material is widely used throughout Australia and by public water authorities.

These pipes are designed to have the same life expectancy as a typical domestic building, which is 50 years. Experience in Europe has shown that buried PVC pressure pipes (a comparable pipe we use for our water network) dug up after 60 years of active use were proven to be fit for purpose when analysed and likely to have a further life expectancy of 50 years.

How does your local water network manage flooding? What contingency planning do you have in the event of flooding?

Flow's water network, including its wastewater collection, is a closed, pressurised system and can continue to operate under minor flood conditions. Using a pressure sewer system means stormwater does not flow into our pipes, as it can do when a flood-prone area is serviced by a traditional gravity sewer. Pressure sewer pipes are not affected by groundwater infiltration, which is the primary reason that traditional sewer networks overflow and pollute the environment.

How long does it take to fix problems?

Our monitoring of the system allows us to see if we have a major leak or any unusual flow patterns. We employ local contractors to help maintain the system who are on call just down the road.

ATTACHMENT 4

Eastern Curlew Impact Management Plan

EASTERN CURLEW IMPACT MANAGEMENT PLAN

SHORELINE REDLANDS

Prepared for
Shoreline Redlands Pty Ltd

Biodiversity Assessment and Management Pty Ltd
PO Box 1376
CLEVELAND 4163

Specialised ecological knowledge that reduces your risk

Document Control Sheet

File Number: 0345-004

Project Manager/s: Adrian Caneris

Client: Shoreline Redlands

Project Title: Eastern Curlew Impact Management Plan

Project Author/s: Dr Jo Chambers, Adrian Caneris and Dr Penn Lloyd

Project Summary: Identify potential impacts to Eastern Curlew and other migratory shorebirds as a result of the Shoreline Urban Village Development, and provide management strategies to avoid or mitigate significant impacts.

Draft Preparation History:

Draft No.	Date draft completed	Reviewed by	Issued by
0345-004 Draft A	22/05/2017	Dr Penn Lloyd and Jedd Appleton	Dr Jo Chambers
0345-004 Draft B	25/5/2017		Dr Jo Chambers

Revision/ Checking History Track:

Version	Date of Issue	Checked by	Issued by
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Destination	Revision							
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PDF – backup – archived Disk/tape	A	22/05/2017	B	25/5/2017	0	05/6/2017	1	20/6/2017
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Purpose of Report

Biodiversity Assessment and Management Pty Ltd has produced this report in its capacity as {consultants} for and on the request of Shoreline Redlands (the "Client") for the sole purpose of identifying potential impacts to Eastern Curlew and other migratory shorebirds as a result of the Shoreline Urban Village Development, and providing management strategies to avoid or mitigate significant impacts (the "Specified Purpose"). This information and any recommendations in this report are particular to the Specified Purpose and are based on facts, matters and circumstances particular to the subject matter of the report and the Specified Purpose at the time of production. This report is not to be used, nor is it suitable, for any purpose other than the Specified Purpose. Biodiversity Assessment and Management Pty Ltd disclaims all liability for any loss and/or damage whatsoever arising either directly or indirectly as a result of any application, use or reliance upon the report for any purpose other than the Specified Purpose.

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Signed on behalf of
Biodiversity Assessment and Management Pty Ltd

Date: 20 June, 2017

Managing Director

EXECUTIVE SUMMARY

Environmental Outcomes

The objectives of this Eastern Curlew Impact Management Plan (ECIMP) are to ensure no significant direct or indirect impacts to Eastern Curlew *Numenius madagascariensis* and other migratory shorebirds or their habitats occur as a result of the Shoreline urban village development, Redland Bay, Queensland (the development).

Potential Impacts

As there will be no development within foraging or potential roosting habitats for Eastern Curlew and other migratory shorebirds within the adjacent Moreton Bay, there will be no direct impacts on these habitats. However, the development has potential to cause indirect impacts to Eastern Curlew and other migratory shorebirds, which can be broadly grouped into two categories:

1. Physical disturbance causing flight response, which could be the result of humans, dogs or boats traversing low-tide feeding habitats or traversing areas in line of sight of feeding shorebirds, increased boat traffic or increased noise and light spillage.
2. Reduction in food resources within the adjacent Moreton Bay, caused by increased runoff of pollutants, increased sedimentation and increased freshwater inundation entering potential shorebird habitats.

Management Measures

The existing band of mangrove vegetation which ranges in width from approximately 30 m to 120 m, provides an effective barrier to potential human and/or dog, disturbances to Eastern Curlew and other migratory shorebirds whilst foraging, due to the dense growth form of mangroves and associated ground cover of pneumatophores growing in soft mud. This band of mangrove vegetation, which will assist in minimising noise and light disturbances for foraging birds will be retained, protected and managed as part of the proposed development.

Community education, including educational signage along the foreshore, will be used to ensure physical disturbances from humans and/or dogs do not increase as a result of the proposed development. Advice from DoEE will be sought when compiling the community education package to ensure that this mitigation strategy achieves the objectives of this plan.

Foreshore walkways will be lit by bollard style lighting. Any other lighting required for safety purposes will be directional away from Moreton Bay.

Modelling results (Design Flow 2017) indicate that the proposed treatment and control of storm water runoff from the proposed development will result in an improvement in water quality entering Moreton Bay.

Monitoring

Targeted shorebird surveys will be undertaken on a yearly basis during the construction period and thereafter until 65% of development on the eastern side of Serpentine Creek Road is occupied and the Foreshore Open Space area is developed, to monitor the numbers of shorebirds using the adjacent habitats at low tide and any real or potential sources of disturbance observed and the response of the birds to these disturbance sources. Monitoring surveys will also include inspections of mangrove habitats, including stormwater outlet locations for signs of weed incursions, erosion, plant die-back and human/dog disturbances, (e.g. footprints, refuse) excluding disturbances as a result of ongoing RCC mosquito control. A monitoring report will be prepared at the end of each monitoring period, noting any significant changes in measured variables, trends and conditions to ensure alignment with DoEE reporting requirements.

As part of the community education program, community members will also be encouraged to report to the Project Manager any observed disturbances to migratory shorebirds or human/dogs traversing migratory shorebird foraging habitats.

Water quality entering Moreton Bay that could potentially impact on Eastern Curlew foraging habitats will be managed and monitor in accordance with the Hydrological and Water Quality Management report (Design Flow 2017).

Performance and Completion Criteria

- Eastern Curlew and other migratory shorebird species are at densities that reflect baseline densities (BAAM 2016) in the adjacent feeding habitats, accounting for a background decline in shorebird populations relating to ongoing habitat loss at key stop-over sites in Asia.
- There is no reporting or other evidence of weed intrusions or mangrove vegetation die-back recorded in areas adjacent to migratory shorebird foraging habitats during construction and for five years following total occupation of the proposed development.
- There is no reporting or other evidence of human and/or dog disturbance of foraging Eastern Curlew or other migratory shorebirds during construction and for five years following total occupation of the proposed development.
- There is no evidence of human/dogs traversing migratory shorebird foraging habitats during construction and for five years following total occupation of the proposed development.
- There is no reporting or other evidence of increased light or noise disturbance to foraging migratory shorebirds during construction and for five years following total occupation of the proposed development.
- There is no reporting or other evidence of recreational activities causing sudden loud noises within the foreshore open space area during construction and for five years following total occupation of the proposed development.
- Water quality objectives (Design Flow 2017) and Acid Sulfate Soil objective (Douglas Partners 2017) have been met during construction and operation.

Corrective Measures

If the Project Manager is alerted to any incidence of shorebird disturbance, or targeted shorebird monitoring surveys detect significant changes in Eastern Curlew numbers and/or human or dog disturbance to foraging shorebirds, these incidences will be investigated within 48 hours of being reported and actions to rectify any breaches of mitigation measures or mangrove vegetation buffer habitats will be commenced within seven days of the initial report. If considered necessary, DoEE will be contacted to request guidance on additional measures required to rectify/eliminate disturbances.

Corrective actions for water quality and potential acid sulfate have been provided in (Design Flow 2017 & Douglas Partners 2017 respectively).

Auditing

A suitably experienced, independent ecologist will be engaged to inspect each staged development area adjacent to the foreshore to ensure mitigation measures have been implemented. Audits of the Project Manager's incidence reports and the yearly targeted shorebird survey reports will be undertaken on a yearly bases to ensure the mitigation measures and any necessary corrective actions specified within this ECIMP have been undertaken to ensure the objectives of this ECIMP have been achieved.

The need for additional audits will be triggered if any breaches in the mitigation measures have been recorded.

Auditing schedules for water quality and potential acid sulfate soils have been provided in (Design Flow 2017 & Douglas Partners 2017 respectively).

EASTERN CURLEW IMPACT MANAGEMENT PLAN
SHORELINE REDLANDS

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Table of Terms and Abbreviations

BAAM	Biodiversity Assessment and Management Pty Ltd
DoEE	Commonwealth Department of the Environment and Energy
ECMP	Eastern Curlew Impact Management Plan
EPBC	Environmental Protection and Biodiversity Conservation

Appendices

1.0 INTRODUCTION

This Eastern Curlew *Numenius madagascariensis* Impact Management Plan (the Plan) has been prepared for Shoreline Redlands Pty Ltd to ensure that all potential impacts to the local Eastern Curlew population and other migratory shorebirds known to feed in small numbers within the Moreton Bay Ramsar wetland immediately adjacent to the Shoreline urban village development, Redland Bay, Queensland (the development) are appropriately identified and managed.

The objectives of the plan are to ensure no significant direct or indirect impacts to Eastern Curlew and other migratory shorebirds or their habitats occur as a result of the development.

The compilation of this Plan addresses the Commonwealth Department of the Environment and Energy (DoEE) request for further information for preliminary documentation for the Shoreline urban village development (EPBC Ref 2016/7776, Items 3, 4 and 7).

2.0 BACKGROUND

2.1 THE DEVELOPMENT

The Shoreline development will include approximately 3800 new residences, a town centre, school, recreational and sporting facilities, restaurants, 22 ha of foreshore parkland and over 20 ha of rehabilitated flora and fauna habitats.

No development is proposed within or below the highest astronomical tide level (HAT); therefore, there will be no direct disturbance to Eastern Curlew or other migratory shorebird habitats (**Appendix 1**).

The closest built form to potential shorebird habitats is a pedestrian walkway, which is generally 100 – 150 m away from potential foraging habitats.

2.2 MORETON BAY

The Shoreline development area is adjacent to Moreton Bay, which is recognised as important habitat for migratory shorebirds, including Bar-tailed Godwit *Limosa lapponica*, Whimbrel *Numenius phaeopus* and Eastern Curlew, three of the four migratory shorebird species recorded from areas adjacent to the development (Bamford *et al*. 2008).

Moreton Bay is listed as a wetland of international importance under the Ramsar Convention on Wetlands 1971. General principles for the management of wetlands of international importance are outlined under Schedule 6 of the *Environment Protection and Biodiversity Conservation Regulations 2000*, these being:

1.01 *The primary purpose of management of a declared Ramsar wetland must be, in accordance with the Ramsar Convention:*
  - *(a) to describe and maintain the ecological character of the wetland; and*
  - *(b) to formulate and implement planning that promotes:*
    - *(i) conservation of the wetland; and*
    - *(ii) wise and sustainable use of the wetland for the benefit of humanity in a way that is compatible with maintenance of the natural properties of the ecosystem.*

1.02 *Wetland management should provide for public consultation on decisions and actions that may have a significant impact on the wetland.*

1.03 *Wetland management should make special provision, if appropriate, for the involvement of people who:*
  - *(a) have a particular interest in the wetland; and*
  - *(b) may be affected by the management of the wetland.*

1.04 *Wetland management should provide for continuing community and technical input.*

2.3 SHOREBIRD OCCURRENCE

Detailed migratory shorebird surveys were conducted between December 2015 and January 2016 within the portion of Moreton Bay immediately adjacent to the development site (study area) (BAAM 2016). Four low-tide and four high-tide surveys were completed during that time in accordance with *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DoE 2015).

The results of the targeted high-tide surveys showed that no Eastern Curlew or other migratory shorebirds were using habitats within the study area as roosting sites.

The low-tide mudflats adjacent to the development, which provide potential foraging habitats for Eastern Curlew and other shorebirds cover an area of approximately 150 ha. The maximum number of Eastern Curlew recorded during the four low-tide surveys was 7 with the total maximum number of the three other migratory shorebirds recorded (Bar-tailed Godwit *Limosa lapponica,* Whimbrel *Numenius phaeopus* and Common Greenshank *Tringa nebularia*) being 62 (BAAM 2016).

During the targeted shorebird surveys all shorebirds were randomly scattered across the entire 150 ha area, with no single location being more regularly utilised than others. Based on this result it is estimated that Eastern Curlew foraging densities adjacent to the development is 1 bird/ 21 ha, with total migratory shorebird densities estimated to be 1 shorebird/ 2 ha. In comparison to shorebird surveys conducted in other areas of Moreton Bay (e.g. Finn (2010)) the densities of Eastern Curlew and other migratory shorebirds near the development area is quite low, suggesting foraging habitats adjacent to the development are of low quality.

The surveys also indicated the development area does not support roosting habitats. The closest known Eastern Curlew and other shorebird roosting area to the development is Point Halloran; approximately 9 km north of the development area.

2.4 EASTERN CURLEW PROFILE

Ecology and Habitat: Eastern Curlews occur on sheltered coasts, especially estuaries, harbours and coastal lagoons, and are often recorded in saltmarsh and on mudflats within mangroves. They mainly forage on intertidal mudflats and sandflats and occasionally ocean beaches, and roost on sandy spits and islets, claypans and saltmarsh, and along the high water mark on beaches (Higgins and Davies 1996). The species is usually located while feeding individually or in small groups. However, large numbers may congregate at high tide roosts (Lane 1987).

Distribution and Breeding: The Eastern Curlew breeds in eastern Siberia during the northern hemisphere summer. Adults vacate breeding areas around June and migrate through Asia on their way to Australia and New Zealand. They arrive in north-eastern Australia as early as late July, but most arrive in eastern Australia by late August and September. It was estimated that Moreton Bay once supported 5,000 Eastern Curlew during austral summer months (Driscoll 1997); however, more recent research indicates that the population of Eastern Curlew in Moreton Bay is declining, as it is worldwide (Wilson et al. 2011).

By October, birds have moved as far south as Victoria and Tasmania (Ueta *et al.* 2002). Birds begin to depart to return to breeding grounds around March and April (Lane 1987).

However, approximately 25% of the local population, made up mainly of juvenile birds, remains in south-east Queensland during the breeding season (Driscoll and Ueta 2002).

Within Australia, Eastern Curlews occur in suitable habitat on all coasts (Higgins and Davies 1996). The closest known Eastern Curlew and other shorebird roosting area to the development is Point Halloran, approximately 9 km north of the development area.

Research into habitat selection and foraging ecology of Eastern Curlew conducted at Moreton Bay showed that substrate resistance was a strong indicator of habitat selection, with intertidal flats with deep sand deposits being the substrate preferred by feeding Eastern Curlew (Finn 2009). This research also showed that Eastern Curlew strongly preferred to feed relatively close (0-50 m) to the moving low water line (Finn 2009).

Eastern Curlew have been shown to initiate flight response to disturbance (referred to as FID – flight-initiation distance) at greater distances than other shorebirds (Smit and Visser 1993; Paton *et al*. 2005; Glover *et al.* 2011), with larger body mass being interpreted as the factor influencing their sensitivity to disturbance. A study of shorebird FID conducted at Victoria, Australia showed the mean FID for Eastern Curlew was 126 m (Glover *et al*. 2011).

3.0 EXISTING THREATS AND IMPACTS

For the past 50 years or more, much of the development area has been previously cleared for agricultural activities, including a plant nursery and vegetable/crop farming.

Existing potential threats to Eastern Curlew and other migratory shorebirds from current and past land uses include:

- Humans and dogs disturbing feeding birds.
- Untreated stormwater runoff into Moreton Bay, which may contain excess levels of fertilizers, herbicides and pesticides, as well as sedimentation. Stormwater runoff could impact on food resources for Eastern Curlew and other migratory shorebirds (benthic invertebrates).
- Nosie disturbance to feeding Eastern Curlew and other migratory shorebirds from farm machinery.
- Construction of dams, which change natural hydrological flows that could impact on Eastern Curlew and other migratory shorebirds' food resources.
- Invasive pests encroaching into mangrove vegetation causing impacts to overall ecological values of these areas.
- Clearing of mangrove vegetation for infrastructure and boat access (Google aerial imagery shows a number of boat launch points in close proximity to the development).
- Recreational and commercial marine traffic.

These existing threats, with the exception of marine traffic, will be eliminated or appropriately mitigated as part of the development (refer **Section 5.0**).

4.0 POTENTIAL IMPACTS FROM THE DEVELOPMENT

As there will be no development within foraging or potential roosting habitats for Eastern Curlew and other migratory shorebirds, there will be no direct impacts on these habitats. However, the development has potential to cause indirect impacts to Eastern Curlew and other migratory shorebirds, which can be broadly grouped into two categories:

1. Potential Physical Disturbance causing Flight Response

Any form of disturbance that causes a bird to take flight can lead to a decrease in energy uptake and an increase in energy expenditure, which can lead to an overall reduction in health and fitness, dependent on the frequency and duration of disturbance. Increased disturbances as a result of the development could potentially cause additional pressures on shorebird populations that are already showing signs of population decline.

Potential physical disturbances from the development could be the result of:

I. Humans and/or dogs traversing low-tide feeding habitats.
II. Humans and/or dogs traversing areas in line of sight of feeding shorebirds.
III. Increased boat traffic adjacent to feeding areas.
IV. Increased noise and light spillage.

2. Potential Reduction in Food Resources

Any impacts to water quality within Moreton Bay can cause impacts to essential food resources (benthic invertebrates) for Eastern Curlew and other migratory shorebirds.

Potential impacts to food resources as a result of the development could be caused by:

- Increased runoff of potentially toxic pollutants entering Moreton Bay;
- Increased sedimentation causing smothering of feeding grounds;
- Increased freshwater inundation impacting on the health of benthic invertebrates.

5.0 MANAGEMENT MEASURES

1. Physical Disturbance causing Flight Response

i. Humans and/or dogs traversing low-tide feeding habitats

During the targeted shorebird surveys (BAAM 2016) the only potential disturbance as a result of human and/or dog traffic could occur along a narrow and relatively small sandy beach located approximately 300 m north of the development (refer **Figure 5.1**). People walking dogs were occasionally observed walking along this narrow beach.

A band of mangrove vegetation ranging in width from approximately 30 m at its narrowest point to approximately 120 m at its widest cover will be retained, protected and managed to separate the development area from Eastern Curlew low-tide feeding habitats (**Figure 5.2**). This band of mangrove vegetation would form an effective barrier to human and dog traffic accessing low-tide Eastern Curlew habitats due to the dense growth form of mangroves and associated ground cover of pneumatophores (**Photos 1 & 2**).

The mudflats associated with the mangrove vegetation consist of very soft mud, which will restrict people from entering or traversing these zones. No persons or dogs were observed traversing the low-tide mudflats during the targeted surveys.

The proposed development includes foreshore open space ranging in width from approximately 35 m at its narrowest point to approximately 300 m at its widest point. A pedestrian walkway will be established throughout much of the foreshore open space area, adjacent to, but not within, the existing mangrove vegetation (refer **Appendix 1**). The closest point of the proposed walkway to shorebird foraging habitats is approximately 45 m; therefore there will be a low to medium level of risk of disturbance to Eastern Curlew foraging at this closest point.

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Photo 1 shows broad band of mangrove vegetation separating Eastern Curlew habitats from the development.

Photo 2 shows dense growth form of mangrove vegetation.

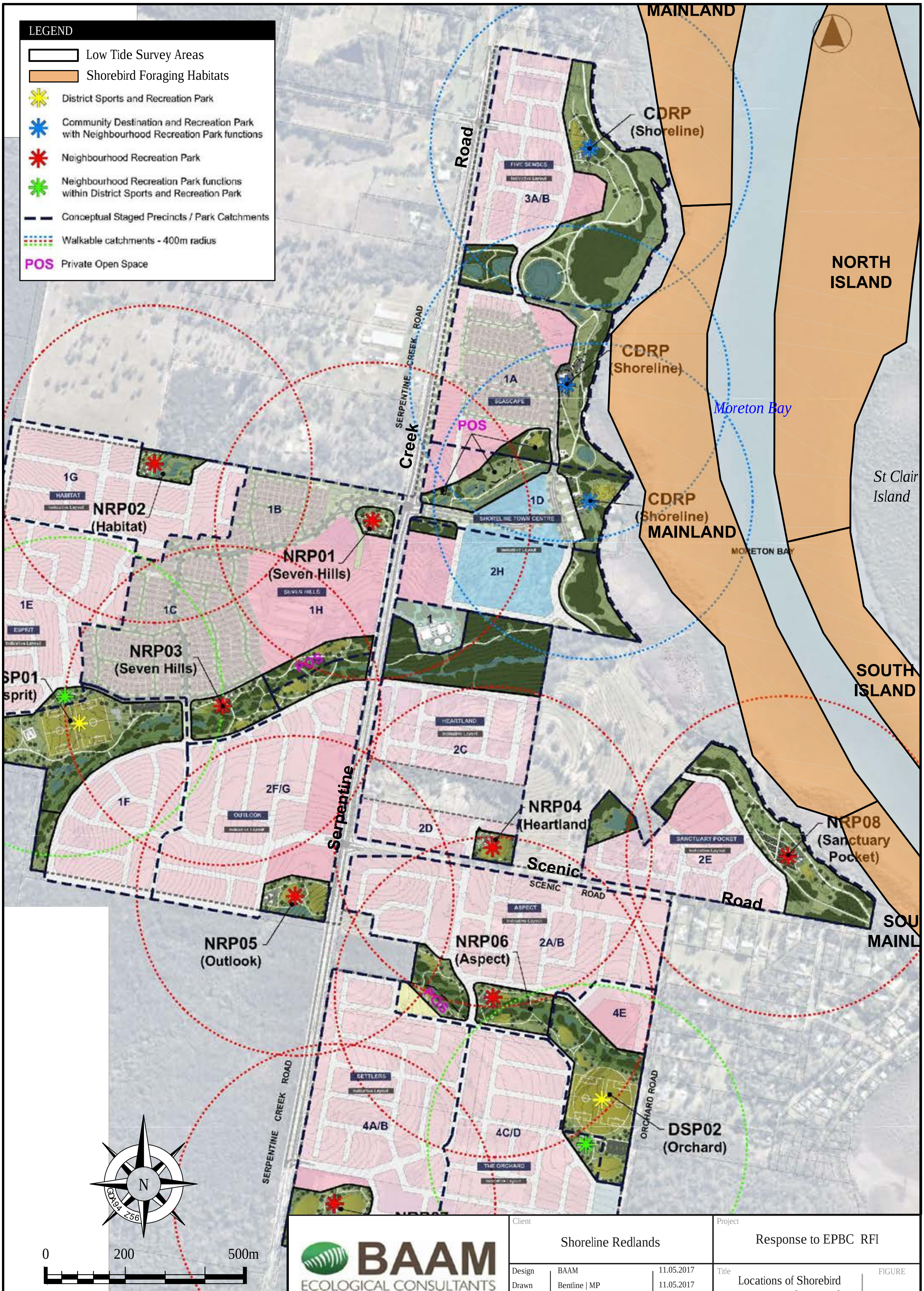
BAAM ECOLOGICAL CONSULTANTS

Client	Shoreline Redlands		
Design	BAAM	5.06.2017	
Drawn	Bentline | MP	5.06.2017	
Scale	1:20,000	Job # 0345-004	
Cad File	BAAM_SFS008.dwg	Rev 1.0	

Project
Eastern Curlew Impact Management Plan

Title
Area of Potential Haman/Dog disturbance

ATTACHMENT
5.1



BAAM
ECOLOGICAL CONSULTANTS

Client
Shoreline Redlands

Project
Response to EPBC RFI

Design	BAAM	11.05.2017
Drawn	Bentline | MP	11.05.2017
Scale	See Scale Bar	Job # 0345-004
Cad File	BAAM_SFS009.dwg	Rev 1.0

Title
Locations of Shorebird Foraging Habitats and Shoreline Development

FIGURE
5.2

Three community destinations and recreational parks and one neighbourhood recreational park are proposed within this foreshore open space area (refer **Appendix 1**). The closest of these recreational parks to shorebird foraging habitats is approximately 70m

If an intrepid walker or dog did manage to traverse through the band of mangroves to access Eastern Curlew feeding habitats, the very soft mud substrate would effectively restrict further movements.

It is therefore considered that the risk of humans and/or dogs entering Eastern Curlew feeding habitats would be low.

Mitigation Measures

During Construction

As part of the induction process for site construction, it will be the responsibility of the Project Manager (refer **Section 6.2**) to advise all contractors that bringing dogs into the development area is prohibited during construction and that no contractor/employee is to traverse the mangrove lined intertidal area.

Regardless of the low risk of threat, a community education program will be developed prior to the occupation stage, which includes educational signage erected at strategic locations along the formed walkway running adjacent to the band of mangroves.

The community education program will inform residents/visitors of the presence of Eastern Curlew and other migratory shorebirds and the impacts caused by disturbance to feeding birds. It is proposed that the education program will be prepared in leaflet form to be provided to all new and prospective property buyers at time of purchase/inspection. It will be the Principal’s responsibility (refer **Section 7/1**) to ensure that all local real estate agents and the Shoreline Redlands website http://shorelineredlands.com.au/ display this leaflet.

Advice from DoEE will be sought when compiling the community education package to ensure that this mitigation strategy achieves the objectives of this plan. Research has shown that community education can play a significant role in decreasing physical disturbance threats to migratory shorebirds (Burger *et al*. 2005).

Corrective Actions

If the Project Manager is alerted to any incidence of shorebird disturbance, or targeted shorebird monitoring surveys detect significant changes in Eastern Curlew numbers and/or human or dog disturbance to foraging shorebirds, these incidences will be investigated within 48 hours of being reported and actions to rectify any breaches of mitigation measures or mangrove vegetation buffer habitats will be commenced within seven days of the initial report. If considered necessary, DoEE will be contacted to request guidance on additional measures required to rectify/eliminate disturbances.

ii. Humans and/or dogs traversing areas in line of sight of feeding shorebirds

Mangrove vegetation ranging in width from approximately 30 m to approximately 120 m separates shorebird foraging habitats from the proposed active open space within the Shoreline foreshore open space area; therefore, there is minimal risk that humans and dogs traversing the proposed walkway would be sighted by (and disturb) foraging shorebirds.

The soft muddy substrate of shorebird foraging habitats adjacent to the proposed development area is expected to create an effective barrier to human or dog intrusions into foraging habitats; therefore, there is minimal risk that humans or dogs would traverse foraging habitats.

It is expected that the mitigation measures, performance and completion criteria and corrective actions proposed to address the impact of humans and/or dogs traversing low-tide feeding habitats (above) would also be sufficient in managing the impact of humans and/or dogs traversing areas in line of sight of feeding shorebirds.

iii. Increased boat traffic

At low tide, areas adjacent to the development are too shallow to allow boat traffic. The distance between Eastern Curlew feeding habitats and potential boat traffic ranges from approximately100 m at the narrowest point to approximately250 m at the widest point (refer **Figure 5.2**). The mean FID response for Eastern Curlew has been shown to be 126 m (Glover *et al*. 2011); therefore there is a low risk that increased boat traffic could disturb foraging Eastern Curlew.

Figure 5.2 shows the narrow, deep-water channel that separates Eastern Curlew feeding habitats adjacent to the development from feeding habitats adjacent to Pannikin Island.

During the targeted shorebird surveys (BAAM 2016), recreational 'crabbers' were observed using this channel on two occasions at high tide only. It is expected that this channel would be too shallow for boat traffic during low tide. The proposed development does not include construction of a boat ramp within the development area; therefore it is considered that the proposed development will not cause an increase in boat traffic at this location.

As there are no Eastern Curlew or other migratory shorebirds using the development area or adjacent Pannikin Island as a roost site, it is concluded that the proposed development will not cause any significant impacts on roosting Eastern Curlew or other migratory shorebirds.

As there are no plans to construct a boat ramp within the development area as part of the proposed development, it is considered that there will be no significant increase in boat traffic that could cause significant impacts to foraging Eastern Curlew or other shorebirds.

Based on the low risk of potential impacts to roosting and foraging shorebirds as a result of increased boat traffic, it is considered that specific mitigation measures for this potential risk are not required.

iv. Increased Noise and Light

A band of mangrove vegetation ranging in width from approximately 30 m at its narrowest point to approximately 120 m at its widest cover will be retained, protected and managed to separate the development area from Eastern Curlew low-tide feeding habitats (**Figure 5.2**). This band of mangrove vegetation would form an effective barrier to noise and light disturbances to Eastern Curlew and other migratory shorebirds due to the dense growth form of mangroves (**Photos 1 & 2**).

The proposed development includes foreshore open space that is generally 100 m wide, but ranges in width from approximately 35 m at its narrowest point, to approximately 300 m at its widest point. A pedestrian walkway will be established throughout much of the foreshore open space area, adjacent to, but not within, the existing mangrove vegetation (refer **Appendix 1**). The closest point of the proposed walkway to shorebird foraging habitats is approximately 45 m.

Three community destinations and recreational parks and one neighbourhood recreational park are proposed within this foreshore open space area (refer **Appendix 2**). The closest of these recreational parks to shorebird foraging habitats and, therefore, the closest potential threat of noise and light disturbance from recreational activities is approximately70m.

<u>Mitigation Measures</u>

The retention, protection and ongoing management of retained intertidal vegetation will assist in minimising the threat of noise/light pollution disturbing foraging shorebirds.

Prior to occupation educational signage will be erected at strategic locations (to be determined in consultation with developers and DoEE on completion of final designs) along the pedestrian walkway and. Educational material will advise residents/visitors of the nearby presence of shorebirds and the threat that increased or sudden loud noises can disturb foraging shorebirds. Signage will be erected prior to occupation.

Any public events within the foreshore open space area will require authorised permits from RCC. Permits will have controls on noise levels for any events.

The walkway will be lit by bollard style 'smart' lighting. Any other lighting required for safety purposes will be directional away from Moreton Bay.

<u>Corrective Actions</u>

If the Project Manager is alerted to any incidence of shorebird disturbance as a result of light or noise, or targeted shorebird monitoring surveys detect significant changes in Eastern Curlew numbers and/or human or dog disturbance to foraging shorebirds, these incidences will be investigated within 48 hours of being reported and actions to rectify any breaches of mitigation measures or mangrove vegetation buffer habitats will be commenced within seven days of the initial report. If considered necessary, DoEE will be contacted to request guidance on additional measures required to rectify/eliminate disturbances.

2. Reduction in Food Resources

Baseline water quality testing and MUSIC modelling (DesignFlow 2017) determined that with the proposed mitigation measures, water quality entering Moreton Bay will be improved as a result of the proposed development.

A Water Quality Management Plan (Design Flow) details the management measures, corrective actions and performance criteria to ensure that changes in water quality as a result of the development will not impact on Eastern Curlew or other shorebird foraging habitats

It is therefore considered that storm water runoff will not have any significant impacts on shorebird foraging habitats.

6.0 MONITORING

Four low-tide targeted shorebird surveys, undertaken in accordance with DoEE (2015) guidelines will be undertaken on a yearly basis during the construction period, including one survey in late September (during inward migration) and three over the period November-January when peak numbers of migratory shorebirds are present in Moreton Bay. Each survey will be conducted within the four-hour period either side of low tide. Data collected during the surveys will include the numbers of shorebirds using the area at low tide and any real or potential sources of disturbance observed and the response of the birds to these disturbance sources.

Monitoring surveys will also include inspections of mangrove habitats, including stormwater outlet sites for signs of weed incursions, plant die-back, erosion and human/dog disturbances (e.g. footprints, refuse).

Yearly surveys will continue until 65% of the development is occupied within areas east of Serpentine Creek Road and the Foreshore Open Space Area is developed.

Wherever practical, dependent on tide times, surveys will be conducted at times of peak use of the Foreshore Area.

A monitoring report will be prepared at the end of each monitoring period, noting any significant changes in measured variables, trends and conditions to ensure alignment with DoEE reporting requirements. The report will include tabulated data (migratory shorebird census and feeding habitat quality, records of disturbances, vegetation health and stormwater outlet site stability) from all monitoring events to allow assessment of trends. A copy of the yearly report will be provided to DoEE.

As part of the community education program, community members will also be encouraged to report to the Project Manager any observed disturbances to migratory shorebirds or human/dogs traversing migratory shorebird foraging habitats.

<u>Performance / Completion Criteria</u>

- Eastern Curlew and other migratory shorebird species are at densities that reflect baseline densities (BAAM 2016) in the adjacent feeding habitats, accounting for a background decline in shorebird populations relating to ongoing habitat loss at key stop-over sites in Asia.
- There is no reporting or other evidence of weed intrusions or mangrove vegetation die-back recorded in areas adjacent to migratory shorebird foraging habitats during construction and for five years following total occupation of the proposed development.
- There is no reporting or other evidence of increased light or noise disturbance to foraging migratory shorebirds during construction and for five years following total occupation of the proposed development.
- There is no reporting or other evidence of recreational activities causing sudden loud noises within the foreshore open space area during construction and for five years following total occupation of the proposed development.

7.0 MANAGEMENT RESPONSIBILITIES

7.1 SHORELINE REDLANDS (PRINCIPAL)

The roles and general responsibilities of the Principal are to:

- Comply with the Eastern Curlew Impact Management Plan (ECIMP);
- Comply with the *Nature Conservation Act 1992;*
- Develop a community education program;
- Nominate a Project Manager who will represent the Principal in reviewing the performance of contractors, issue instructions and variations, and be responsible for ECMP implementation; and
- Promptly notify the DoEE of any changes to this ECMP and its implementation, reporting or monitoring, and any breach of Administrating Authority conditions and proposed corrective action.

It will be the responsibility of the Principal to ensure that the contents of the ECMP are adequately communicated to all contractors, residents and visitors and that they are advised of the seriousness of potential impacts if the recommended actions are not observed.

7.2 PROJECT MANAGER

This Eastern Curlew Impact Management Plan (ECMP) will be overseen by the Project Manager.

The Project Manager is responsible for:

- Implementation of the ECMP to ensure the minimisation of environmental impact from the project;
- Ensuring the mitigation measures detailed in this ECMP, including the community education program, are implemented;
- Ensuring a review of this ECMP is undertaken in year 3 in the first instance and then at intervals of not less than five years or sooner if required. Any significant or unexpected alteration in the proposed development may require the ECMP to be revised and amended accordingly. Any changes or amendments proposed to the ECMP will be forwarded to DoEE for comment/approval prior to their adoption;
- Keeping up-to-date records of all disturbance incidence reports, monitoring events, results and corrective actions;
- Reviewing and advising DoEE of any proposed changes to the ECMP; and
- Designate suitably experienced persons for the management and auditing of the ECMP as required.

7.3 DESIGNATED PERSON (DP)

The roles and responsibilities of the Designated Person are to:

- Liaise with the Project Manager to facilitate compliance with legislation, Council policy and conditions during the development;
- Conduct audit inspections as required /requested during earthworks, and clearing or other inspections as triggered by environmental events or incidents;
- Advise the Project Manager on the compliance and effectiveness of the ECMP /Site Instructions and its implementation;
- Immediately contact the Project Manager regarding any environmental incidents that have the potential to cause environmental harm to Moreton Bay, request written details within 24 hours of occurrence, and issue Site Instructions for rectification/remediation to the Project Manager as soon as possible;
- Issue Site Instructions (for correction of non-compliance) to the Project Manager within seven (7) days of inspections and completion of the Inspection Procedures and Checklist(s);
- Maintain accurate reports (incidents, near miss, results of monitoring) to be provided to DoEE within ten days of request.

8.0 AUDITING

On completion of each stage of development within areas adjacent to the foreshore and prior to occupation, a suitably experienced, independent ecologist (auditor) will be engaged to inspect lighting, signage and retained mangrove vegetation to ensure that all mitigation measures provided in the ECIMP have been implemented.

On a yearly basis the auditor will review the Project Manager’s incidence reports and the yearly targeted shorebird survey reports to ensure the mitigation measures and any necessary corrective actions specified within this ECIMP have been undertaken to ensure the objectives of this ECIMP have been achieved.

Any reported breaches of the mitigation measures detailed in this ECIMP will trigger the need for additional auditing to ensure that corrective actions have been implemented and the reported breach has been rectified.

9.0 REFERENCES

BAAM (2016). *Migratory Shorebird Surveys – Shoreline.* Prepared for Shoreline Redlands.

Bamford, M. Watkins, D. Bancroft, W. Tischler G. and Wahl, J. (2008). Migratory Shorebirds of the East Asian-Australian Flyway: Population estimates and Internationally important sites. Wetlands International - Oceania. Canberra, Australia. Published by Wetlands International – Oceanic.

Burger, J, Jeitner, C, Clark, K and Niles LJ (2005). The effect of human activities on migrant shorebirds: successful adaptive management. *Environmental Conservation* **31** (4) pp. 283-288.

DesignFlow (2017). *Shoreline Redlands Hydrology and Water Quality Assessment.* Prepared for Shoreline Redlands Pty. Ltd.

Driscoll, PV and Ueta, M (2002). 'The migration route and behaviour of eastern curlews *Numenius madagascariensis.*' *Ibis*, **144**: 119-130.

DoEE (2015). *Industry guidelines for avoiding, assessing and mitigation impacts on EPBC Act listed migratory shorebird species.* Commonwealth Department of the Environment and Energy.

Finn, PG (2009). Habitat selection, foraging ecology and conservation of Eastern Curlews on their non-breeding grounds. PhD thesis. Griffith University.

Glover, HK, Weston, MA, Maguire, GS, Miller, KK and Christie, BA (2011). Towards ecologically meaningful and socially acceptable buffers: response distances of shorebirds in Victoria, Australia, to human disturbance. Landscape and Urban Planning 103: 326– 334.

Higgins, PJ and Davies, SJJF (eds.) (1996). *Handbook of Australian, New Zealand and Antarctic birds,* Vol. 3, *Snipe to pigeons.* Oxford University Press, Melbourne.

Lane, B (1987). *Shorebirds in Australia*. Nelson Publishers, Melbourne.

Paton, DC, Ziembicki, M, Owen, P and Heddle, C (2000). Disturbance distances for water birds and the management of human recreation with special reference to the Coorong region of South Australia. *The Stilt* **37** (2000).

Reid, T and Park, P (2003). 'Continuing decline of eastern curlew, *Numenius madagascariensis,* in Tasmania.' *Emu*, **103**: 279-283.

Smit, CJ and Visser, GJ (1993). Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bulletin 68: 6-19.

Ueta, M, Antonov, A, Artukhin, Y and Parilov, M (2002). 'Migration routes of eastern curlews tracked from far east Russia.' Emu, 102: 345-348

Wilson, H.B., Kendell, B.E., Fuller, R.A. Milton, D.A. and Possingham H.P. (2011). Analyzing Variability and the Rate of Decline of Migratory Shorebirds in Moreton Bay, Australia. *Conservation Biology* **25** (4): 758-766.

APPENDIX 1

Open Space Concept Plan

SHORELINE

Legend

✳	District Sports and Recreation Park
✳	Community Destination and Recreation Park with Neighbourhood Recreation Park functions
✳	Neighbourhood Recreation Park
✳	Neighbourhood Recreation Park functions within District Sports and Recreation Park
— —	Conceptual Staged Precincts / Park Catchments
⋯⋯	Walkable catchments - 400m radius
POS	Private Open Space

Notes

Local Authority: Redland City Council
Contour interval: 1.0m

Design is conceptual only and subject to detailed design and Council approvals for each relevant stage. Areas and dimensions are approximate only and are subject to final survey.

Foreshore RP line plotted from DCDB records and is approximate only and subject to detailed site survey.

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Sports, Recreation & Open Space

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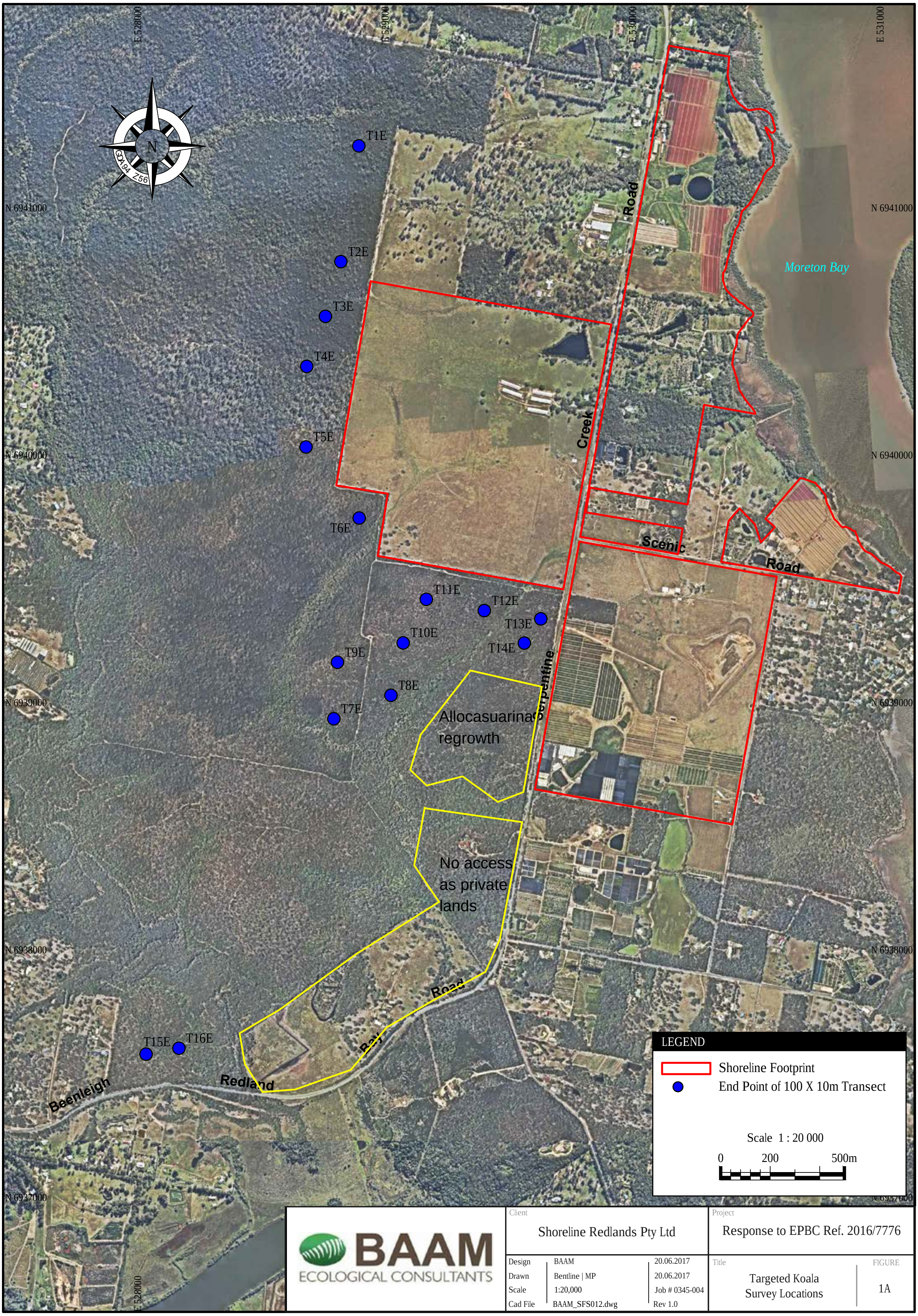
Drawing Ref: UD-7558-031-A
Date: 30/11/2016
Scale: 1:10,000 @ A3 - 1:5,000 @ A1
0 100 200 300 400m

Conceptual Masterplan
Shoreline - Redland Bay
for Redland Bay Southpark Corporation Pty Ltd & Sutgold Pty Ltd

ATTACHMENT 5

Results of Targeted Koala Surveys



BAAM ECOLOGICAL CONSULTANTS

Client
Shoreline Redlands Pty Ltd

Project
Response to EPBC Ref. 2016/7776

Design	BAAM	20.06.2017	
Drawn	Bentline | MP	20.06.2017	
Scale	1:20,000	Job # 0345-004	
Cad File	BAAM_SFS012.dwg	Rev 1.0	

Title
Targeted Koala
Survey Locations

FIGURE
1A

Results of Targeted Koala Surveys in Western and Southern Bushland Habitats

Transect	Trees Searched	Count	DBH (cm)	Comment	Representative photographs	
					Start of Transect	End of Transect looking towards e start
1	*Eucalyptus racemosa* *Lophostemon confertus* *Eucalyptus planchoniana*	2 2 1	5 to 50	dominated by regrowth *Allocasuarina littoralis* **Fauna Evidence** Wallaby and Ringtail possum scats. **No Koala evidence**		
2	*Eucalyptus planchoniana* *Eucalyptus racemosa*	4 5	10 to 50	dominated by regrowth *Allocasuarina littoralis* one old growth tree present; tree death observed **Fauna Evidence** Macropod scats **No Koala evidence**		

Transect	Trees Searched	Count	DBH (cm)	Comment	Representative photographs	
					Start of Transect	End of Transect looking towards e start
3	*Eucalyptus planchoniana* *Eucalyptus racemosa*	6 3	15 to 45	dominated by regrowth *Allocasuarina littoralis* **Fauna Evidence** Macropod scats **No Koala evidence**		
4	*Eucalyptus racemosa* *Eucalyptus planchoniana* *Lophostemon suaveolens* *Corymbia intermedia*	4 5 1 1	40 to 120	Open woodland with abundant healthy old growth trees **Fauna Evidence** wallaby and ringtail possum scats, bandicoot diggings **No Koala evidence**		
5	*Corymbia trachyphloia* *Angophora sp.* *Lophostemon suaveolens* *Eucalyptus racemosa*	1 5 1 5	25 to 130	dominated by regrowth *Allocasuarina littoralis* at start of transect; 4 old growth trees present **Fauna Evidence** Macropod scats **No Koala evidence**		

Transect	Trees Searched	Count	DBH (cm)	Comment	Representative photographs	
					Start of Transect	End of Transect looking towards e start
6	*Angophora leiocarpa* *Angophora sp.* *Eucalyptus racemosa* *Corymbia trachyphloia*	12 50 2 2	5 to 60	mainly regrowth Angophora **Fauna Evidence** **No Koala evidence**		
7	*Corymbia trachyphloia* *Eucalyptus planchoniana* *Melaleuca quinquenervia* *Eucalyptus racemosa* *Lophostemon suaveolens*	7 10 4 4 2	5 to 40	tree death observed; **Fauna Evidence** Echidna in burrow, bandicoot diggings, wallaby scats **No Koala evidence**		
8	*Angophora sp.* *Melaleuca quinquenervia* *Eucalyptus racemosa* *Lophostemon confertus* *Lophostemon suaveolens*	6 6 2 1 1	10 to 30	**Fauna Evidence** ringtail possum and macropod scats, bandicoot diggings **No Koala evidence**		

Transect	Trees Searched	Count	DBH (cm)	Comment	Representative photographs	
					Start of Transect	End of Transect looking towards e start
9	*Eucalyptus racemosa* *Melaleuca quinquenervia* *Lophostemon suaveolens* *Corymbia trachyphloia* *Angophora sp.*	5 4 4 1 1	15 to 45	dominated by regrowth *Allocasuarina littoralis* one old growth tree (100 DBH) **Fauna Evidence** **No Koala evidence**		
10	*Corymbia intermedia* *Corymbia trachyphloia* *Angophora sp.* *Eucalyptus racemosa*	6 6 11 3	5 to 40	open woodland; no old growth trees present **Fauna Evidence** wallaby scats, bandicoot diggings **No Koala evidence**		
11	*Angophora spp.*	48	10 to 30	dominated by mature and regrowth Angophora spp. **Fauna Evidence** macropod scats, bandicoot diggings **No Koala evidence**		

Transect	Trees Searched	Count	DBH (cm)	Comment	Representative photographs	
					Start of Transect	End of Transect looking towards e start
12	*Melaleuca quinquenervia* *Angophora* *Corymbia intermedia* *Lophostemon confertus* *Eucalyptus racemosa*	8 2 1 3 5	5 to 30	dominated by regrowth trees **Fauna Evidence** **No Koala evidence**		No photo, but similar vegetation along entire transect.
13	*Melaleuca quinquenervia* *Eucalyptus planchoniana* *Corymbia intermedia* *Eucalyptus racemosa*	2 15 3 12	10 to 30	dominated by Allocasuarina at start of transect; *E. racemosa* woodland at end of transect **Fauna Evidence** **No Koala evidence**		
14	*Melaleuca quinquenervia* *Eucalyptus planchoniana* *Corymbia intermedia* *Eucalyptus racemosa*	52 19 1 17	10 to 35	mainly regrowth **Fauna Evidence** Ringtail possum scats, bandicoot diggings **No Koala evidence**		

Transect	Trees Searched	Count	DBH (cm)	Comment	Representative photographs	
					Start of Transect	End of Transect looking towards e start
15	*Eucalyptus racemosa* *Corymbia intermedia* *Corymbia trachyphloia* *Melaleuca quinquenervia* *Eucalyptus carnea*	7 2 7 1 1	10 to 80	selective clearing evident; **Fauna Evidence** dog scats ringtail possum scats, bandicoot diggings **No Koala evidence**		
16	*Eucalyptus tereticornis* *Eucalyptus racemosa* *Corymbia intermedia* *Lophostemon confertus* *Eucalyptus propinqua* *Corymbia trachyphloia*	4 4 6 6 5 1	30 to 60	lantana dominated ground layer; healthy canopy **Fauna Evidence** macropod scats bandicoot diggings **No Koala evidence**		

ATTACHMENT 6

Koala Impact Management Plan

KOALA IMPACT MANAGEMENT PLAN

SHORELINE REDLANDS

Prepared for
Shoreline

Biodiversity Assessment and Management Pty Ltd
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BAAM
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Document Control Sheet

File Number: 0345-004

Project Manager/s: Adrian Caneris

Client: Shoreline Redlands Pty Ltd

Project Title: Shoreline Koala Impact Management Plan

Project Author/s: Dr Jo Chambers, Adrian Caneris

Project Summary: Identify potential impacts to Koala and provide management strategies to minimise significant impacts to Koala and their habitats as a result of the Shoreline Urban Development.

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Purpose of Report

Biodiversity Assessment and Management Pty Ltd has produced this report in its capacity as {consultants} for and on the request of Shoreline Redlands (the "Client") for the sole purpose of identifying potential impacts to Koala and providing management strategies to minimise significant impacts on Koala and their habitats as a result of the Shoreline Urban Development (the "Specified Purpose"). This information and any recommendations in this report are particular to the Specified Purpose and are based on facts, matters and circumstances particular to the subject matter of the report and the Specified Purpose at the time of production. This report is not to be used, nor is it suitable, for any purpose other than the Specified Purpose. Biodiversity Assessment and Management Pty Ltd disclaims all liability for any loss and/or damage whatsoever arising either directly or indirectly as a result of any application, use or reliance upon the report for any purpose other than the Specified Purpose.

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Signed on behalf of
Biodiversity Assessment and Management Pty Ltd

Date: 20 June, 2017

Managing Director

EXECUTIVE SUMMARY

Environmental Outcomes

The objectives of this Koala Impact Management Plan (KIMP) are to ensure no significant direct or indirect impacts to Koala *Phascolarctos cinereus* occur as a result of the Shoreline urban village development, Redland Bay, Queensland (the development).

Potential Impacts

Potential impacts to Koala as a result of the development include:

- temporary (short-term) loss of refuge and feeding habitat;
- death or injury to resident Koalas during vegetation clearing;
- increased risk of stress and disease; and
- increased risk of death or injury as a result of:
  - vehicle strike,
  - dog attack, and
  - an increase in pest animals that may prey on Koalas.

Management Measures

Detailed design has resulted in minimal clearing of existing Koala habitat. The proposed retention, protection, restoration and revegetation of approximately 9 ha of Koala habitat will result in a 30% overall increase in Koala habitat at this location.

The unavoidable loss of any non-juvenile Koala habitat tree, as defined by the South East Queensland Koala Conservation State Planning Regulatory Provisions (KSPRP), will be offset at the rate of three new Koala habitat trees planted for the loss of every one Koala habitat tree, in accordance with the *Queensland Environmental Offsets Policy* V1.1. The restoration, protection and ongoing monitoring and management of the Koala offset areas as prescribed in the Offsets Delivery Plan (to be prepared in accordance with the *Queensland Environmental Offsets Policy* V1.1) will provide a net benefit in Koala habitat in the area and will therefore compensate for the loss of existing Koala habitat.

All native vegetation clearing will be conducted in accordance the *Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016* (EPA 2006) Policy 6, to minimise the risk of death or injury to Koala during clearing events.

The development includes the creation of three fauna corridors to link eastern bushland patches to large bushland areas to the west of the development. Each corridor will include either a dedicated fauna underpass or vegetated overpass with strategically located fauna fencing to facilitate safe Koala movements across Serpentine Creek Road. The locations of the fauna crossings are shown in **Figure 4.1.**

As the majority of intact and interconnected Koala habitat will be retained as part of the development, and clearing will be staged in line with development staging (allowing time for establishment of the Koala offset areas), there will be minimal net loss of Koala habitat during construction. Given this, together with the low density of Koalas in the local landscape, it is considered there is a very low risk that resident Koalas will be forced to move away from the local area in search of food or refuge habitat during the sites development. The creation of the three fauna corridors will also ultimately improve habitat connectivity and safe movement.

A community education program will be developed by Shoreline Redlands prior to occupation and relayed to new residents and visitors to the development regarding the presence of Koala in the local area and the legal requirement for dogs to be restrained on a leash at all times when outside of their property (except within dedicated 'off leash areas') and particularly the importance of keeping dogs contained within property boundaries at night.

Monitoring

Areas immediately adjacent to the development (i.e. within 100 m) will be surveyed within six months from the date of Commonwealth approval, and subsequently on an annual basis, for the presence of Koalas and/or Koala signs (scats and scratches) to provide baseline data.

Every five years for the first 15 years, a detailed survey of the local Koala population will be undertaken. The approach and techniques employed for this survey will be in accordance with the most up to date scientifically proven survey methodology.

Monitoring of fauna underpasses/overpasses to determine if Koala are successfully moving through these will be conducted on a yearly basis commencing once this infrastructure has been established. The use of camera traps (dependent on security risks) and/or sand traps will be used to verify fauna usage of the underpasses/overpasses. Inspections of fauna exclusion fencing will also occur as part of the underpass monitoring.

Monitoring of retained, restored or newly established Koala habitats will be monitored in accordance with the Koala Offset Delivery Plan and Shoreline Open Space Landscape Strategy.

As part of the community education program, Community members will be encouraged to report any incidences of unrestrained dogs to the Redland City Council (RCC) dog control unit. Community members will also be asked to report to RCC any adverse interactions between Koala and threats (dogs/vehicles/humans) and any breaches in fauna exclusion fencing observed. The Project Manager will investigate these reports within 48 hours of their registration and initiate corrective actions (e.g. identify the owners of an unleashed wandering dog,) as required. The Project Manager will liaise with RCC on a fortnightly basis regarding any reported adverse interactions and will assist RCC in mitigating the cause/s wherever possible.

Performance and Completion Criteria

- Resident Koalas are occupying habitats incorporated into the development area and in adjacent bushland at densities that reflect average densities in comparable habitat within the local area.
- All retained, restored and newly established Koala habitats are showing signs of good vegetation health.
- No increase of dead, sick, or injured Koalas as a result of the development is recorded.
- Evidence of Koala and other native fauna using underpasses/overpass is recorded, with evidence increasing over time in response to revegetation success.

Corrective Measures

The Open Space Landscape Strategy and the approved State Offset Delivery Plan will prescribe management and monitoring actions to ensure any tree death or impacts to habitat quality within the declared wildlife corridors and Koala habitat offset area are identified and reported to the Project Manager, and cause investigated and rectified, if the cause is a result of the development.

An Action Plan to minimise the risk of death or injury to Koala during construction and occupation is provided in **Table 4.1** of this Plan.

If any breaches of Koala exclusion fencing or incidents where Koala/vehicle/dog interactions have occurred the Project Manager will be notified immediately and investigations into the cause of any breaches in mitigation measures will be commenced within 48 hours of being notified.

The Project Manager, in consultation with the Designated Person, Redland City Council and the Queensland Department of Environment and Heritage Protection, will take immediate action to rectify the breach or undertake measures to mitigate the risk of further Koala/vehicle/dog interactions.

Auditing

An appropriately experienced ecologist (e.g. Certified Environmental Practitioner) will inspect the development area at the start and end of each stage of development to ensure that mitigation measures stipulated in this KIMP have been implemented.

The results of annual monitoring and any incident reports will be submitted to the appointed auditor on a yearly basis for review to ensure that monitoring and management responses have been successfully completed.

SHORELINE KOALA IMPACT MANAGEMENT PLAN

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List of Abbreviations

BAAM	Biodiversity Assessment and Management Pty Ltd
DEHP	Queensland Department of Environment and Heritage Protection
DoEE	Commonwealth Department of the Environment and Energy
KIMP	Koala Impact Management Plan
KSPRP	South East Queensland Koala Conservation State Planning Regulatory Provisions
LGA	Local Government Area
PM	Project Manager
SOP	Standard Operation Procedures

1.0 INTRODUCTION

This Koala Impact Management Plan (KIMP) has been prepared for Shoreline Redlands Pty Ltd to ensure that all potential impacts to the local Koala *Phascolarctos cinereus* population from the Shoreline urban village development (hereafter referred to as "the development") are identified and appropriately managed.

The compilation of this Plan addresses Items 5, 6 and 8 of the Commonwealth Department of the Environment and Energy (DoEE) request for further information for preliminary documentation for the Shoreline urban village development (EPBC Ref: 2016/7776).

The objectives of this KIMP are to ensure no significant direct or indirect impacts to Koala occur as a result of the development.

2.0 EXISTING IMPACTS

Currently, the local Koala population may suffer harassment from farm/domestic dogs, vehicle strike along Serpentine Creek Road, and disease, which affects a large number of Koala within Redland City.

A review of the Queensland Department of Environment and Heritage Protection (DEHP) Koala records for Redland City indicates there has only been one reported dog attack and one reported vehicle strike within the vicinity of the development (**Figure 2.1**) over the past ten years.

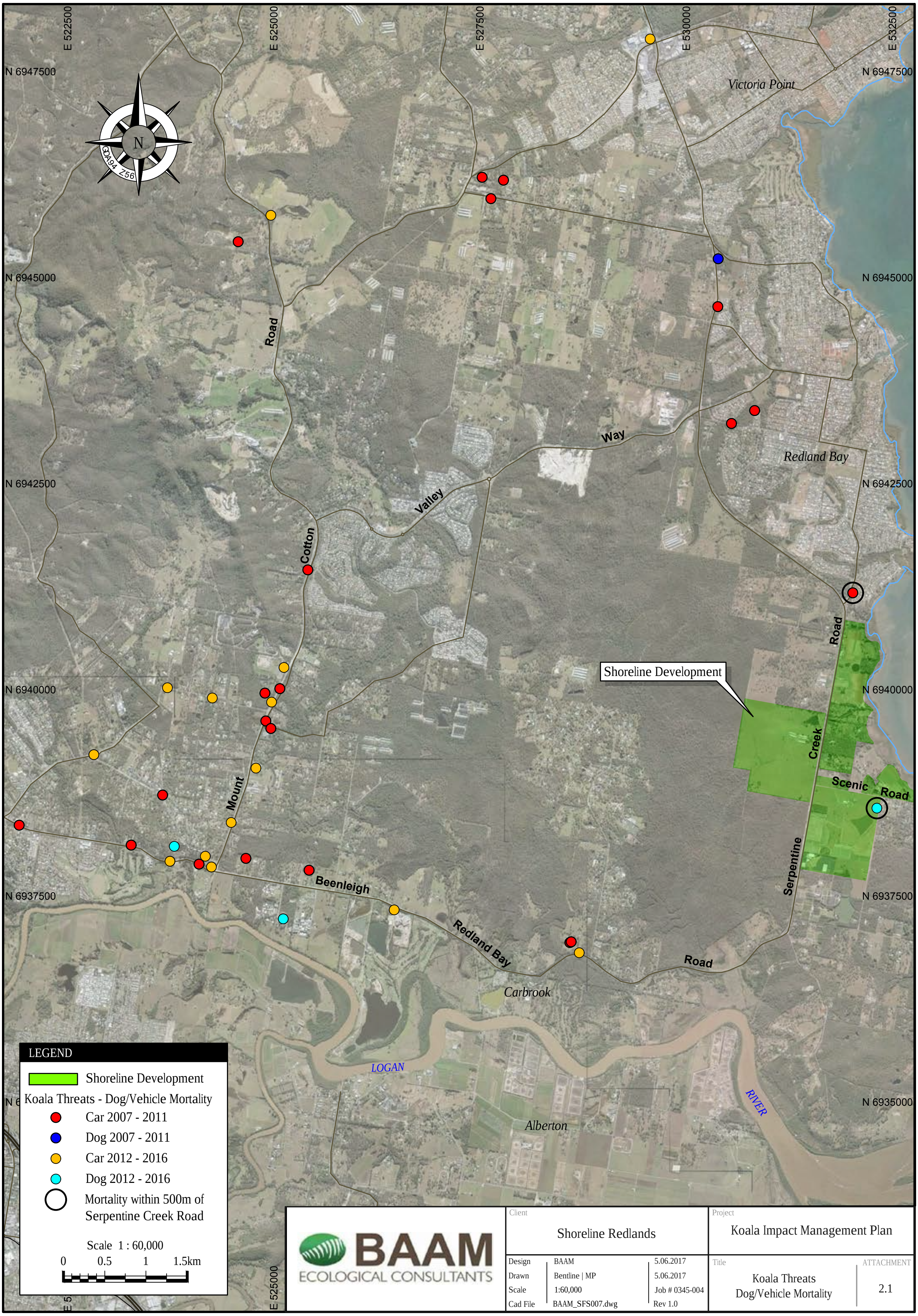
In contrast, there have been 23 reported vehicle related Koala deaths and two reported dog related deaths over the past 10 years within the neighbouring Logan City suburbs of Cornubia and Carbrook and along Mount Cotton Road to the west (**Figure 2.1**).

During the past five years there have been nine reported cases of sick or dead Koalas as a result of cystitis or conjunctivitis within the Redland Bay area, and there have been 10 reports of sick or dead Koalas as a result of cystitis or conjunctivitis within the Carbrook/Cornubia area.

3.0 POTENTIAL IMPACTS

Both direct and indirect impacts, short-term and long-term in duration, may apply to Koalas as a result of the development. This includes:

- temporary (short-term) loss of refuge and feeding habitat;
- death or injury to resident Koalas during vegetation clearing;
- increased risk of death or injury as a result of:
    - vehicle strike,
    - dog attack, and
    - an increase in pest animals that may prey on Koalas; and
- increased risk of stress and disease.



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Client	Shoreline Redlands		Project	Koala Impact Management Plan
Design	BAAM	5.06.2017	Title	Koala Threats Dog/Vehicle Mortality
Drawn	Bentline | MP	5.06.2017	ATTACHMENT	2.1
Scale	1:60,000	Job # 0345-004		
Cad File	BAAM_SFS007.dwg	Rev 1.0		

4.0 MANAGEMENT MEASURES

Management measures to reduce the likelihood of these potential impacts causing long-term, significant impacts to the local Koala population are provided in the following sections.

4.1 TEMPORARY (SHORT-TERM) LOSS OF REFUGE AND FEEDING HABITAT

Under the *EPBC Act referral guidelines for the vulnerable Koala* (Department of the Environment 2014), Koala habitat is defined as any forest or woodland containing species that are known Koala food trees, or shrubland with emergent food trees. Of the Koala habitat trees recorded within the Shoreline development footprint, only three species (*Eucalyptus microcorys, E. racemosa* and *E. tereticornis*) are recognised by the Australian Koala Foundation as known Koala food trees within Redland City (AKF 2015).

For the most part, Koala habitat within the development area was present in isolated clumps or bushland patches, single trees scattered throughout Lots, or was located along road edges.

The development area, excluding the western road reserve, currently supports approximately 15 ha of potential Koala habitats, of which approximately 12 ha will be retained, 1.2 ha is proposed to be cleared, and 1.4 ha will incorporate sensitive design to minimise impacts to Koala feed trees.

The total area of the 20 m wide road reserve located to the west of the development, which will provide road access, is 2.52 ha. Final design plans for the western roadway are yet to be completed, although with sensitive design, and minimising earthworks wherever practical, it is expected that 30% of the Koala habitat trees within this 2.52 ha area will be retained.

To be conservative in our calculations of area of Koala habitat loss, we have assumed that all trees within the road reserve will be removed. It is therefore estimated that a maximum of 3.72 ha of Koala habitat will be removed as part of the development.

Hydrological modelling (Design Flow 2016) has identified two minor catchments draining into the adjoining bushland reserve to the west of the development area. Potential impacts to waterways downstream of the site relate to downstream areas becoming wetter. This is due to smaller events being translated to runoff which would have previously infiltrated.

In terms of quantity management it is proposed to attenuate peak flows for flood events from the Q1 to Q100. The water quantity management objectives are:

Waterway Stability:
Limit Peak 1 year ARI flows at site boundary for critical duration event (60 minutes or longer) to pre-development conditions.

Flooding Objectives:
Protect people, property and infrastructure from flooding within and external to site boundary:

- Preserve peak site discharges and flood levels downstream of the site at or below predevelopment conditions for all events from 2 to 100 year ARI;
- Provide suitable flood conveyance capacity through site and ensure development zone has 100 year ARI flood immunity (plus suitable freeboard).

This runoff will continue within the existing waterway flow paths entering into Melaleuca dominated habitats, which are well adapted for such minor changes. Therefore, there will be no significant impacts (edge effects) to retained bushland vegetation expected as a result of changes to the existing hydrological features of the western portions of the development area.

Management Measures

Detailed design has resulted in the retention of the majority of Koala habitat within the development area. The 3.72 ha of Koala habitat potentially requiring clearing, is distributed across the entire development footprint, and clearing of this habitat will be staged in line with development progress.

Furthermore, as part of the development, proposed restoration and revegetation activities will create 8.8 ha of Koala habitat within designated wildlife corridors. This will consist primarily of Koala feed trees, and will see an almost 30% increase in Koala habitat. The proposed restoration objectives for each strategic location are:

- Western corridor – 4.3 ha.
- Southern corridor – 2.5 ha.
- Town centre corridor – 1.1 ha.

- Northern corridor – 0.9 ha.

Works on the creation of additional Koala habitats will be undertaken in line with development progress.

The unavoidable clearing of non-juvenile Koala habitat trees (as defined by the South East Queensland Koala Conservation State Planning Regulatory Provisions [KSPRP]) will be offset in accordance with the *Queensland Environmental Offsets Policy V1.*2, which requires three Koala trees planted and established for each tree lost. This will provide an even greater increase in Koala habitats in comparison to what currently exists. The plantings of Koala habitat trees in offset areas will commence in line with development progress.

The restoration, protection and ongoing monitoring and management of the Koala offset areas as prescribed in the Offsets Delivery Plan (to be prepared in accordance with the *Queensland Environmental Offsets Policy V1.*2), as well as the restoration and supplementary plantings of Koala habitat trees in all retained open space and conservation areas (refer to Shoreline Open Space Landscape Strategy (BAAM 2016)), will provide a net gain in Koala habitat in the area, and will therefore compensate for the loss of existing Koala habitat.

Monitoring

Monitoring of Koala presence and health and retained and revegetated habitats will be undertaken as per **Section 5.0**.

Corrective Actions

The Shoreline Open Space Landscape Strategy and the approved State Offset Delivery Plan will prescribe actions to ensure that any tree death or impacts to habitat quality within adjacent retained habitats, the declared wildlife corridors and Koala habitat offset area are identified, reported to the Project Manager (refer **Section 6.2**) and the cause investigated and rectified, if the cause is a result of the development.

4.2 DEATH OR INJURY TO RESIDENT KOALAS DURING VEGETATION CLEARING AND CONSTRUCTION

Without appropriate management, the development has potential to result in death or injury to Koala throughout the vegetation clearing phase. The initial and most likely impact would be injury or death to Koalas should an animal be present at the proposed vegetation clearance area.

Management Measures

All vegetation clearing will be conducted in accordance with the *Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016* (Environmental Protection Agency 2006) Policy 6: Vegetation clearing practices. This involves the following key elements.

1. The staging or limiting of vegetation clearance to what is required for safe and efficient development

This requires that vegetation clearing is limited to those areas required for development at that time. This method allows for the retention of Koala habitats until development progresses to that area and helps reduce any lag time between clearing and restoration of Koala offset areas.

2. The sequential clearance of trees

Under the *Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016*, ‘sequential clearing’ means:

(1) clearing of trees is carried out in a way that ensures Koalas living in or near the area being cleared (the clearing site) have enough time to move out of the clearing site without human intervention, , by:
    (a) carrying out the clearing in stages; and
    (b) ensuring not more than the following is cleared in any one stage:
        (i) for a clearing site with an area of 6ha or less—50 percent of the site’s area;
    (c) ensuring that between each stage there is at least one period of 12 hours that starts at 6p.m. on a day and ends at 6a.m. on the following day, during which no trees are cleared on the site; and
(2) clearing of trees is carried out in a way that ensures, while the clearing is being carried out, appropriate habitat links are maintained within the clearing site and between the site and its adjacent areas, to

allow Koalas living on the site to move out of the site; and

(3) no tree in which a Koala is present, and no tree with a crown overlapping a tree in which a Koala is present, is cleared.

3. All clearing will be undertaken under the guidance of a licenced and experienced Koala Spotter

A Koala Spotter means a person who is licenced by the DEHP to act as a ‘fauna spotter catcher’. The persons engaged must have demonstrated experience in locating Koalas in Koala habitats. Prior to the commencement of, and during, felling operations, it is the responsibility of the Koala Spotter to identify trees in which a Koala is present and any trees where their crown overlaps trees in which a Koala is present and convey this information to the person(s) conducting the clearing.

A Koala spotter is to be independent of the clearing operators and is not to be involved in the clearing of vegetation while they are responsible for identifying Koalas present on the site.

The above actions will be standard practice for the duration of the development. Shoreline Redlands will ensure that all treed areas are assessed by a licenced and experienced Koala Spotter/Handler in advance of proposed vegetation clearance activities.

4. The exclusion of vegetation clearance between the hours of 6pm and 6am

No vegetation is to be cleared outside of daylight hours, other than in the case of an emergency action.

Corrective Actions

An Action Plan to minimise the risk of death or injury to resident Koalas, together with corrective actions, is provided in **Table 4.1.**

Table 4.1. Action Plan to prevent death or injury to Koalas during vegetation clearing and construction. Refer to Section 5.0 for Responsible Officers.

Performance Goal	Actions / Responsible Officer(s)	Performance Criteria	Corrective Actions / Responsible Officer(s)	Timing / Frequency
To minimise the risk of death or injury to Koala during vegetation clearing and construction activities	• A 'Standard Operation Procedure' (SOP) will be developed and implemented for vegetation clearance activities within each development area. As a minimum, it will ensure that: - all vegetation clearance on-site is authorised and is specified as part of the development process; - all fauna inspections are conducted immediately prior to clearance, - a licenced and experienced Koala Spotter/Handler is employed for all inspections, - all clearance is staged (i.e. no more than 50% of a patch that is ≤6 ha cleared in any one day and allowing at least 12 hours during which no trees are cleared), - all clearance areas are clearly defined (e.g. temporary fencing, signage, etc.), and - a protocol is in-place for the removal of fauna identified within the clearance area (i.e. either naturally or by a licenced and experienced Koala Handler) / ***Project Manager (PM).*** • An 'operation protocol' is developed and implemented to manage Koalas that accidently access unsafe areas, which suspends all activities in the vicinity of the Koala until the Koala has moved independently out of the danger zone or is relocated to a safe area by a licenced and experienced Koala Spotter/Handler. (Wherever practical, the animal will be encouraged to move of its own volition.) /***PM***. • The integrity of Koala exclusion fencing (and signage) will be periodically inspected /***PM***	• No death or injuries to Koalas have occurred as a result of development activities (including vegetation clearance). • The 'Standard Operation Procedure' for vegetation clearance is implemented and functioning effectively on-site. • No unauthorised vegetation clearance has occurred. • Evidence that a licenced and experienced Koala Spotter/Handler has been employed for vegetation clearance activities is available and their contact details are easily accessible on-site for emergency relocation tasks. • The Koala exclusion fencing (and signage) is installed and functioning effectively around high risk areas. • The 'operation protocol' to manage Koalas that accidently access unsafe areas areas is implemented and functioning effectively on-site. • Evidence that the integrity of the Koala exclusion fencing has been periodically inspected is available. • No deaths, injuries or near-misses have occurred during construction f the development.	• All Koala deaths or injuries will be investigated within 24 hours of notification and reported to the Regulatory Authorities within 7 days and, as required, actions will be developed to prevent future Koala deaths or injuries within 7 days. • All failures of the SOP for vegetation clearance will be investigated within 24 hours and, as required, actions will be developed within 7 days to prevent future failures */ **PM**.* • All failures of the Koala exclusion fencing will be repaired in a timely manner and will be investigated and, as required, actions will be developed to prevent future breaches */ **PM*** within 7 days of notification of failure. • All failures of the 'operation protocol' to manage Koalas that accidently access unsafe areas will be investigated within 24 hours of notification and, as required, actions will be developed within 7 days to prevent future failures */ **PM***. • All incidents of unauthorised vegetation clearance will be investigated within 24 hours of notification and, as required, actions will be developed within 7 days to prevent future incidents */ **PM***. •	• The 'Standard Operation Procedure' for vegetation clearance will be established before development commences and will be maintained over the life of the development. • The 'operation protocol' to manage Koalas that accidently access unsafe areas will be established before development commences and will be maintained over the life of the development. • Koala exclusion fencing (and signage) will be established before the development commences and will be advanced as required to keep pace with development activities over the life of the development.

4.3 INCREASED RISK OF DEATH OR INJURY DURING OPERATION

4.3.1 Vehicle Strike

A review of the DEHP reported Koala sightings for Redland City and Logan City local government areas (LGAs) indicates there have been no reported Koala/vehicle interactions within the immediate area of the Shoreline Development since 2007, whereas along Beenleigh Redland Bay Road to the south there have been 11 reported Koala/vehicle interactions since 2007, with five of the vehicle hits occurring within the last five years (**Figure 2.1**).

The significantly higher rate of vehicle-related Koala mortality to the south of the development area could be the result of:

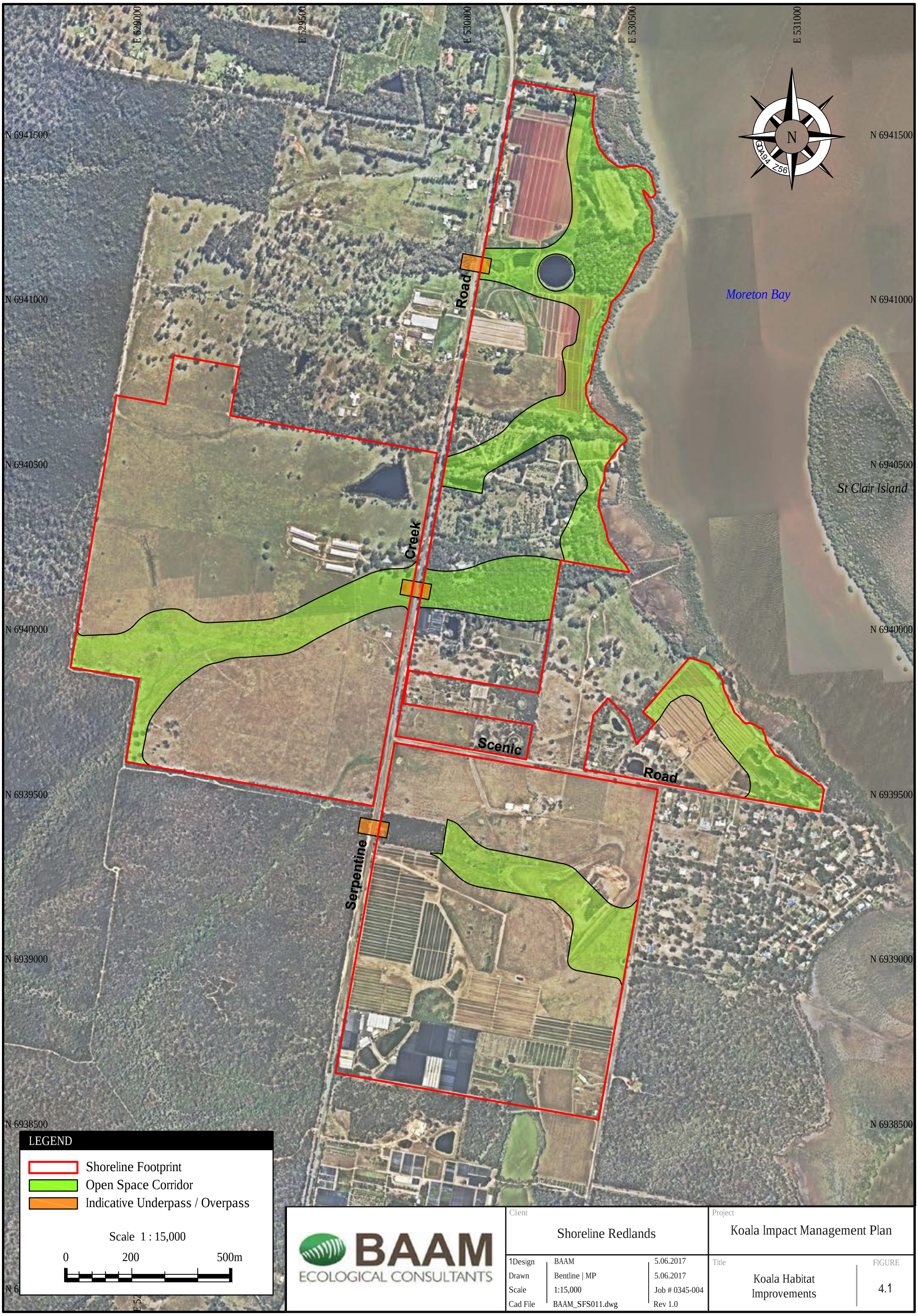
- vehicle traffic along Beenleigh Redland Bay Road being currently significantly higher than along Serpentine Creek Road; or
- the lack of exclusion fencing and safe movement opportunities, high speed limit (80 km) and poor visibility of road verges; or
- higher Koala population densities to the south and west of the development area than that recorded within Redland Bay; a factor that has been discussed in BAAM (2014, updated 2016), which means a higher probability of Koala/vehicle interactions.

The population of Redland City is forecast to increase by approximately 40,000 by 2031 with Redland Bay forecast to increase by approximately 4,000 (refer VLC 2015). Traffic modelling (VLC 2015) suggests traffic volume in line with general population growth heading north from the proposed development along Serpentine Creek Road will increase by approximately 50% by 2031, and traffic volumes along Beenleigh-Redland Bay Road to the south will increase by approximately 11% by 2031. This increase in traffic has the potential to cause an increase in Koala/vehicle interactions.

Management Measures

The proposed development incorporates the creation of three fauna corridors to link eastern bushland patches to large bushland areas to the west of the development. **Figure 4.1** shows how the development will result in improved linkage of Koala habitats and provide for safe movement across Serpentine Creek Road to retained bushland to the west.

The creation of these corridors will commence in line with development progress. The northern and central corridors will include dedicated fauna underpasses, while the southern corridor will include a vegetated overpass, with strategically located fauna exclusion fencing, to facilitate safe Koala movements across Serpentine Creek Road. In some locations fauna exclusion fencing will be amalgamated into existing condition noise barrier.



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Client
Shoreline Redlands

Project
Koala Impact Management Plan

1Design	BAAM	5.06.2017
Drawn	Bentline | MP	5.06.2017
Scale	1:15,000	Job # 0345-004
Cad File	BAAM_SFS011.dwg	Rev 1.0

Title
Koala Habitat Improvements

FIGURE
4.1

The following design elements will be incorporated into the fauna underpasses and overpass:

Underpass

a. Koala exclusion fencing or noise barrier will be deployed to choreograph Koalas to the underpasses.

b. Koala fencing will be amalgamated into conditioned noise barrier fencing at locations where noise barrier fencing is required.

c. The dedicated fauna underpasses will provide for a dry land passage portal of a minimum size of 1.4 meters high by 2 meters wide.

d. Other design considerations include the following:

  i. provision of an unobstructed view through to the far side of the underpass.

  ii. design to ensure suitable drainage and avoidance of water pooling – i.e. even shallow pools of surface water may deter Koala and other terrestrial species from using the crossing structure.

  iii. underpass floors are to be designed to remain dry except during and immediately after significant rainfall events where the structure quickly dries out, or ledges or Koala furniture are incorporated in the underpass to provide a dry path for movement.

  iv. If point iii above is not achievable, then the fauna underpass is to incorporate a Koala "bridge" structure comprising of a line of raised interconnecting logs which mirrors the length of the underpass to reduce the threat of predation and/or provide a resource for Koala access in the event of inundation.

  v. Habitat rehabilitation to provide some protective cover on approach/exiting the underpass, though vegetation should not obstruct access or view of underpass entrance.

Overpass

The final design of the overpass has not been completed but it will broadly follow the design for the successful Compton Road overpass, with a separated pedestrian walkway constructed on the outer edge of the overpass. This successful land overpass incorporates dense plantings of locally sourced vegetation to provide a continuous strip of the surrounding bushland, as shown in **Photo 1**.

Photo 1. Google Earth photo of Compton Road overpass.

Koala Fencing

For the development, it is recommended fencing be installed to minimise Koala-vehicle collision under circumstances where it is desirable to guide Koalas to the road underpass/overpass adjoining key habitat or corridor areas. Due to the unpredictable movement and dispersal patterns of the species it is not possible to ensure that all animals are guided to this crossing point, hence the aim of minimising, rather than eliminating of casualties.

It is also understood that noise barrier will be erected along Serpentine Creek Road. Wherever fauna exclusion fencing is required at locations requiring noise attenuation, fauna exclusion fencing will be amalgamated into the noise attenuation structure to exclude fauna from accessing the roadway. The fencing will be installed as part of the road upgrade of Stage 2 of the development.

Exclusion fencing will also be established, as required along the western and southern boundaries of the development, in areas west of Serpentine Creek Road, to minimise the risk that Koala could come in contact with vehicles.

The following specific design features are recommended for fauna exclusion fencing, outside of areas requiring noise attenuation:

1. The fence need only be 1.2 m high, with 60 centimeter strip of metal or Perspex (such as Colorbond or Perspex sheeting) attached to the top rail on the exclusion side of the fence. Koalas are unable to progress past the 60 cm slippery metal/Perspex surface to breach the fence. The lower height of the fence would require less clearing or maintenance of overhanging branches as branches can be retained that are further than 1.5 m above the fence, and the lower fence also has reduced wind capture implications than taller fencing.
2. Where practicable, an area 3 m from the fence needs to be cleared and maintained to prevent Koalas from jumping onto or over the fence from nearby trees and shrubs.
3. As there is potential for a Koala to enter the exclusion area, it is important to provide opportunities for the Koala to exit. The provision of a timber pole against the fence will facilitate movements out of the exclusion area. It is considered that the provision of a timber pole is a crucial fencing design element that would reduce the amount of time that a Koala would spend within the road, hence reducing the opportunity for injury, stress or vehicle collision.

Corrective Actions

An agreement between the Principal (refer **Section 6**), DEHP and Redland City Council will be established requiring the Principal to advise, or be advised of, any Koala/vehicle interactions recorded within the immediate vicinity of the development.

The Project Manager, in consultation with the Designated Person and Redland City Council, will take immediate action to identify the cause and to rectify the breach or undertake measures to mitigate the risk of further Koala/vehicle interactions.

4.3.2 Increase in Dog Attack and Pest Animals that may Prey on Koala

Wild dogs and wandering domestic dogs are a major threat to Koala. A review of the DEHP reported Koala sightings for the Redland City and Logan City LGAs indicates there has been only one reported Koala/dog interaction within the area of the Shoreline Development since 2007, whereas along Beenleigh Redland Bay Road to the south there have been two Koala dog/interactions since 2007 (see **Figure 2.1**).

The development will cause an increase in the presence of domestic dogs in the local area, which in turn presents an increased risk of Koala/dog interactions.

Management Measures

A community education program will be developed by Shoreline Redlands prior to occupation and relayed to new residents and visitors to the development regarding the presence of Koala in the local area and the legal requirement for dogs to be restrained on a leash at all times when outside of their property (except within dedicated ‘off leash areas’), and particularly the importance of keeping dogs contained within property boundaries at night.

Exclusion fencing will also be established along the western and southern boundaries of the development, in areas west of Serpentine Creek, Road to minimise the risk that Koala could come in contact with domestic dogs.

Corrective Actions

Community members will be encouraged to report any incidences of unrestrained dogs or any adverse interactions between Koala and threats (dogs/vehicles/humans) observed to RCC. The Project Manager will investigate these reports within 48 hours of their registration and initiate corrective actions (e.g. identify the owners of an unleashed wandering dog,) as required. The Project Manager will liaise with RCC on a fortnightly basis regarding any reported adverse interactions and will assist RCC in mitigating the cause/s wherever possible. The Project Manager will liaise, who will promptly notify the Redland City Council dog control unit.

4.4 INCREASED RISK OF STRESS AND DISEASE

Management Measures

Adherence to the management measures outlined in the previous sections and to the Action Plan in **Table 4.1** will greatly minimise the risk of stressing resident Koalas during construction and operation of the development, which will also reduce the risk of resident Koalas succumbing to disease.

In particular, as the majority of intact and interconnected Koala habitat will be retained as part of the development, and clearing will be staged in line with development staging (giving time for establishment of the Koala offset areas), there will be minimal net loss of Koala habitat as the development becomes operational. As the majority of intact and interconnected Koala habitat will be retained as part of the development, and clearing will be staged in line with development staging (allowing time for establishment of the Koala offset areas), there will be minimal net loss of Koala habitat during construction. Given this, together with the low density of Koalas in the local landscape, it is considered there is a very low risk that resident Koalas will be forced to move away from the local area in search of food or refuge habitat during the sites development. The creation of the three fauna corridors will also ultimately improve habitat connectivity and safe movement.

Corrective Actions

Regular monitoring of the local Koala population (as discussed in **Section 5.0**) will ensure the early detection of any increase in recorded Koala showing signs of disease.

Any recorded signs of disease will be immediately reported to the Project Manager (refer **Section 6.0**),who will arrange for the Daisy Hill Koala hospital to inspect and, if necessary, capture the infected/sick Koala for treatment.

The Project Manager will liaise with appropriate wildlife officers from DEHP to determine if the local Koala population are experiencing an increase in disease related illness and what management measures are required to reduce the risk of further Koala being impacted by disease.

5.0 MONITORING

Areas immediately adjacent to the development (i.e. within 100 m) will be surveyed within six months from the date of Commonwealth approval, and subsequently on an annual basis, for the presence of Koalas and/or Koala signs (scats and scratches) to provide baseline data.

Every five years for the first 15 years, a detailed survey of the local Koala population will be undertaken. The approach and techniques employed for this survey will be in accordance with the most up to date scientifically proven survey methodology.

Monitoring of retained, restored or newly established Koala habitats will be monitored in accordance with the Shoreline Open Space Landscape Strategy and the Koala Offset Deliver Plan.

Monitoring of fauna underpasses/overpass to determine if Koala are successfully moving through these will be conducted on a yearly basis commencing once this infrastructure has been established. The use of camera traps (dependent on security risks) and/or sand traps will be used to verify fauna usage of the underpasses/overpass. Inspections of fauna exclusion fencing will occur as part of the underpass monitoring.

5.1 PERFORMANCE CRITERIA

- Koalas are occupying habitats incorporated into the development and habitats adjacent to the development at densities that reflect average densities in comparable habitat within the local area;
- All retained, restored and newly established Koala habitats are showing signs of good vegetation health.

- No increase of dead, sick, or injured Koalas as a result of the development is recorded;
- Evidence of Koala and other native fauna using underpasses/overpass, with evidence increasing over time in response to revegetation progress.

5.2 REPORTING

A report will be prepared at the end of each monitoring period, noting any significant changes in measured variables, trends and conditions to ensure alignment with Commonwealth reporting requirements. The report is to include tabulated data (Koala census and Koala habitat quality) from all monitoring events to allow assessment of trends

A copy of the yearly report will be provided to DoEE.

6.0 MANAGEMENT RESPONABILITIES

6.1 SHORELINE REDLANDS (PRINCIPAL)

The roles and general responsibilities of the Principal are to:

- Comply with the Koala Impact Management Plan.
- Comply with the Queensland *Nature Conservation Act 1992* and subordinate legislation.
- Develop a community education program relating to Koalas.
- Nominate a Project Manager who will represent the Principal in reviewing the performance of contractors during construction or residents during occupation, issue instructions and variations, and be responsible for KIMP implementation.
- Promptly notify DoEE of any changes to this KIMP and its implementation, reporting or monitoring, and any breach of administrating authority conditions and proposed corrective action.
- Identify the locations for Koala tree offset plantings and submit to DEHP an Offset Delivery Plan for approval.

It will be the responsibility of the Principal to ensure that the contents of the KIMP are adequately communicated to all contractors/residents and visitors, and that they are advised of the consequences if the recommended actions are not observed.

6.2 PROJECT MANAGER

This Koala Impact Management Plan (KIMP) will be overseen by the Project Manager.

The Project Manager is responsible for:

- Ensuring the management measures outlined in this KIMP, including the community education program, are implemented prior to commencement of construction and occupation.
- Ensuring a review of this KIMP is undertaken in year 3 in the first instance and then at intervals of not less than five years, or sooner if required. Any significant or unexpected alteration in the development may require the KIMP to be revised and amended accordingly. Any changes or amendments proposed to the KIMP will be forwarded to DoEE for comment prior to their adoption.
- Administering a community education program for contractors/residents regarding the potential impacts to Koala during vegetation clearing, development activities and occupation and associated impact management strategies. This includes information for all contractors, employees, residents and visitors regarding dog and vehicle interactions with Koala.
- Ensuring a qualified fauna spotter has assessed any areas where vegetation is to be cleared prior to works commencing and to report on Koalas sighted during clearing, and keep such records for a period for at least five (5) years. The fauna spotter will remain on site during all clearing of native vegetation.
- Keeping up-to-date records of all incidence reports, monitoring events, results and corrective actions.

- Designate suitably experienced persons for the management and monitoring of the KIMP as required.

6.3 DESIGNATED PERSON

The roles and responsibilities of the Designated Person are to:

- Liaise with the Project Manager to facilitate compliance with legislation, Council policy and Commonwealth conditions during the development.
- Conduct audit inspections as required /requested during construction, and vegetation clearing, or other inspections as triggered by environmental events or incidents.
- Advise the Project Manager on the compliance and effectiveness of the KIMP/Site Instructions and its implementation.
- Immediately contact the Project Manager regarding any environmental incidents that have the potential to cause environmental harm, request written details within 24 hours of occurrence, and issue instructions for rectification/remediation to the Project Manager as soon as possible.
- Maintain accurate reports (incidents, near miss, results of monitoring) to be provided to DoEE within ten days of request.

6.4 FAUNA SPOTTER/CATCHER

A qualified fauna spotter/catcher, with demonstrated experience in Koala detection, will be appointed to conduct pre-clearing surveys of the site and to be present during vegetation clearing.

The fauna spotter will submit to the Project Manager a report that provides details of daily activities undertaken.

7.0 AUDITING

An appropriately experienced ecologist (e.g. Certified Environmental Practitioner) will inspect the development area at the start and end of each stage of development to ensure that mitigation measures stipulated in this KIMP have been implemented.

The results of annual monitoring and any incident reports will be submitted to the appointed auditor on a yearly basis for review to ensure that monitoring and management responses have been successfully completed.

8.0 REFERENCES

BAAM (2014). *Shoreline Ecological Assessment.* Report prepared for Shoreline Redlands and updated in 2016 in accordance with Commonwealth request.

BAAM (2016). *Shoreline Open Space Landscape Strategy.* Report prepared for Shoreline Redlands.

Department of the Environment (2014). *EPBC Act referral guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory.* Commonwealth of Australia.

Design Flow (2016). *Shoreline Redlands Water Sensitive Design Preliminary Advice.* Prepared for Shoreline Redlands.

Environmental Protection Agency (2006). *Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016*. Published by the Queensland Government.

(AKF 2015). National Koala Tree Planting List. Australian Koala Foundation.

VLC (2015). *Shoreline Urban Village, Redland Bay Road South - Traffic Impact Assessments Transport Modelling and Traffic Forecasts.* Report prepared by Veitch Lister Consulting for Fiteni Homes and Fox & Bell.

ATTACHMENT 7

Shoreline Economic and Employment Aspects Summary Report

Shoreline

Economic and Employment Aspects

Summary Report

Prepared for

Fox+Bell Group and Fiteni Homes

Prepared by

Giles Consulting International

June 2014

CONTENTS

1 Introduction

1.1 Purpose

The purpose of this summary report is to provide an economic and employment assessment of the proposed Shoreline development in Redland City. The report is prepared for Fox+Bell and Fitini Homes.

The Fox+Bell Group and Fitini Homes wish to engage closely with the Economic Development area of Redland City Council and with Economic Development Queensland as this work proceeds.

This summary report has been prepared to highlight the key issues as the basis for discussions with agencies as part of the pre-lodgment process. A more detailed economic and employment report will accompany the Development Application.

The objective of the engagement process with agencies is to ensure that as far as possible there is alignment between the economic and employment objectives sought for the Shoreline proposal and those sought by the state and local authorities.

The summary report examines the following:

- The Shoreline proposal and its economic goals,
- The current demographic, economic, business and employment needs in Redland City and major component parts of the City,
- The opportunities and strategies that are available to address economic and employment issues in Redland City,
- Sensitivity assessments of the impacts of the proposed Shoreline development on the social, demographic, economic and employment issues facing Redlands,
- The ability of the developer to deliver on the economic goals and objectives, and
- An economic development and employment strategy for Shoreline and how this can contribute to the achievement of local, regional and state objectives.

Following consultation with and responses from EDQ, RCC and other agencies, the Shoreline economic and employment statement will be further developed and will be submitted with the Development Application.

2 Background

2.1 Strategic Intent

Shoreline is a residential and employment centre located in southern Redland City and when combined with the adjacent Redlands Business Park is part of an integrated strategy to provide economic opportunity and employment in Redland City. The Redlands Business Park is also developed, operated and managed by Fox+ Bell.

The residential development at Shoreline and the number and mix of employment at

Shoreline and in the Business Park are designed to offer the opportunity to live and work in the same area.

2.2 Site

The Shoreline site is located off the Cleveland Redland Bay Road/Serpentine Creek Road, in the southern part of Redland City as shown in Attachment 1. The site comprises a total of 310Ha, of which the principals Fox+Bell and Fitini Homes own 230Ha and expect to own, control or have Cooperative Development Agreements for a total of up to 270Ha.

The Redlands Business Park is located on a 43Ha site in German Church road, in the southern part of Redland City, about 3km from Shoreline. The concept for the Business Park is to give residents the opportunity to find employment within their local area without having to travel to obtain employment. It is the only site in Redland City with a significant bank of vacant land for industry and employment purposes.

2.3 Planning and Development Status

A significant proportion of the Shoreline site is currently zoned as an investigation area under the Redland City Town Plan. The area was identified as an investigation area in the 2005 South East Queensland (SEQ) Regional Plan but not in the 2009 SEQ Regional Plan.

RCC is undertaking a review of its Town Plan scheduled for completion in 2014 with Draft Plans expected in late 2014. The SEQ Regional Plan is also undergoing review with a Draft expected later in 2014.

The Redlands Business Park is now about one quarter developed with an estimated 300 employees in 40 businesses. Planning approval is in place for the full development of the Park.

3 Shoreline Proposal

3.1 Vision

The vision for Shoreline is to create a balanced community that integrates economic, social and environmental planning that will enhance the Redland's region in the following ways:

- Be based on an economic strategy that not only reflects on the Redland City economy but addresses current local deficiencies, and
- The creation of destinations that will-
    - Minimise the leakage of wealth, services and jobs from the City
    - Creates new wealth and opportunity in Redland City, and
    - Attracts wealth earned elsewhere

Shoreline, taken in conjunction with the Redlands Business Park, is considered to be a catalyst project, which will create a balanced community by increasing investment, jobs and opportunity for Redland City. This is particularly critical for the adjoining Southern Moreton

Bay Islands that face considerable socio economic issues.

3.2 Key Components

3.2.1 Shoreline

The key components are based on the approximately 220Ha of developable land in the investigation area. The residual area will be used for extensive open space and environmental areas. The development has a 2km frontage to Moreton Bay.

Fox+Bell and Fitini Homes plan to develop an urban village containing 4,100 lots to cater for some 10,00 people.

Other key features of the proposal are:

- A discrete new village with readily identifiable boundaries accommodating up to 10,000 persons clustered about a small local commercial centre, which contains convenience retailing, cafes/restaurants and commercial facilities;
- A range of residential types and densities developed at an average of 15 dwellings/tenements per hectare;
- A 'new economy' development to provide up to 50% job self sufficiency by creating the correct economic and social settings with around 1,900 new jobs contained within the urban fabric;
- Build out time of 8-15years;
- A 29Ha foreshore park fronting Moreton Bay. This will include some conservation areas but will be mainly used for active recreation;
- Possible construction of a boardwalk including 2 small jetties about the town centre parkland. Possible construction of a major jetty in the north of the site;
- Creation of 2 major wildlife corridors connecting the coastal areas with habitat to the west of the site;
- Best practice including the integration of recreation areas and open space with storm water conveyance and treatment. Treatment areas where possible will be landscape features, and
- Vertical realignment of Serpentine Creek Road to accommodate the proposed intersections, a fauna overpass and 2 fauna underpasses.

Broadly it is expected that the following residential development will be achieved:

Table 1 Housing and Population

	Units	Population
High Density	114	205
Village Centre	740	1,332
Medium Density	760	1,368
Small Lot	1.185	3,081
Traditional	1.273	3,565
Total	4,072	9,551

Source: Shoreline

In addition to the housing development proposed, some 16,600m^2 of commercial, retail, recreation and community space, a P-12 school and a wide range of other community spaces will be provided.

The investment in civil works is estimated at $400m, the housing will require some $1700m, and the commercial and community development another $80-100m for a total of some $2.3b during the 8-15 year construction period.

The Shoreline proposal is based on achieving employment of 1,900 ongoing jobs in a mix of population serving and population supporting functions across a wide range of industry sectors including Education, Health, Recreation, Business Services and Tourism.

3.2.2 Redland Business Park

The Redlands Business Park comprises a 43Ha site with capacity to provide employment opportunities for some 1,700 people. A saleable area of 228,000m^2 is permitted for general industry and employment purposes.

The planning approval allows a wide range of business uses including the following activities: industry, business services, mechanical, construction services, food processing, high technology scientific services and warehousing.

Currently some 300 people are employed in the Business Park in 40 businesses, and there is capacity for a further 1,400 in the remaining 180,000m^2.

3.3 Track Record

The Fox+Bell Group's focus is on community development in Redland City. Their projects include residential, retail, commercial and industrial, many of which they have retained as investments. Major projects are:

- Redland Bay Village (The development started life as two disparate but adjoining strip shopping centres in an area designated by the council as a neighbourhood centre. Over a period of years, Fox+Bell amalgamated the sites and redeveloped them into a coherent centre focused on a main street);
- Victoria Point Lakeside (Completed in 2007, the 25,000m^2 mixed use shopping centre and life and leisure precinct, includes a 9-screen cinema complex);
- Orchard Beach (A premium quality waterfront estate located in Redland Bay, with 151 allotments with water frontage);

- Grosvenor Park (An 83 lot residential sub-division in Thornlands);
- Parklands (A 165 lot residential estate that was the first in Redland City designed to demonstrate sustainable housing design with over 25 percent of the development dedicated park and extensive rehabilitation of creek frontages and watercourses), and
- Redlands Business Park (A 43 hectare site situated at German Church Road is a new regional integrated employment centre which encourages job retention and growth within Redland City. It has the potential to employ 1,700 people with 9 hectares set aside for fauna habitat and rehabilitation.)

Fox+Bell has invested over $100m in these developments during the past 14 years, which has facilitated an additional $250m investment by other investors, homeowners, etc.

Fiteni Homes has been trading for over 40 years, has a solid reputation and a proven track record. Fiteni Homes is based at Capalaba in Redland City and services a market area that includes metropolitan Brisbane (including Bayside suburbs), Gold Coast City and the near north coast.

3.4 Corporate Capacity

The delivery of Shoreline is dependent on the ability of the principals and their advisors to plan and deliver a shovel ready project. The Directors of Fox+Bell and Fiteni Homes have extensive building and development experience and a commitment to the Redlands area. The Directors live and work in the area.

Fox+Bell was formed in 1986 and the Directors collectively are members of a wide range of business and community groups including:

- Housing Industry Association;
- Urban Land Development Institute;
- Former president of the Institution of Surveyors Australia QLD Division;
- Treasurer of the Redlands Institute;
- Board member Sheldon College;
- President Redland City Chamber of Commerce;
- Past President Australian Appaloosa Association;
- Executive member Redlands Farmers Cooperative;
- Committee member Friends of Peel Island;
- Executive member Redland Bay Residents Association, and
- Member Redland Bay P&C

4 Key Assessment Factors

The Shoreline proposal and its economic and employment objectives are assessed against:

- Queensland Government economic and employment objectives;

- Queensland Government planning objectives;
- RCC economic and employment objectives;
- RCC planning objectives;
- The needs of the Redland area based on the results from the 2011 Census including Journey to Work and other more recent data;
- Updated Population Estimates for the area;
- Community expectations based on surveys;
- Forecast population growth for Redland City and its component areas, based on the 2013 Queensland Government Projections;
- Employment needs in the area;
- The employment and economic impacts likely to be generated or created by the Shoreline Project, and
- The contribution the Shoreline project would have in meeting clear needs in the Redlands area.

5 State Objectives

5.1 Economic Development and Employment

In recent years there have been significant changes in State policy towards economic development and employment generation and the importance these factors should receive in considering planning matters.

The principal statements, policies and actions have included.

- Development of the *Four Pillars Economic Policy* (2012), based on cutting red tape and regulation, speeding up project approvals for business to help get Queensland's economy growing and creating jobs;
- *Governing for Growth* enabling a stronger Queensland economy (2013),
- Release of *Governing for Growth* Economic Strategy and Action Plan (2014) as a whole-of-government strategy that ensured all government departments and entities are focused on growing the state's economy and delivering the aspirations and targets to be set out in *The Queensland Plan;*
- The establishment of Economic Development Queensland (EDQ) as the state government's streamlined business unit for residential, urban and industrial development with its primary focus to facilitate economic development throughout Queensland, and
- Development of the *Queensland Plan* (due mid 2014).

The common themes in these initiatives are to increase productivity, achieve higher employment and facilitate low unemployment. Furthermore, the planning system is being redesigned to give greater weighting to economic and employment factors in considering planning matters.

5.2 SEQ Plan

The 2005 SEQ Plan identified the subject area as an investigation area. The 2005 Plan's narrative forecast the subject site would be suitable for development in 2010 to 2015. Notwithstanding this, the site was removed from the urban footprint in the 2009 Plan.

The *South East Queensland Regional Plan 2009-2031* (SEQ Plan) is still the formal regional planning policy, but a revised draft is expected in late 2014. The restrictive features of the SEQ Plan 2009 are increasingly at variance with the Government's planning and economic development objectives. For example the previous Government's *Q2 Vision* that underpinned the SEQ Plan 2009 vision and targets in the region has been replaced.

Notwithstanding the mooted changes in the expected draft SEQ Plan, the key economic and employment objectives in the 2009 SEQ Plan included:[1]

- Future employment growth will be accommodated within urban areas through a combination of activity centres, specialised employment precincts and limited home-based business;
- By consolidating urban growth into an identified area, travel times and distances can be greatly reduced and accessibility to essential services improved;
- The impacts of traffic congestion on the region can be greatly reduced by locating self-contained activities in well defined nodes along existing and planned transport corridors;
- Plan for employment to support a strong, resilient and diversified economy that grows prosperity in the region by using its competitive advantages to deliver exports, investment and sustainable and accessible jobs;
- Attractive living and working environments, and lifestyle opportunities, are essential to create communities with high levels of self-contained employment, and
- To achieve balanced growth, consideration needs to be given to the identification of additional business and industry needs in appropriate locations throughout SEQ.

In relation to Redland City, the SEQ Plan (2009) notes that:

- Approximately 20,000 extra dwellings will be required (based on then population and housing projections);
- Low employment self containment needs to be addressed, and
- The timely provision of infrastructure, particularly for transport is essential.

It is expected that the broader State Queensland Plan and State economic development and employment objectives and strategies would underpin the revised SEQ Plan.

6 Redland City Council Objectives

6.1 Economic Development Strategy

It is understood that RCC has developed and adopted a new Economic Development Strategy, but to date it has not been publicly released.

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[1] *South East Queensland Regional Plan 2009-2031.*

The former 2008-2012 Redland City Economic Development Strategy contains the following:

> *Economic development is a sustainable increase in living standards that delivers increased income, better education and health as well as environmental protection, and*
>
> *The economic vision of Redland City is one of lifestyle – a great place to live, work and play. The vision includes the development of a vibrant and sustainable economy with a strong local workforce and a high level of self-containment.*

The economic development strategy goals included:

- *Developing an appropriately trained workforce;*
- *Encouraging the establishment and growth of appropriate businesses;*
- *Optimising the use of scarce natural assets;*
- *Promoting the region as a great place to live, work and play, and*
- *Working together (a partnership with the community and the region) to achieve common goals.*

The Strategy noted that:

> *Redland City has a relatively low level of employment self-containment. The city currently has a workforce of around 61,000 workers. Approximately 60 per cent of these travel outside of the city to work every day. To increase employment self-containment to a more acceptable level of around 60 per cent will require approximately 22,500 jobs in the next 18 years.*
>
> *The current low level of employment self-containment causes stress, clogs arterial roads, generates pollution and impacts lifestyle. Providing more jobs in Redland City, increasing self-containment, and matching the skill base to industry sectors in which the city has a competitive and comparative advantage, would significantly reduce a number of these problems.*

The Strategy also noted that:

> *In order to ensure sustainable economic growth, it will be necessary to create the right conditions for business to thrive. This will be achieved through focusing on the development of economic 'enablers'. The 10 key enablers are:*
>
> - *Export generation (international and/or inter-regional);*
> - *Local substitution for imports;*
> - *Self-containment of services (in sub-region);*
> - *Investment attraction;*
> - *Workforce capability enhancement;*
> - *Strategic infrastructure development;*
> - *Creation of new businesses from within;*
> - *Availability of investment capital;*
> - *Competitive economic conditions, and*
> - *Innovation.*

Many of the economic and employment needs evident in 2008 are also apparent today, so it would be surprising if similar underlying themes were not repeated in the new RCC Economic Development Strategy.

6.2 Redland City Plan

The site is currently zoned as an investigation area under the Redland City Town Plan.

RCC is undertaking a review of its Town Plan scheduled for completion in 2015 with Draft Plans later in 2014.

More details are provided in Shoreline Planning Reports.

6.3 Other Redland City Strategies

RCC has a wide range of other Strategies that bear to some degree on the economic and employment issues including:

- Tourism Strategy for the Redlands 2010-2014;
- Redlands Social Infrastructure Strategy 2009;
- Redlands Housing Strategy 2011-2031;
- Redland City Centres and Employment Strategy 2010, and
- Draft Redlands Local Growth Management Strategy 2008;

6.4 Common Themes

The common and recurring themes from the State Government and RCC policies and strategies include:

- Increased economic and employment growth achieved in a balanced way;
- Increased employment self containment for Redland;
- Increased wealth and community well-being achieved by increased employment, higher wealth self-containment, reduced income leakages and attraction of income and wealth from elsewhere;
- Need for private capital to undertake the investment and the efficient use of scarce public capital;
- Increased investment in infrastructure, particularly for public transport, and
- To address particular socio-demographic needs in the region for social infrastructure, jobs and housing in particular for residents of the Moreton Bay Islands.

In addition, at the Commonwealth level there is strong policy support for adjusting to the downturn in mining investment with a shift of resources to investment in residential, commercial and infrastructure. The Commonwealth’s strategies are underpinned by objectives to increase participation in employment and productivity.

The key for Shoreline is to align with these policies, strategies and associated actions.

7 Economic Needs Assessment

7.1 Relevant Catchments

The economic and employment needs of the Redlands area are assessed on the basis of the following units:

- Redland City LGA that comprises the two Statistical Area Level 3 areas of Capalaba (except for Belmont-Gumdale which is in Brisbane City Council area), comprising the northern part of the Redland City and Cleveland-Stradbroke SA3 to the south (except for about 3% of the area and 310 people on Redland Islands which is also located in Brisbane City, and
- Particular attention to the southern Cleveland-Stradbroke area and the Redland Islands SA2.

Maps for these areas are shown at Attachment 2.

7.2 Overview

In general, Redland City, particularly the southern part, experiences broadly similar characteristics to many other areas on the fringe of the Brisbane metropolitan area including:

- Relatively high population growth;
- A lack of local employment opportunities;
- A concentration of employment in those sectors that serve the population;
- Public transport under pressure;
- Inadequate employment opportunities for the emerging school leavers and young adult cohorts;
- High private costs in time and transport and high public costs in providing transport infrastructure to deal with the demands, and
- The need for investment to deal with these imbalances.

Redland City also experiences a significant problem of high unemployment, low socio economic status, poor transport and high social needs among residents living on the Southern Moreton Bay Islands (Redland Islands SA2).

The orientation of the examination of the economic and employment base for Redland City and its component parts is to focus on those factors that contribute directly to increased Gross Regional Product (GRP) and indirectly to community wellbeing. This structure focused on the GRP drivers which are principally wages and salaries, and to a lesser extent profits and government transfers.

The main driver for GRP and per capita GRP is wages and salaries, which in turn depend on:

- Labourforce participation rates and workforce participation, and ultimately to age structure and employment opportunities;
- Hours worked (to overcome the measurement problems of including anyone as employed if they worked for only one hour per week), with more hours worked generally leading to higher incomes and higher GRP per capita;
- The industry and occupation structure that drives wages and salaries, so an area with a higher proportion of industries that typically pay higher wages than another industry will have higher incomes and higher per capita GRP, and
- The average incomes that reflect the above factors.

Through both the consumption and labour supply side, population growth is also a key variable.

The advantage of this approach is that it avoids a large data set of descriptive factors that usually lead to ‘so what’ responses.

These characteristics are examined in more detail in the following sections that provide the foundation for the economic and employment needs assessment and the degree to which the proposed development can help address some of these issues.

7.3 Population

7.3.1 Past Growth

The main features of the population growth in Redland City from 2003 to 2013 is the steady overall population growth of 19.6%, and the significantly faster growth in the southern Cleveland – Stradbroke SA2 of about double that at 35.7%. This compares with 5.6% for the northern area.

Table 2 Population Growth 2003 to 2013

Capalaba SA2	2003	2008	2013	Change 2003-13	Percent Change
Alexandra Hills	17713	17255	17367	-346	-2.0%
Birkdale	14057	14505	15159	1102	7.8%
Capalaba	17649	17478	17701	52	0.3%
Thorneside	3562	3598	3741	179	5.0%
Wellington Point	9782	10921	11752	1970	20.1%
Total Capalaba SA3 except Belmont Gumdale	62763	63757	65720	2957	5.6%
Cleveland – Stradbroke SA2					
Cleveland	13577	14343	15390	1813	13.4%
Ormiston	5468	5741	5954	486	8.9%
Redland Bay	8593	12718	14670	6077	70.7%
Redland Islands	6684	8014	9173	2489	37.2%
Sheldon - Mount Cotton	4629	5611	7203	2574	55.6%
Thornlands	8577	12245	13736	5159	60.1%
Victoria Point	12917	14640	15904	2987	23.1%
Total Cleveland - Stradbroke	60445	73312	82030	21585	35.7%
Redland City	**123208**	**137069**	**147750**	**24542**	**19.6%**

Source: ABS 3218.0 Regional Population Growth Australia. 2014

The overall pattern of settlement is reflected in the population growth with the northern well-established areas growing slowly or even declining as in the case of Alexandra Hills and the more rapid growth on the southern fringe, in particular in Redland Bay and Sheldon-Mt Cotton. The proposed Shoreline development represents the normal extension of the well-established pattern of development in Redland City,

7.3.2 Projected Growth

The Queensland Population Projections (2013 Edition) show the same broad patterns of projected growth for the period 2011 to 2036 with the southern Cleveland-Stradbroke SA3, growing much faster than the northern area to the extent that by 2036 the southern part of Redland City is significantly larger (119,026) than the northern longer established Capalaba SA3 part (87,568).

Table 3 Redland City Projected Population Growth 2011 to 2036

Capalaba SA2	2011	2036	Change 2011-2036	Percent Change
Alexandra Hills	17,306	18,750	1,444	8.3%
Birkdale	14,914	19,185	4,271	28.6%
Capalaba	17,557	23,427	5,870	33.4%
Thorneside	3,672	4,127	455	12.4%
Wellington Point	11,397	14,085	2,688	23.6%
Total Capalaba SA3 In Redland City	64,846	79,575	14,729	22.7%
Cleveland – Stradbroke SA2				
Cleveland	15,033	21,623	6,590	43.8%
Ormiston	5,830	7,864	2,034	34.9%
Redland Bay	14,038	20,081	6,043	43.1%
Redland Islands	8,955	13,853	4,898	54.7%
Sheldon - Mount Cotton	6,717	10,492	3,775	56.2%
Thornlands	13,294	23,930	10,636	80.0%
Victoria Point	15,307	21,181	5,874	38.4%
Total Cleveland - Stradbroke	79,174	119,026	39,852	50.3%
Redland City	**143,711**	**198,290**	**54,579**	**38.0%**

Source: Projected population (medium series), by statistical area level 2 (SA2), SA3 and SA4, Queensland, 2011 to 2036. 2013 Edition. Note that there is a difference of between 309 and 311 between the sum of the component SA2 areas and the Projections for Redland City as about 3% of the Redland Islands is in Brisbane City.

The 2013 Edition of the Queensland Population Projections shows a marginal increase for a given future year, over the 2008 Queensland Population Projections that underpinned the SEQ Plan 2009.

7.3.3 Demographic Profile

Redland City has a population profile that is broadly similar to that for Greater Brisbane area, but this comprises the northern part (Capalaba SA3) that is slightly younger and Cleveland-Stradbroke that has a high proportion of the population over 65.

The other striking feature of the Cleveland-Stradbroke area is the relatively low proportion of the population in the most economically active age groups from 15-60 years.

The lower proportion of economically aged population and the higher proportion of older people has significant structural influences on the economic base of the area. Generally labour force participation will be lower, incomes lower and wealth generation lower than in those areas with a higher proportion of the population in the economically active population and with higher labourforce participation.

Without a structural change in the population age structure in the Cleveland-Stradbroke area, through population growth and renewal, there is limited scope to achieve the increase in income and wealth objectives that are sought by RCC and are also included in the Shoreline objectives.

Table 4 Age Profile 2011 (%)

Age Structure	0-14	15-64	65 and over	Total
Capalaba SA3	20.4	68.1	11.5	100.0
Cleveland Stradbroke SA3	19.9	63.6	16.5	100.0
Redland LGA	20.1	68.1	11.8	100.0
Greater Capital City Brisbane	20.1	68.1	11.8	100.0

Source ABS Census

7.4 Employment

7.4.1 Employment Status

The employment status data for Redland City were broadly similar to those for Brisbane.

The key employment status indicators of labourforce participation (the labourforce as a percent of the total population) and workforce participation (the workforce as a percent of the total population) for Cabalaba SA3 were about the same as or better than those of Greater Brisbane. However, for Cleveland-Stradbroke SA3 the participation rates were much lower than those of Capalaba or Greater Brisbane. Unemployment in Cleveland-Stradbroke SA3 was marginally higher than in Cabalaba SA3 as was the proportion of people working part time.

Table 5 Labourforce Status 2011

	Capalaba SA3	Cleveland Stradbroke SA3	Greater Capital City Brisbane
Worked Full time	23315	22300	654897
Worked Part time	10893	11312	296515
Away from Work	2086	2072	59204
Worked	36294	35684	1010616
Unemployed	1977	2038	62863
Labourforce	38271	37722	1073497
Population	69943	76459	2065996
Unemployment Rate	5.2%	5.4%	5.9%
Labourforce participation	54.7%	49.3%	52.0%
Workforce participation	51.9%	46.7%	48.9%
Full time Percent	64.2%	62.5%	64.8%

Source ABS Census Community Profile Place of Residence Usual Residence basis

The employment status clearly reflects age structure, but may also reflect lower employment opportunities in southern Redland City. A pattern of average unemployment rates coupled with lower participation and more part time work is often an indicator of discouraged workers who are neither working nor looking for work, or would work more hours if the opportunities were available.

A greater number and range of employment opportunities in southern Redland City is a clear economic and social goal.

7.4.2 Hours Worked

The proportion of the workforce working full time (35 hours and more) was broadly similar for Capalaba SA3 and Greater Brisbane and marginally higher than for Cleveland-Stradbroke SA3. Correspondingly, a higher proportion of the workforce worked shorter hours in Cleveland-Stradbroke SA3

Overall there is not a significant difference in hours worked between each of the areas.

7.4.3 Income

Median personal income for Redland City residents at the 2011 Census was $38,425, $7,286 less than the Queensland median at $45,711.

Personal Income and Family Income in Capalaba SA3 were above those for Brisbane at the 2011 Census, but those for Cleveland-Stradbroke SA3 were well below, at 91.6% of the Brisbane level for Personal Income and 96.7% for Family income.

Lower average incomes reflect the lower participation rates, the fewer hours worked and slightly higher unemployment rate for Cleveland-Stradbroke SA3. Lower incomes flow on to lower consumption.

7.4.4 Industry and Occupation of Employment

The industry and occupation of employment reflect the economic base of the area and can have a major impact on average incomes and hence wealth.

However, the usual residence basis of the population that has been considered to date is limited for these characteristics as less than half the Redland City resident based workforce work in Redland City. The industry of employment for residents of Capalaba SA3 and Cleveland-Stradbroke SA3 are very similar. On a place of residence basis the main industries are summarised below.

Table 6 Residence Based Main Industry of Employment (%)

	Capalaba SA3	Cleveland Stradbroke SA3
Health care and social assistance	11.8%	11.6%
Retail trade	11.6%	10.9%
Manufacturing	11.0%	10.0%
Construction	10.6%	11.5%
Education and training	7.1%	7.4%
Professional, scientific and technical services	6.7%	6.3%
Public administration and safety	6.1%	5.6%
Transport, postal and warehousing	6.1%	5.6%
Accommodation and food services	5.1%	5.6%
Wholesale trade	5.0%	4.9%
Other	18.9%	20.7%
Total	100.0%	100.0%

Source ABS Census Community Profile Place of Residence Usual Residence basis. The Capalaba SA3 data includes the Belmont Gumdale SA4 area, but as the characteristics of the area are broadly representative of the rest of Capalaba SA3 area, and it is 5% of the Redland City population its inclusion is not considered misleading.

On a residence basis there is a focus on primarily population serving employment in Health, Retail, Education and Training, and Construction.

From 2006 to 2011 the largest increases in employment took place in Health Care, Construction, Education and Training and Accommodation and Food Services.

Based on work by the National Institute of Economic and Industry Research, the Redland City Profiles assessed that when hours worked are taken into account to provide Full Time Equivalent employment, the key industries of employment on a residence basis for Redland City are:

- Construction, 14.6%;
- Retail, 13.9%;
- Health Care, 12.9%;
- Education and Training, 8.9%, and
- Manufacturing, 8.6%.

On a place of work basis, there are important differences between Capalaba and Cleveland-Stradbroke, with the importance of the retail centres in Capalaba apparent. Conversely Health Care and Accommodation and Food Services are more important for Cleveland Stradbroke.

Table 7 Workplace Based Main Industry of Employment (%)

Industry	Capalaba SA3	Cleveland Stradbroke SA3
Retail trade	20.1%	12.2%
Health care and social assistance	11.2%	16.3%
Construction	10.0%	7.8%
Education and training	10.0%	10.0%
Manufacturing	8.5%	9.0%
Accommodation and food services	6.8%	9.0%
Professional, scientific and technical services	5.7%	5.6%
Other services	5.3%	4.0%
Wholesale trade	4.8%	2.8%
Transport, postal and warehousing	3.4%	2.9%
Other	14.2%	20.7%
Total	100.0%	100.0%

Source ABS Census Community Profile Working Population

Surprisingly the Construction employment in Cleveland-Stradbroke is relatively low on a workplace basis compared with a residence basis, which means many construction workers living in the area need to leave the area to work.

7.4.5 Location of Employment

On most employment indicators, Redland City and its major geographical components perform quite well, such as participation rates and unemployment rates. However the major issue facing Redland City is the lack of local jobs relative to the population and hence low employment self-containment.

The objective of seeking higher levels of employment self-containment to reduce the demand on infrastructure, particularly transport, underpins the SEQ 2009 and previous Plans and it would be surprising if it were not the case in the forthcoming SEQ Plan review.

While the concept of employment self-containment underpins much planning and the benefits are self-evident, the measures of employment self-containment require careful assessment.

It would be reasonable based on distance and identifiable separate labour markets that areas such as the Sunshine Coast would have high levels of employment self-containment and a low leakage to Brisbane, whereas Redland and Logan cities due to proximity and economic integration in the Brisbane labour market would have lower employment self-containment levels.

There are also major issues with the ABS workplace location as some 20% of respondents do not identify a place of work, and the assumption needs to be made that they are distributed like those who do state a workplace location. The level of underreporting is much higher in some inherently mobile industries, such as construction, than in more geographically stable industries such as public administration, education and health.

The transport benefits of higher local employment also need to be balanced against the productivity and efficiency benefits of clusters or higher concentrations of employment. Planning needs to balance these competing objectives.

In addition, the employment self-containment data needs to be considered in context. For example there are areas of Logan City much closer to Shoreline than some of the northern parts of Redland City. Cross LGA boundary movements mean lower employment self-containment (an undesirable objective), even though it is a shorter trip and creates lower public and private costs (a desirable objective) than a longer trip within Redland City.

There is also evidence that workers in Cleveland-Stradbroke SA3 travel south ‘against the tide’ to Logan and Gold Coast to a greater degree than those in the northern Redland City area, and going against the tide balances flows and makes better use of existing roads infrastructure.

Nevertheless the population growth and employment growth for Redland City are out of balance. Not only does this create more demands for infrastructure, but it also results in leakages of income and expenditure away from Redland City with the result that actual economic performance is likely to be well below that implied in residence based Census results.

While it is hard to define a level of employment self-containment that should be the target for Redland City, it is clear that a development such as Shoreline and the associated Redlands Business Park should not make matters worse, and in effect make a positive contribution to the jobs balance.

Increased employment opportunities relative to population growth are likely to provide private benefit to residents, benefits to the developer by being able to command higher residential land prices and benefits to the state and local governments in the form of lower infrastructure demands and consequent investment.

In terms of the place of residence and place of work relationship the Census provides the best basis for assessments reinforced by Journey to Work Surveys conducted by the Queensland Department of Transport and Main Roads that provide average commuting travel distances for key areas is SEQ. It should be noted however that the Department of Transport and Main Roads report *Travel in South East Queensland* May 2012, unfortunately does not include Redland City as either a workplace origin or destination as Redland City is included in the Brisbane data.

The Queensland Department of Treasury and Trade has undertaken a major exercise to adjust for underreporting of place of residence and place of work. The LGA based results at the 2011 Census show:[2]

- In terms of the balance of the number of people from an area and the number of jobs in the area, Redland was among the LGAs in SEQ with the highest relative jobs deficiency of 38.9% (resulting from an employed population of 73,278 and 44,781 jobs located in the city (Moreton Bay LGA was highest at 39.1%);
- In terms of the proportion of employed population working in the same LGA, Redland was among the lowest in SEQ with 46.6% of the residents working in Redland, and 43.9% working in Brisbane (Logan was lowest at 44.0%), and

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[2] Unpublished Census Journey to Work data provided by Queensland Department of Treasury and Trade.

- Of all the jobs in Redland City, Redland residents had 76.3%, with small reverse flows from Brisbane residents (4.1%) and Logan residents (3.8%).

The overall journey to work data for SEQ in 2011 needs to be analysed carefully as it shows:

- Overall the SEQ system is in balance, but the distribution of the location of residence and jobs is out of balance on an LGA level;
- The importance of distance as the key metric rather than merely crossing an LGA boundary;
- The importance of relatively separate labour markets (Sunshine Coast/Noosa and the Gold Coast) all with high employment self-containment;
- The integration of the Brisbane labour market with Redland, Moreton Bay and Ipswich having generally similar characteristics;
- The over concentration of employment in Brisbane, and
- The confounding impacts of the location of LGA boundaries.

In the absence of careful analysis there is the clear risk of planning over reactions.

Notwithstanding the qualifications, there is a clear need for more jobs in Redland to provide a better balance between jobs in the City and residents in the City seeking employment.

Further fine-grained analysis of the journey to work patterns of Capalaba SA3 and Cleveland-Stradbroke SA3 residents by workplace destination of work also at the SA3 level show the following:

- There are important differences in travel patterns between Capalaba SA3 and Cleveland-Stradbroke SA3 residents, with Capalaba SA3 residents much more likely to work in Brisbane (44.9%), compared with Cleveland-Stradbroke SA3 residents (30.5%);
- About twice the proportion of Capalaba SA3 residents (10.2%) work in the adjacent area of Wynnum-Manly SA3 as do the residents of Cleveland-Stradbroke SA3 (5.4%);
- Also a much higher proportion of Capalaba SA3 residents (16.7%) work in the Inner Brisbane SA3 as do the residents of Cleveland-Stradbroke SA3 (11.5%);
- Capalaba SA3 residents are slightly more likely to work in the adjacent South Brisbane (13.4%) compared with 10.2% for Cleveland-Stradbroke SA3 residents, and
- Overall there is much less outflow of Cleveland-Stradbroke SA3 residents travelling to other areas for employment with 34.0% living and working in the same SA3 area compared with 23.6% of Capalaba SA3 residents.

This analysis also points to the fact that residents in the southern Redland City area are more likely to work locally, less likely to travel further for jobs, more likely to travel ‘against the tide’ to Logan, Gold Coast and Ipswich and thus less likely to create additional demands on transport infrastructure than residents of the northern parts of Redland City.

7.4.6 Industry Basis of Location of Employment

In terms of the relationship of the industry basis of local jobs, compared with the employed residents in that industry, Redland City has high ratios for:

- Accommodation and Food Services, 0.97
- Agriculture, 0.90;
- Retail, 0.83;
- Education and Training, 0.79, and
- Health care, 0.73.

There are low ratios of local people in an industry and jobs in that industry for:

- Transport, 0.29;
- Financial and Insurance Services, 0.32;
- Public Administration and Safety, 0.37;
- Wholesale, 0,38 and
- Professional Scientific and Technical Services, 0.44.

This means that there is a better overall balance between jobs in an industry and people from Redland City working in that industry for Accommodation and Food Services, Health and Education for example than for those industries with lower ratios.

Taking the income of the industry of employment into account there is a mix of higher and lower paid industries where Redland City has better or worse employment ratios. For industries with high ratios, Education and Training and Health care tend to be better-paid industries, but Accommodation and Food Services and Retail less well paid.

There is also a mix in those industries with low ratios, but on balance there is likely to be a net loss of income potential for Redland as a result of the availability of jobs balance for Redland City. It is however important to note that the local jobs may or may not be filled by local residents.

The ratio of employment self-containment on an industry basis, (that is the number of residents employed in Redland City and working in that industry in Redland City), shows broadly similar patterns to the above with high levels of employment self-containment (relative to the average for Redland City of 40.1%) in:

- Accommodation and Food Services, 67.3%
- Agriculture, 62.5%;
- Retail, 58.7%;
- Rental and Hiring/Real Estate, 55.4%,
- Health Care, 52.0% and
- Education and Training, 46.7%

There are low levels of employment self-containment in:

- Transport, 21.4%;
- Public Administration and Safety, 27.3%,

- Wholesale, 27.7% and
- Financial and Insurance Services, 27.8%, and
- Construction, 29.7%;

From 2006 to 2011, there was virtually no change in the level of employment self-containment, from 39.9% in 2006 to 40.1% in 2011.

7.4.7 Socio Economic Status

The Socio-Economic Indexes for Areas (SEIFA) has been developed by the ABS and ranks areas in Australia according to relative socio-economic character. The indexes are based on a wide range of information from the 2011 Census with different indexes using different factors and weightings.

SEIFA 2011 consists of a set of four Indexes:

- Index of Relative Socio-economic Disadvantage (IRSD),
- Index of Relative Socio-economic Advantage and Disadvantage (IRSAD),
- Index of Education and Occupation (IEO), and
- Index of Economic Resources (IER).

The Indexes indicate the collective socio-economic characteristics of the people living in an area. The scores are a weighted combination of the selected indicators of advantage and disadvantage that have been standardised to a distribution with a mean of 1000 (the national average).

The Indexes allow comparisons between Redland City and its component parts with other regional cities in Queensland, with Brisbane and with all other local government areas and similar areas in Australia. Significantly, the Indexes are based on place of residence not place of work.

The Indexes are widely used by Commonwealth and State agencies to measure relative need.

The main points from the overall summary Socio-Economic Index of Advantage and Disadvantage for Redland City are that:

- Redland City has a score of 1030, against the national average of 1000, meaning that Redland City has characteristics that are above the national average;
- Redland City ranks below Brisbane (1057) but above the other major regional areas of Gold Coast (1016), Sunshine Coast (1001) Moreton Bay (999) and well above Logan (965) and, Ipswich (960);
- The above pattern was reflected in the other Indexes with Redland City ranking behind Brisbane, but above the other regional areas;
- In the case of the Index of Education and Occupation, that broadly measures education, qualifications and occupational rankings, the same patterns applied but Brisbane was the only area scoring more than the national average (1072), with Redland City at 983, but above the other regions.

At the SA2 level (essentially suburbs), there are differences with some areas such as Wellington Point, Sheldon-Mt Cotton and Ormiston ranking well above the average for Redland City and other areas Thornside and Alexandra Hills ranking below average. There is one significant standout and that is the Redland Islands SA2 area.

The Redland Islands SA2 area has SEIFA rankings that are among the lowest in Queensland

On the broadly based Index of Relative Socio-economic Advantage and Disadvantage, the Redland Islands in the bottom 20 SA2 areas of more than 500 SA2 areas in Queensland. It ranks above the remote aboriginal communities of Yarrabah, Aurukun and Palm Island that are the lowest in the state but it has socio economic and related needs that are similar to Woodridge, Kingston, Eagleby and Inala, in Logan City. The difference is that overall Redland City SEIFA scores are relatively high for SEQ, but those of Logan are relatively low, therefore the relative difference is greater.

Some of the issues facing Moreton Island Residents are addressed in the University of Queensland report *Concentrating disadvantage through housing processes: Local perceptions, experiences and responses in Logan and Russell Island*, Queensland. (2014). The areas of disadvantage identified in this report are the same as those in the SEIFA results considered above.

The difference in scale in SEIFA scores in the southern part of Redland City are stark and point to the need for a wide range of services. Chiefly among them are employment opportunities in the area to fit the skill base of those in need on the Redland Islands.

In summary on SEIFA rankings, Redland City performs well, behind Brisbane but with better scores than other major regional centres in SEQ. However, there is a glaring problem in meeting the needs of residents of the Moreton Bay islands (Redland Islands SA2) in the south of the city.

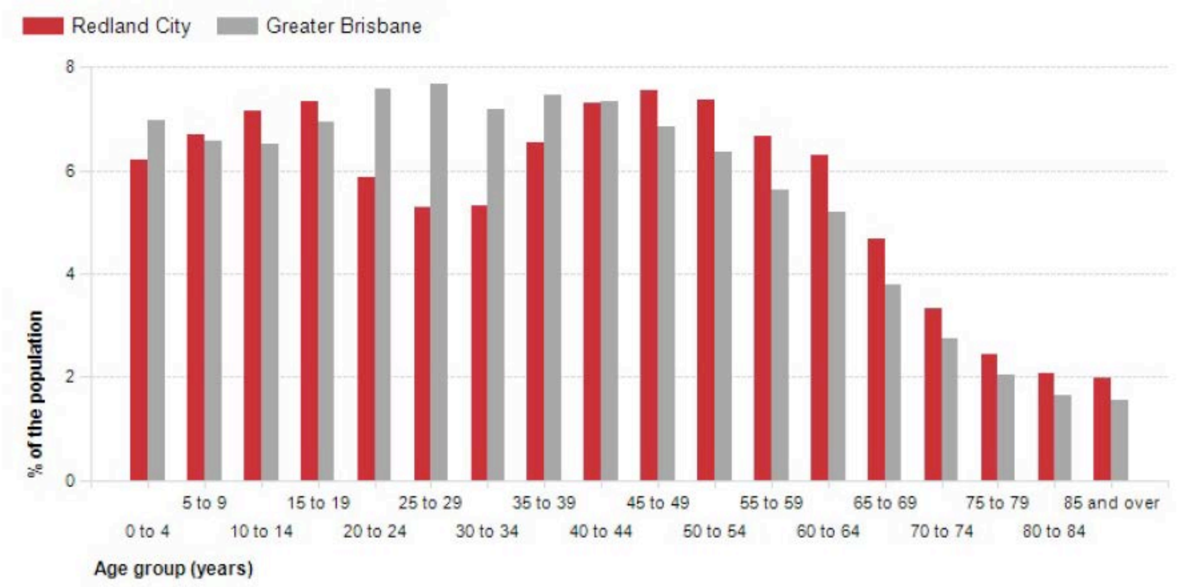
The need is for a wide range of social and community services, which are outside the scope of this assessment, but also for increased work opportunities in the southern part of Redland City.

7.4.8 Other Characteristics

A wide range of secondary research was undertaken that identified the following key features of the Redland's economy and employment structure:

- Redland City has higher proportions of both young people (5-19 years and those over 45 years than Brisbane) but correspondingly lower proportions in the prime economically active age groups from 20-44 years), which has significant impacts on labourforce participation, income, consumption and wealth.
- There were also particularly high rates of growth from 2006 to 2011 for those aged over 50 years and particularly slow growth in those 30 to 50 years, again in the prime economically active age group.

Chart 1 Age Structure Redland and Greater Brisbane



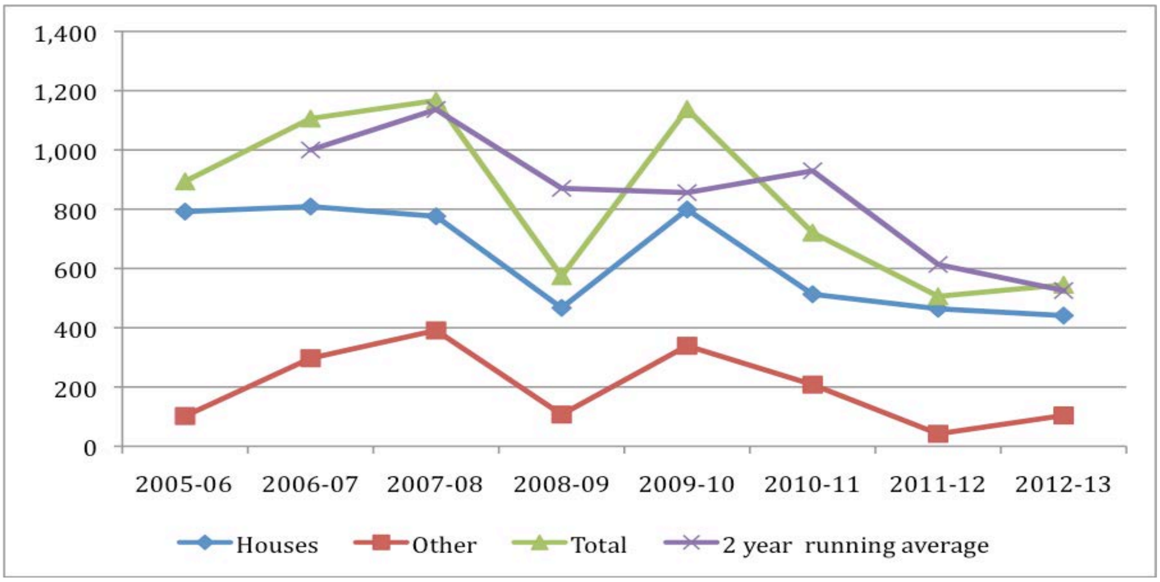
The Redland City Community Profile and Economic Profile shows that at the 2011 Census:

- Redland City had a lower proportion of the population with bachelor degrees or higher, than Brisbane, but higher levels of vocational qualifications, which reflect the employment base of the City;
- A relatively low proportion of jobless families;
- A relatively low proportion of working age people receiving income support or unemployment benefits;
- A relatively low proportion of the population of indigenous heritage, but high unemployment rates for this group of the population;
- About average Queensland rates for youth disengaged in either education or employment;
- Youth unemployment rates are higher in the southern Redland City area;
- Low income and Housing stress are particularly noticeable on the Moreton Bay Islands;
- Redland City residents relied on a car as a driver for 65.8% and 5.1% as a passenger of the trips to work compared with 7.0% for public transport, which compares with Greater Brisbane of 12.9% for public transport, 58.8% as a car driver and 5.5% as a car passenger, and
- Dependence on cars to travel to work increased marginally from 2006 to 2011.

7.4.9 Building and Construction

In recent years there has been a significant decline in residential construction in Redland City with the total number of Houses and Other dwellings running at levels in 2012/13 that were less than half those in 2005/06 and 2007/08.

Chart 2 Building Approvals Redland City 2005/06 to 2012/13



Australian Bureau of Statistics, Building Approvals, Australia (8731.0

In a community where Building and Construction employment is a significant part of the labour force, the pressure to move out of the city to find work elsewhere is likely to have a significant effect on employment self-containment and also the objectives of building increased income, wealth and consumption expenditure in the City.

7.4.10 Community and Business Attitudes

Community attitudes that have bearing on economic and employment issues have been assessed by several studies. A survey of 31 Redland businesses in 2014 found that:

- Overall 74% of the business customer base was accounted for by Redland City residents, the “export” based customers comprising customers elsewhere in Brisbane (11%), other Queensland customers (3%), 8% for customers in other parts of Australia and 3% foreign exports.
- The businesses in the retail and commercial areas were much more dependent on the local residents and those in the Redlands Business Park have a much higher proportion of their business generated outside Redland City and hence attracted income to the City;
- There were marked differences between the reliance on Redland residents-
    - Extremely high for retail, food and personal services (generally 90-95%),
    - Businesses providing professional and consulting services and those in trades had over 40% of their business being generated outside Redlands/Brisbane, and
    - Business in the Redlands Business Park showed a greater propensity to export to Brisbane, other parts of Australia and overseas.
- The main business issues were clustered around several themes, as follows:
    - 25% were doing well, or had no issues

  - 23% were seeking more business, wanted more development and greater population
  - 12% commented on deficiencies in hard and soft infrastructure such as poor IT communications, poor public transport and a lack of skilled labour as limiting their business
  - 34% had a range of complaints concerning-
    - Too much competition (14%),
    - General high costs (8%),
    - Landlord issues (6%)
    - Parking (3%), and
    - Too much red tape (3%).
  - The remaining 6% of issues raised covered a range of business specific matters.

A community-based survey involving over 600 responses was undertaken in 2013 by Internet Thinking. The main findings in relation to economic and employment issues were:

- Residents were seeking better roads for those commuting to Brisbane to work;
- The need to create local employment was important for many respondents, and
- A major dislike about living in Redland City was the need to commute to Brisbane to work.

7.4.11 Summary of Economic Needs and Solutions

On many key economic criteria, Redland City performs well. The major issues for the Redland City economy and employment structure are:

- The age structure with relatively high proportions of the population in the 5-19 age group, the 55 and over age group and the rapid growth of those 55 years and over-
  - The younger age cohort directs attention to the need for an adequate number and range of employment and education and training opportunities, and
  - The older age group reduces overall labourforce and employment participation and that flows directly through to reduced income and wealth creation, and consumption expenditure with a result of lower GRP.
- The lack of employment opportunities and range of employment opportunities to better match the residential population-
  - There is a concentration of local employment in population serving rather than export oriented industries;
  - The results are additional private costs in travel to work elsewhere, and additional public costs to meet infrastructure needs, and
  - But there were different journey to work patterns between those living in the northern part of Redland City compared with those living in the south.
- As a result of the employment imbalances and flows, Redland City loses economic potential in higher costs and greater escape expenditure, resulting in lower wealth (GRP/capita) than would otherwise be the case;

- A particular example is the Building and Construction sector which constitutes a relatively large component of the resident workforce (and FTE after hours worked are included), 'loses' a significant proportion of this employment base as it needs to work outside Redland City which is compounded by the fact that residential construction levels In Redland City are now at about half the level they were 5-6 years ago, and
- Redland City suffers from a significant problem of high unemployment, low socio economic status, poor transport and high social needs among residents living on the Moreton Bay islands

The key solutions to the above needs include:

- Creating a range of employment opportunities that cater for:
    - School leavers;
    - The older population, particularly as in the longer-term the age of accessing the old age pension increases, and
    - Those in the most economically active age group (20-54 years) in industries where Redland has competitive labourforce advantages such as Health, Education and Construction.
- Creating a range of investment and business opportunities that will provide the basis for the above employment, and attract those in the most economically active age group to locate in the City;
- Creating employment opportunities at a rate that improves the employment balance and potentially employment self-containment, noting that there will always likely be high movements between Redland and Brisbane as adjoining LGAs,
- Generating more construction activity, and
- Pay particular attention to the location of employment opportunities so as to reduce the average travel to work distance, as a more important metric than crossing LGA boundaries.

8 Economic Impact

8.1 Construction

The Shoreline project will comprise a total building and construction direct investment of $2.3b, of which civil works will be $400m and other residential, community and commercial building of $1,900m. It is expected that the project will be completed in about 8-15 years from commencement, with 10 years used in the calculations below.

Based on the State Government economic multipliers for the Brisbane Moreton Region, (that includes Redland City) and discounting to 2013 values, it is expected that the direct investment will be associated with:

- Directly generating 8,193 FTE person years employment in the life of the project or an average of 819 per year assuming a 10 year project life;
- There could be flow-on Type 1 impacts of 15,500 FTE jobs created in the Brisbane Moreton economy as the impacts flowed through the economy, that is 1555 per year FTE;

- The Shoreline project is expected to be associated with direct Value Add growth to the economy of $544m and up to $969m as Type 1 impacts flow throughout the Brisbane Moreton economy.

The flow-on economic impact of the future development of the Redlands Business Park has not been assessed. However the potential 180,000m^2 of vacant industrial and employment land could be expected to house some 90,000m^2 of building potential for development.

At average industrial commercial construction cost the additional investment to build out would be some $1,800/m^2 excluding fit out and additional civil engineering costs. This is calculated to be about $160m of construction activity.

8.2 Ongoing Employment

In addition to the construction employment, it is expected that the Shoreline project will provide employment capacity for 1,900 workers.

In addition, in the associated and nearby development of the Business Park there are currently 300 workers in 40 businesses. The additional building area at the Business Park has capacity for a further 1,400 workers based on floorspace standards appropriate to the uses.

The total employment capacity of the related developments is 3,600.

8.3 Jobs Balance

The jobs balance is the relationship between the total number of jobs available and the workforce. A 100% rate would imply that there was the same number of jobs in an area as there were people living in an area and working. A higher jobs balance provides the potential for higher employment self-containment.

In 2011 Redland had a jobs balance of 59%, and that proposed for Shoreline and the Redlands Business Park is 80.3% (including the existing employment at the Business Park) for total employment and 73.6% for new employment.

Table 8 Proposed Jobs Balance

Shoreline Population	9,600
Employment Participation	46.7%
Expected Workforce	4,483
Shoreline additional jobs	1,900
Business Park additional jobs	1,400
Total new employment	3,300
Shoreline/Business Park Jobs Balance	73.6%
Redland 2011 Jobs Balance	59.0%

The higher jobs balance ratio in the proposed Shoreline/Redlands Business Park coupled with the range of jobs proposed for Shoreline and existing higher self-containment in the

Cleveland-Stradbroke SA3 in 2011 gives the potential for increased employment self-containment above the 2011 levels that existed for Redland City.

9 Land Supply In Redland

9.1 Key issues

This section of the Report considers the implications of the forecast land supply and dwellings for the planning of residential development in Redland City. These forecasts raise significant issues for Redland City and if adopted would generate significant risks for the future residential land supply, and other adverse social and economic consequences.

The Planning for Redland City and the Population Projections for the City are based in large part on the assessments undertaken in the Queensland Government's Broad Hectare Study (2013 Edition) and the Queensland Projected Dwellings forecasts (2013 Edition).

The following key assumptions from the Broad Hectare report and the Dwelling Projections are addressed, the data presented, assessments made and the issues and implications considered:

- The very high dependence on the smallest parcels of land for future supply;
- The very low availability of large parcels of land;
- The extremely high conversion rate from Theoretical to Expected yield;
- The very high dependence on higher density residential development;
- The use of dwelling occupancy rates that do not reflect long term trends;
- The apparent lack of an allowance for unoccupied dwellings, and
- Lack of account for key economic and infrastructure drivers for demand for higher density dwellings.

Key differences between Redland City and the other comparable Local Government Areas (LGAs) are noted.

9.2 Very Large Proportion of Small Parcels Under 1.2Ha

A key issue in the future supply of residential land is the composition of the beginning stock of Broad hectare land. In terms of land area:

- Nearly 20% of the future residential Broad hectare land supply in Redland is assumed to comprise very small parcels (under 1.2Ha), and
- Redland is more than twice as dependent on small parcels (18.2%) as the average for the comparable areas of Ipswich, Gold Coast, Logan and Moreton Bay LGAs (8.9%).

Table 9 Broad hectare Parcels under 1.2Ha 2011-2036 (Land area Ha)

	Redland	Ipswich	Gold Coast	Logan	Moreton Bay	Average other LGAs
Under 1.2 Ha	108	693	493	623	443	2252
Total Area Ha	595	7637	3964	10222	3526	25349
Percent Under 1.2ha	18.2%	9.1%	12.4%	6.1%	12.6%	8.9%

Source: Government Statistician. Broadhectare Study 2013 (released 2014). The average of the other LGAs is the average for Ipswich, Gold Coast, Logan and Moreton Bay.

For future dwellings:

- Over 25% of the future dwellings in Redland comprises the development of very small parcels, and
- Redland is 2.5 times more dependent on small parcels to provide dwellings in the future (25.1%), as the average for the comparable LGAs of Ipswich, Gold Coast, Logan and Moreton Bay (10.2%).

Table 10 Broad hectare Parcels under 1.2Ha 2011-2036 (Dwelling Yield Expected)

	Redland	Ipswich	Gold Coast	Logan	Moreton Bay	Average other LGAs
Under 1.2 Ha	2540	6251	10597	8712	4351	29911
Total Area Ha	10105	107232	52557	107132	27183	294104
Percent Under 1.2ha	25.1%	5.8%	20.2%	8.1%	16.0%	10.2%

Source: Government Statistician. Broadhectare Study 2013 (released 2014). The average of the other LGAs is the average for Ipswich, Gold Coast, Logan and Moreton Bay.

The main land supply issues arising from very high dependence on small land parcels include:

- Small parcels of land are hard to consolidate;
- Small parcels take longer to develop for a given yield;
- Small parcels are not cost effective to develop;
- Many small parcels have considerable improvements rendering them unfeasible for development;
- Many small parcels are used for lifestyle purposes and are unavailable for development;
- Small parcels are more likely to lead to fragmented, poorly coordinated and possible overall lower quality outcomes;
- The dependence, complexity, cost and slow development of small parcels means that there are high risks that this component of land supply for Redland will not be available in the time period (next 10 years);
- The consequence of limited supply is increased prices;
- Those that pay this additional cost are existing and future residents moving into the housing market;
- Home ownership will be denied to a greater proportion of the population than would otherwise be the case where home ownership entry for those under 30 years is declining rapidly;
- Lower development efficiency is likely to add to costs, and

- The more Redland residents pay for a given housing product, the less expenditure available for other goods and services and hence will tend to lead to lower consumption and hence lower economic growth.

9.3 Small Proportion of Large Parcels Over 10Ha

Large parcels have all the advantages that small parcels do not possess, such as development efficiency and greater potential for integrated development leading to better development outcomes.

Table 11 Broad hectare Parcels Over 10 Ha 2011-2036 (Dwelling Yield Expected)

	Redland	Ipswich	Gold Coast	Logan	Moreton Bay	Average other LGAs
Over 10 Ha	57	5258	2018	7675	1779	16730
Total Area Ha	595	7637	3964	10222	3526	25349
Percent Over 10ha	9.6%	68.8%	50.9%	75.1%	50.5%	66.0%

Source: Government Statistician. Broadhectare Study 2013 (released 2014). The average of the other LGAs is the average for Ipswich, Gold Coast, Logan and Moreton Bay.

Redland has a very small proportion of land parcels over 10Ha (9.6%) to meet future land supply needs. This compares with the average dependence for Ipswich, Gold Coast, Logan and Moreton Bay LGAs at 66.0%.

The combination of high reliance on difficult small parcels and low reliance on easier large parcels compounds the risks for future land supply in Redland City and increases the risks that planning decisions will be based on assumed land supply that will not eventuate.

9.4 Almost 100 Percent Conversion Efficiency

The Theoretical yield is the potential number of dwellings that could be constructed based on identified land stock and the Expected yield takes into account factors affecting development of land such as ownership and land fragmentation.

In converting from Theoretical to Expected dwelling yield, Redland has a remarkably small loss rate of 0.9%. The average conversion loss rate for Ipswich, Gold Coast, Logan and Moreton Bay LGAs is 15.5%, which is 17 times higher than the loss rate assumed for Redland City.

Even in Brisbane, a highly developed and well-planned area, the loss rate is 7.2%, a loss rate 8 times higher than for Redland.

Table 12 Development Conversion 2011-2036 (Dwelling Yield)

	Redland	Ipswich	Gold Coast	Logan	Moreton Bay	Average other LGAs
Theoretical Yield	10199	140,656	54150	119637	33595	348038
Expected Yield	10105	107232	52557	107135	27183	294107
Difference	94	33424	1593	12502	6412	53931
Percent	0.9%	23.8%	2.9%	10.4%	19.1%	15.5%

Source: Government Statistician. Broadhectare Study 2013 (released 2014). The average of the other LGAs is the average for Ipswich, Gold Coast, Logan and Moreton Bay.

The issues arising for Redland City from the extremely high conversion rate assumption include:

- The small assumed conversion loss rate for Redland is remarkable in itself, but when combined with the high dependence on small parcels that are inherently difficult to convert, then the low loss rate of 0.9% is implausible;
- The justification of the extremely small loss rate for Redland is not made in the Broadhectare study, and
- The minimal loss ratio, the high dependence on small parcels and the small dependence on large parcels compounds at every stage the risk that the actual supply will be much less than that calculated in the Broadhectare study.

9.5 Very High Dependence on Higher Density Development

The Broadhectare Study assumes that from 2011 to 2036, 46% of the additional dwellings in Redland City will be Medium/High Density, compared with the average of 13.4% in this form of housing at 2011.

This implies a significant and rapid social change for Redland City, but without any demand based assessments or consideration of the factors that are associated with and that drive higher density development.

Table 13 Housing Mix 2011-2036 (Dwellings Number)

	Redland	Ipswich	Gold Coast	Logan	Moreton Bay	Average other LGAs
Rural Residential	7	1430	1373	1845	801	5449
Standard	5448	37564	20730	94508	15430	168232
Higher Density	4650	68238	30455	10782	10952	120427
Total	10105	107232	52558	107135	27183	294108

Source: Government Statistician. Broadhectare Study 2013 (released 2014). The average of the other LGAs is the average for Ipswich, Gold Coast, Logan and Moreton Bay.

Table 14 Housing Mix 2011-2036 (Dwellings Percent)

	Redland	Ipswich	Gold Coast	Logan	Moreton Bay	Average other LGAs
Rural Residential	0.1%	1.3%	2.6%	1.7%	2.9%	1.9%
Standard	53.9%	35.0%	39.4%	88.2%	56.8%	57.2%
Higher Density	46.0%	63.6%	57.9%	10.1%	40.3%	40.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Government Statistician. Broadhectare Study 2013 (released 2014). The average of the other LGAs is the average for Ipswich, Gold Coast, Logan and Moreton Bay.

The assumed change in the dwelling mix drives changes in average dwelling occupancy rates. The result of the assumed housing mix (and with given occupancy rates for each type of housing) is that total occupancy rates are assumed to fall much more quickly in Redland City compared with other key reference LGAs (excluding the extreme case for Ipswich with an assumed 63.5% of all future dwellings being Higher density).

Redland occupancy rates in 2011 at 2.61 were very close to those of Moreton Bay LGA (2.66) but to 2036 are forecast to decline at 3 times the rate of those in Moreton Bay LGA due to assumed additional Higher Density in Redland affecting the housing mix.

Table 15 Average Occupancy Rates

LGA	2011	2016	2021	2026	2031	2036	Change
Redland	2.61	2.58	2.56	2.54	2.52	2.50	0.11
Ipswich	2.76	2.68	2.58	2.50	2.45	2.41	0.35
Gold Coast	2.37	2.36	2.34	2.33	2.31	2.29	0.08
Logan	2.88	2.86	2.88	2.87	2.86	2.86	0.02
Moreton Bay	2.66	2.64	2.65	2.64	2.63	2.62	0.04
Average Other	2.67	2.63	2.61	2.58	2.56	2.54	0.12

Source: OESR. Projected dwellings (a) (medium series), by local government area, Queensland, 2011 to 2036

The main issues arising from housing mix and occupancy rate assumptions are:

- The high rate of assumed Higher density development in Redland is based on a planning potential and supply base not on an assessment of demand assessments and social mix, and
- If the very high take up of Higher density does not materialise in Redland, then total housing needs will not be met in the City as planning for and provision of standard density housing would be inadequate.

9.6 Assumed Constant Occupancy Rates

The Broadhectare Study (Table 4 of the Broadhectare Study) assesses the average housing occupancy rates for Redland City (average persons per household) at 2011 as 2.8 for standard dwellings and 1.7 for attached higher density dwellings. These 2011 occupancy rates have been applied to the high, median and low population projections for Redland to determine the supply of land into the future.

However the issue is that there has been a long-term decline in average occupancy rates and while the rate of decline has slowed recently during the Global Financial Crisis and credit crunch period, a significant socio economic change would be needed to reverse the long term declining trend.

If dwelling occupancy rates continue to decline, even at a slower rate, for a given population, lower occupancy rates will require more dwellings and hence more residential land. It should also be noted that relatively small changes in occupancy rates could significantly alter the number of dwellings required to house a forecast population.

9.7 Unoccupied Dwellings

The issue of unoccupied dwellings does not appear to be expressly addressed in the Broadhectare Study, but implies that for the future assessments all new dwellings are occupied (by dividing the total population by the occupancy rates for occupied dwellings). The occupancy rates used are 2.8 for Standard houses and 1.7 for Higher density dwellings, which correspond to the 2011 Census rates for occupied dwellings only. The 2011 Redland City total dwelling occupancy rate was 2.7 for private dwellings.

However, in Redland, as in all parts of Australia, there are always a number of unoccupied dwellings (new dwellings finished waiting sale, vacant due to the occupants being on long vacation, existing dwellings between sales, etc). In Redland City at the 2011 Census, 9.0% of the private dwellings were vacant and over time in Australia, the proportion of unoccupied dwellings has increased.

There are two key issues, the treatment of unoccupied dwellings and the increasing trend over time.

The issue of the impact of unoccupied dwellings on total occupancy rate is significant as the occupancy rate for total persons living in occupied private dwellings (excluding those in Other dwellings such as Caravans, Improvised homes, Cabins, etc) is 2.7, but is 2.4 for total occupied and unoccupied dwellings. A lower occupancy for a given population will mean more lots are needed. At the 2011 Census for the 131,187 persons living in private dwellings in Redland City the difference in occupancy rates is equivalent to 4,795 dwellings.

The trend towards an increase in unoccupied dwellings over time also has not been addressed.

The issues arising from the apparent nil vacancy rate assumptions is that as there will be a proportion of vacant dwellings at any time, the rate of vacant dwellings needs to be expressly incorporated into the assessment by forecasting additional supply needed to match this factor. The result of ignoring this factor is that the future Redland City land supply will be worse than it appears in the Broadhectare Study.

9.8 Demand Issues

Research commissioned by the National Housing Supply Council (now operating within Commonwealth Departments) found that access to employment and service opportunities reflected in effective job density was the key explanatory factor in the attraction of apartment construction activity.

The research found that investment in transport infrastructure can galvanise apartment activity, but the infrastructure needs to be of a sufficient scale to boost an area’s linkages to major employment nodes.

On the basis of this research, a substantial increase in housing density to the scale forecast for Redland City seems most unlikely unless associated with significant upgrades in transport infrastructure and links to major and dense employment nodes.

A given population, (as forecast) and fewer than forecast higher density dwellings, as seems likely without the major employment nodes and significant transport infrastructure, will mean greater demand for standard blocks and the forecast housing mix will need to change.

This issue is particularly pertinent for Redland City as the Queensland Government Dwelling projections show that 73.9% of forecast new dwellings in Redland from 2011 to 2036 will be in the southern part of the City (Cleveland-Stradbroke SA3) where the preconditions for higher density dwelling (high investment in transport infrastructure and very good access to major employment nodes) do not exist now and are likely to be very slow to develop.

There is a clear conflict between the forecast higher proportion of higher density dwellings In Redland City, the location of the new forecast dwellings in the City and the preconditions or co-conditions necessary (transport infrastructure and links with major employment nodes) for significantly higher density development.

9.9 10 Year Forecast Supply

The Broad hectare Study 2013 forecasts that Redland City will have a potential dwelling supply of 11,155 dwellings (10,105 from Broad hectare land and 1,050 from developed parcels) or 10 years supply against a medium dwelling trend requirement of 22,131.

This means that only half the future need is identified on the basis of the assumptions used in the Study.

This assessment has focused on the Broad hectare supply that accounts for over 90% of the future supply in Redland City. This assessment points out that an examination of the assumptions used for the Broad hectare component raises very serious doubts that even the 10-year supply can be achieved, and in fact the supply is likely to be much less.

9.10 Risk Assessment

It is acknowledged that forecasting is difficult.

In the Redland City residential land supply and dwelling forecasts, there are significant issues with key individual assumptions when taken in isolation, as considered above.

However, the more fundamental issue is that every one of the assumptions introduces significant risk to the adequacy of future land supply. The risks inherent in every assumption are all in the one direction. That is, every one of the assumptions when considered individually is likely to lead to an inadequate supply of land.

There are no counter-balancing risks that may mean that the application of the assumption would lead to more land than that required for a given population.

Each of the assumptions when taken together introduces a systematic problem that compounds and increases the risk of inadequate residential land supply.

Reliance on the forecasts in the Broad hectare Study (2013) as a basis for planning residential land supply in Redland City, because of the issues concerning each of the key assumptions, is likely to lead to poor planning outcomes with adverse social and economic effects on key sectors of the community.

A shortage of land would lead to higher prices, increased housing stress and for those able to enter the market a higher proportion of income going to housing and less to other sectors of the economy, with the result of reduced consumption and lower economic growth.

The planning on the future dwelling supply for Redland City, if based on the Broad hectare Study and Government Dwelling forecasts, is betting on the market acceptance of a significant change in housing preference without the infrastructure and employment node access preconditions for this type of higher intensity development being in place. If this bet is not successful, then Redland City will experience severe shortages of standard residential land to house the projected population. The risk is even greater because it is forecast that three quarters of the Redland City housing will be in the southern part of the City where transport and major employment nodes are lacking.

In addition, at the broader level, if these studies are used as a basis for the Redland City Town Plan and economic settings for the City then there is a grave risk that incorrect settings will be made which will misguide the future direction of the limited resources available to the City.

There is also a specific risk with the assumed additional 3,256 dwellings in Redland Islands from 2011 to 2036. The 52.2% increase is projected for an area that ranks in the bottom 25 of over 500 statistical areas in Queensland on the ABS 2011 Socio Economic Index of Advantage and Disadvantage. One would hope that the significant transport, employment, housing and social issues facing the residents of Redland Islands could be addressed before the housing stock was increased by more than 50%. If the remedial preconditions of transport, employment, housing and social needs are not addressed, then there would be further questions about the Dwelling projections for Redland City.

10 Policy and Needs Alignment

There is a close alignment between Commonwealth, State and Redland City policies and strategies and those proposed for Shoreline and the associated Redlands Business Park. Key policy areas are summarized below.

Table 16 Policy Alignment

Policy Direction		**Project Contribution**
Commonwealth Transfer resources from Mining to other construction and residential	✓	The project is expected to ramp up as the mining sector construction contracts, with $400m in civil construction and $1700m in housing construction and about $100m in commercial and community projects.
Commonwealth, State and Local Increased investment	✓	Overall $2.2b in direct investment
Commonwealth, State and Local Increased employment	✓ ✓ ✓	Generation of 3,300 new direct ongoing jobs. Directly generating 8,193 FTE person years employment Up to 15,500 FTE person years employment with flow-on impacts in the regional economy
Commonwealth, State and Local Increased economic growth	✓	Direct Value Add growth to the economy of $544m and up to $969m as Type 1 impacts flow throughout the Brisbane Moreton economy
State and Local Better jobs balance	✓	Substantial increase in jobs balance to 73.6% against Redland City rate of 59.0%
State and Local Employment self-containment	✓ ✓	Potential based on jobs balance, jobs mix and existing patterns for increased employment self-containment. The potential increase in self-containment reduces pressures on the road system.
State and Local Increased employment opportunities for disadvantaged Redland Islands residents	✓	The location of Shoreline and the jobs mix proposed offers potential for increased opportunities in the southern Redlands area particularly for disadvantaged Island residents.
State and Local		Shoreline offers an 'infill' development opportunity based on existing road networks and likely more

Likely lower infrastructure costs compared with other alternative locations	✓	efficient and lower cost services and other infrastructure provision.
State and Local Assured residential land supply	✓	The Broadhectare Study for residential land supply for Redland is a high risk approach based on assumptions of consolidation of small parcels and conversion from theoretical to expected yield that are extreme when compared with other LGAs.
State and Local Assured shovel ready delivery	✓	The track record and experience of Fox+Bell and Fitini homes, and the ownership of the site means that lengthy delays in amalgamation, financing and construction that often plague other developments will not occur.
State and Local Meeting local socio-economic needs	✓	The socio-economic needs identified in the report in relation to age structure, employment opportunities, participation, income and wealth generation are met by Shoreline and the associated Redlands Business Park

11 Sensitivity Testing

11.1 Methodology and Comparative Areas

The Shoreline development has significant merit as a stand-alone development, particularly in association with the related nearly Business Park, but it needs to be assessed against other potential and competing development areas.

While the Shoreline proposal performs well in meeting Commonwealth, State and Local objectives, it needs to demonstrate that it is an effective and efficient location for urban development against other areas in SEQ.

A simplified model has been established that throws some light on the issue of determining if Shoreline is a suitable location to house some 10,000 residents in the next 8-15 years, against other choices available.

The key criteria for the effectiveness and efficiency test will need to be cost against outcomes, and the identification of an appropriate comparative area. The methodology to compare Shoreline against another option needs to compare like with like as much as possible. For this purpose the Flagstone area in southern Logan City has been chosen.

Shoreline is located in an investigation area identified by RCC. The SEQ Plan and Logan City Council have identified the Greater Flagstone area for investigation as a growth area. Specifically a centroid is located on Scenic Road in Redland for Shoreline and Greater Flagstone is located west of Undulla on an extension to New Beith Road.

The following is not intended as a definitive study, but to identify likely differences between the areas in terms of locating some 10,000 people in the next 10-15 years.

The definitive study would involve extensive engineering investigations, traffic studies and cost benefit assessments. Nevertheless some clear pointers are available to assess indicative capital costs, costs to the public sector and private costs, the most significant of which are ongoing travel costs, particularly work related.

Where the same or similar factors affect both areas, these are excluded so the focus is only on the differences.

11.2 Key Comparison Factors

11.2.1 Character of Area

The inherent location, geography and geology of sites drive many of the costs associated with development and directly impact on effectiveness and efficiency measures.

Table 17 Shoreline and Greater Flagstone Key Features

	Shoreline	**Greater Flagstone**
Urban Character	Infill	Fringe
Landscape	On Moreton Bay	Inland
Slope	Flat to undulating	Hilly with rocky outcrops
Water supply	Direct site access from Redland Islands pipeline	Reasonable access to existing systems
Road system	Well developed	Minimal, requiring significant investment
Development Costs	Low to moderate	Moderate to high

11.2.2 Recurrent Private Transport Costs

Over time, travel to work direct costs and the opportunity costs of travel, are the most important private costs. Also travel demand drives roads and public transport needs and the cost of infrastructure.

While the location of such trips is defined, the work place destinations cannot be known in advance, but it is clear from the analysis of Journey to Work data from the 2011 Census and many other studies that travel distance is a key factor.

The test applied in this comparison was travel distance and travel time from the respective origin points to Brisbane CBD and to each of the Principal Activity Centres in Brisbane (south of the river), Logan, Ipswich and Redland. Google Maps was used as the source. The assumption is that travel trips by Shoreline and Greater Flagstone residents are undertaken to the destination centres in the same proportion.

It is clear that this is not as sophisticated as a metropolitan travel origin-destination model, but the differences are so significant that the issue requires close attention.

The comparison is shown in the table below.

Table 18 Comparative Travel and time

	Shoreline	Shoreline	Greater Flagstone	Greater Flagstone
Centre	Distance (km)	Time (minutes)	Distance (km)	Time (minutes)
Brisbane CDB	43	34	50	47
Carindale	33	35	46	44
Upper Mount Gravatt	31	27	40	45
Capalaba	22	26	48	48
Cleveland	17	19	56	58
Beenleigh	19	18	44	42
Springwood	24	22	39	42
Ipswich	63	56	46	50
Springfield	53	41	31	57
Total	305	278	400	433
Difference (Km and Time)	95	155		
Shoreline saving	31.1%	55.8%		

Source: Google Maps

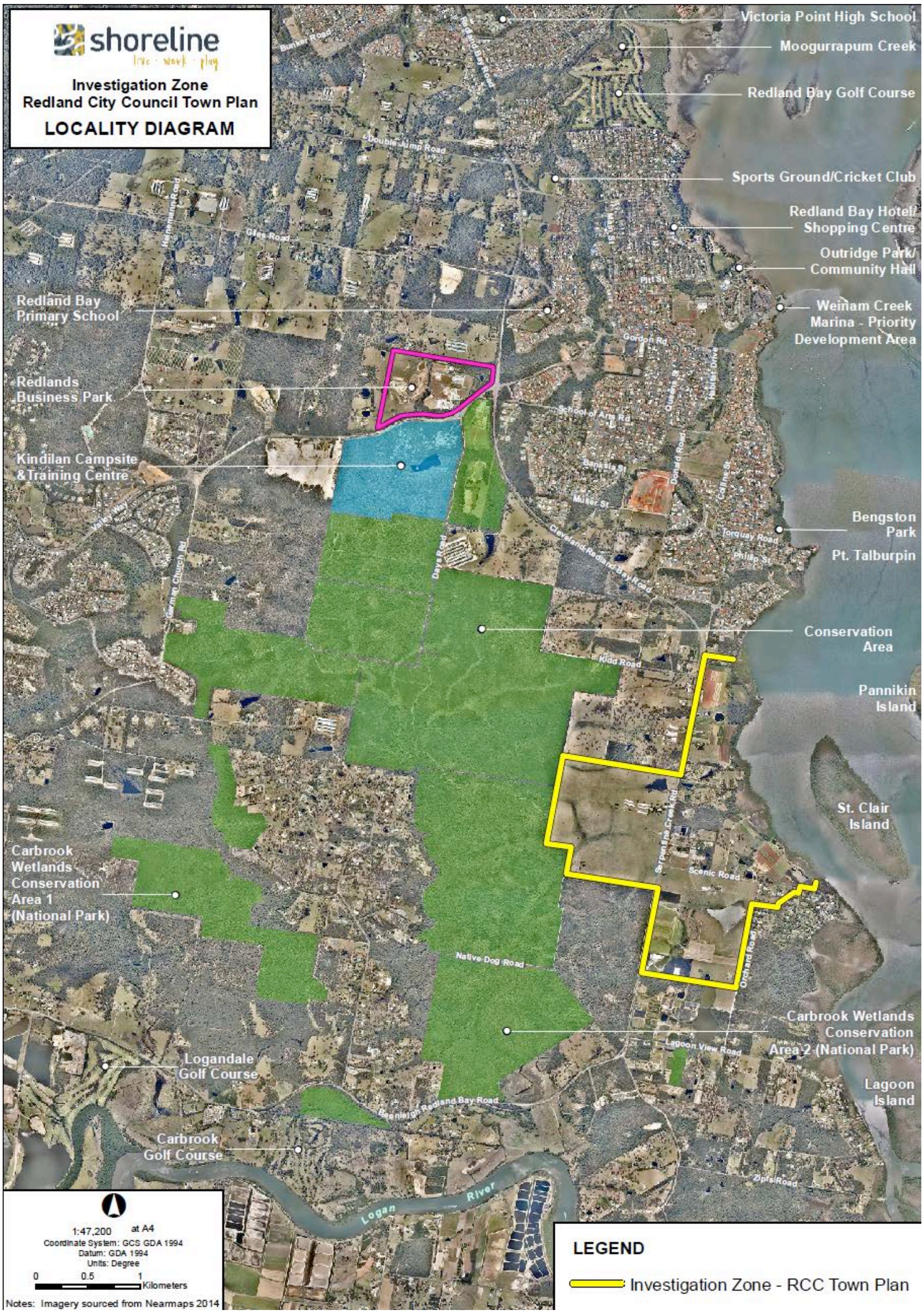
11.2.3 Attractiveness

The preliminary assessment strongly suggests that Shoreline is easier and cheaper to service and is likely to have significant travel time and distance advantages to major centres over Greater Flagstone for the location of an additional 10,000 residents.

In addition, there is no doubt that locations with direct access to Moreton Bay will be favoured to a significantly greater degree than fringe areas well inland.

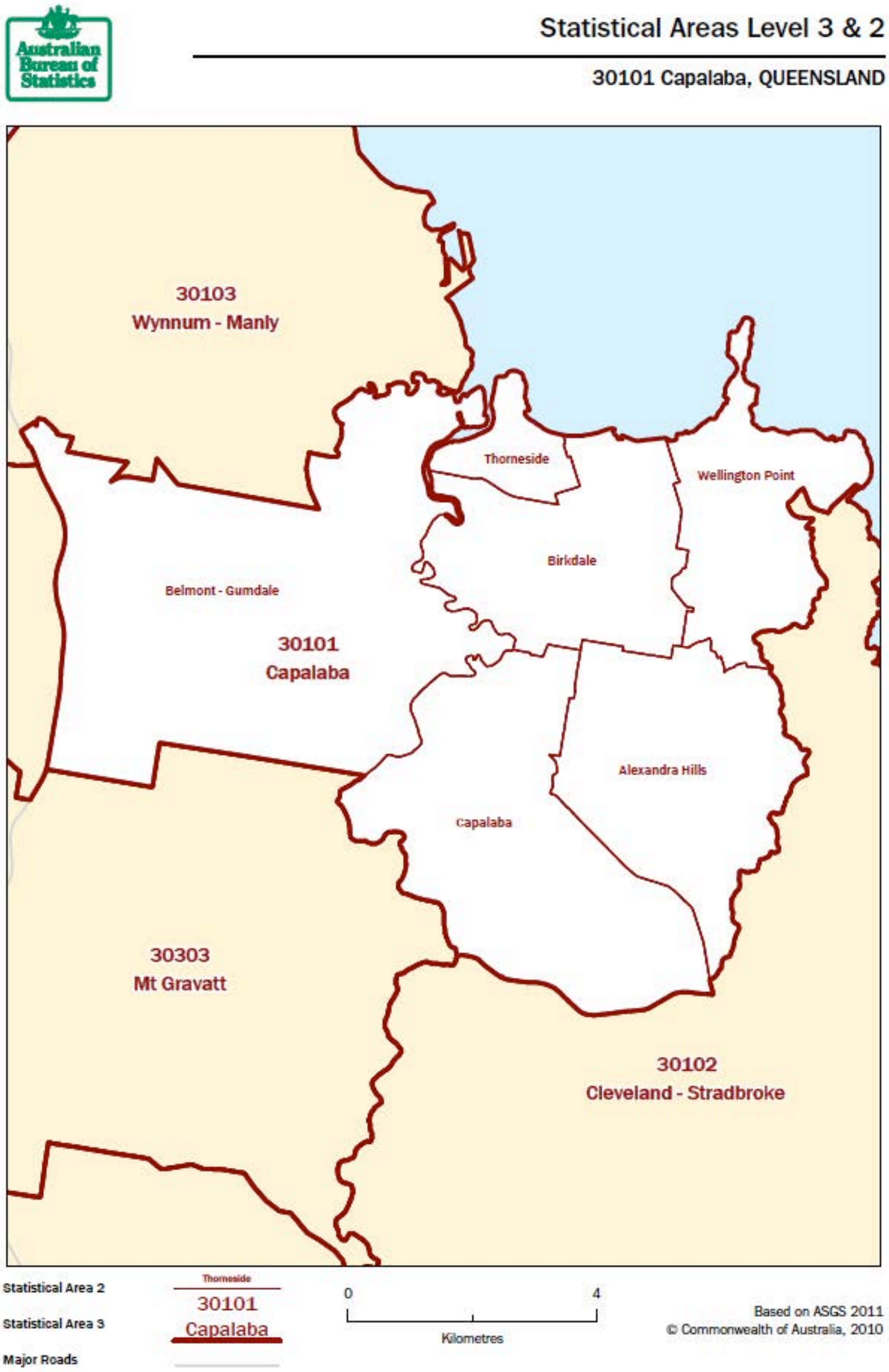
Attachment 1

Site Location



Attachment 2

Statistical Geography



Statistical Areas Level 3 & 2

30102 Cleveland - Stradbroke, QUEENSLAND

Based on ASGS 2011
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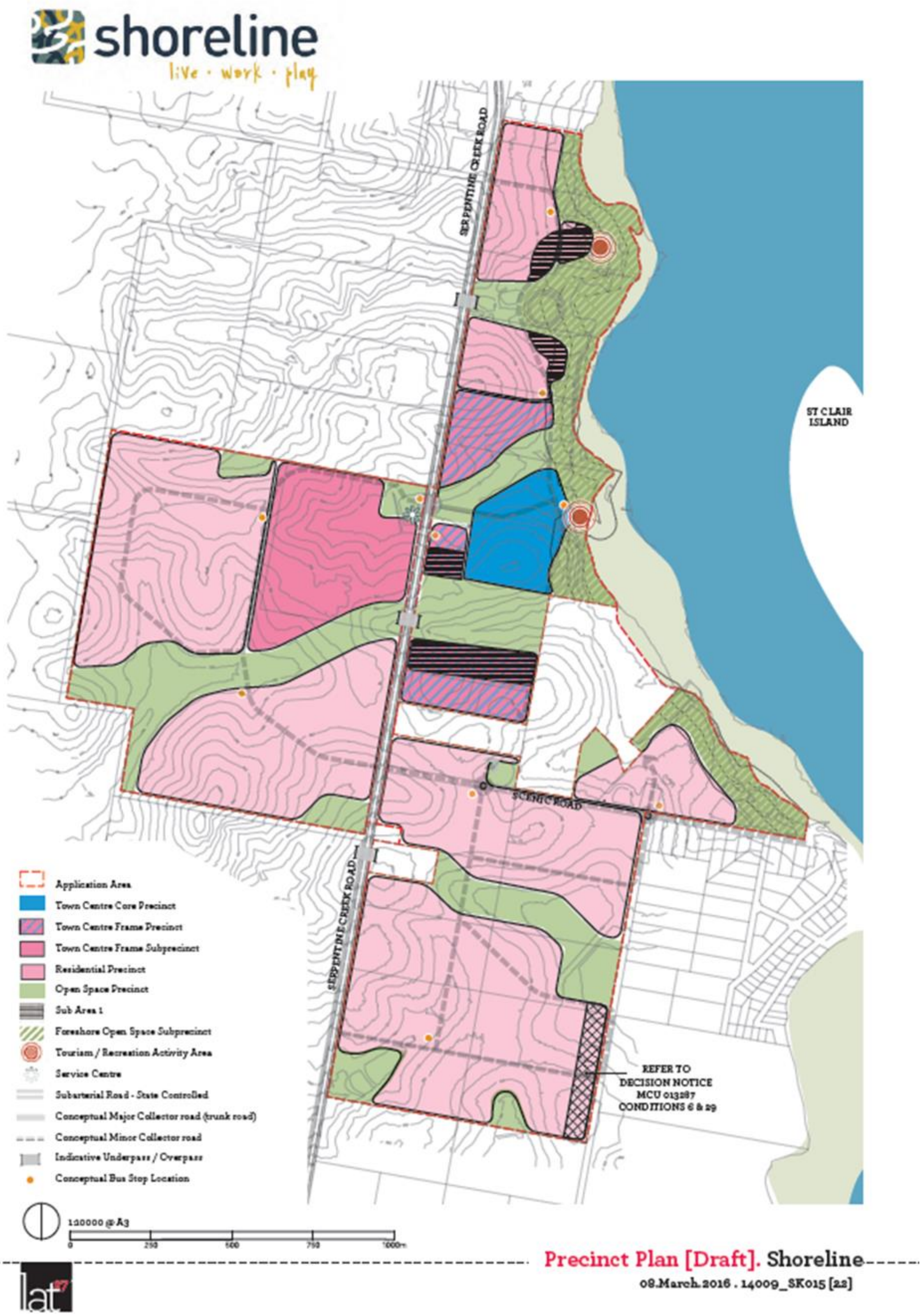
FOI 190207
Document 1c

Project overview map



Australian Government
Department of the Environment and Energy

FOI 190207
Document 1d

EPBC Ref: 2016/7776

s47F
CEO
Shoreline Redlands Pty Ltd
PO Box 649
CLEVELAND QLD 4163

Dear s47F

Invitation to comment on proposed approval decision
Shoreline urban village development, Redlands Bay, Qld (EPBC 2016/7776)

I am writing to you in relation to your proposal to develop an urban village within a footprint of 279.5 hectares in Redland Bay, Queensland (Proposed Action). The Proposed Action was referred and assessed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for its impacts on wetlands of international importance; listed threatened species and ecological communities; and listed migratory species.

I am proposing to approve the Proposed Action subject to conditions.

My proposed decision of approval is attached. In accordance with the EPBC Act, I invite you to provide comments on my proposed decision of approval, including the conditions which I propose to attach, within 10 business days of the date of this letter.

Please quote the title of the action and EPBC reference, as shown at the beginning of this letter, in any correspondence. You can send comments to:

by letter
QLD South and Sea Dumping Section
Assessments and Governance Branch
Department of the Environment and Energy
GPO Box 787
CANBERRA ACT 2601

by email s22 @environment.gov.au

If you have any questions about this decision, please contact the project manager, s22, by email to s22 @environment.gov.au, or telephone s22 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

James Barker
Assistant Secretary
Assessments and Governance Branch
3 /4/ 18

Australian Government
Department of the Environment and Energy

PROPOSED APPROVAL

Shoreline urban village development, Redlands Bay, Qld (EPBC 2016/7776)

This decision is made under sections 130(1) and 133(1) of the *Environment Protection and Biodiversity Conservation Act 1999 (Cth).*

Details

Person to whom the approval is granted (approval holder)	Shoreline Redlands Pty Ltd
ACN or ABN of approval holder	ACN 163 078 715
Action	To develop an urban village within a footprint of 279.5 hectares in Redland Bay, Queensland [See EPBC Act referral 2016/7776]

Approval decision

My decision on whether or not to approve the taking of the action for the purposes of each controlling provision for the action are as follows:

Controlling Provisions

Wetlands of international importance	
Section 16	Approve
Section 17B	Approve

Listed Threatened Species and Communities	
Section 18	Approve
Section 18A	Approve

Listed migratory species	
Section 20	Approve
Section 20A	Approve

Period for which the approval has effect

This approval has effect until Wednesday, 31 March 2038

Decision-maker

Name and position	James Barker Assistant Secretary Assessments and Governance Branch
Signature	**PROPOSED DECISION DO NOT SIGN**
Date of decision	**PROPOSED DECISION - DO NOT DATE**

Conditions of approval

This approval is subject to the conditions under the EPBC Act as set out in ANNEXURE A.

Australian Government

Department of the Environment and Energy

ANNEXURE A – CONDITIONS OF APPROVAL

Project site

1. The **approval holder** must ensure that development associated with the action occurs within the **site** identified in **Attachment A1** as the Application Area.

2. The **approval holder** must ensure that no buildings are constructed within the Foreshore Subprecinct as identified at **Attachment A2** except barbeque shelters, picnic shelters, and toilet amenities.

Shorebird management

3. For the period for which this approval has effect, the **approval holder** must ensure there is no decline in eastern curlew (*Numenius madagascariensis*) density, foraging habitat quality, or foraging habitat extent in the site identified as 'shorebird foraging habitats' at **Attachment A3**, compared to pre-**commencement**, as a result of the approved action.

4. The **approval holder** must prepare and submit an Eastern Curlew Management Plan (ECIMP) to the **Minister** before **commencement**. In addition to the detail provided in *Eastern Curlew Impact Management Plan – Shoreline Redlands – 20 July 2017*, the ECIMP must include:

    a. a scientifically valid monitoring program, sufficient to:

        i. determine pre-**commencement** eastern curlew density, foraging habitat quality and foraging habitat extent;

        ii. detect impacts on the matters identified in condition 4(a)(i); and

        iii. delineate impacts due to the action from impacts due to natural or other anthropogenic causes;

    b. contingency measures to be implemented (such as fencing) in the event that monitoring identifies that the outcome described in condition 3 is not met;

    c. a timeframe for when contingency measures will be implemented;

    d. details of reporting to be provided to the Department in the event that the outcome described in condition 3 is not met; and

    e. provisions to make monitoring results publicly available on the approval holder's website for the life of the project.

5. The ECIMP, including any revised plans, must be peer reviewed by a **suitably qualified person**. The peer review must be submitted to the **Minister** together with the ECIMP and a statement from the **suitably qualified person** stating that they carried out the peer review and evaluated the adequacy of the monitoring, mitigation and management measures proposed. The approved ECIMP must be implemented by the **approval holder**.

6. The **approval holder** must not:

   a. undertake construction within 250m of the Moreton Bay Ramsar wetland between 1 September and 30 March; or

   b. facilitate public access to the Moreton Bay Ramsar wetland,

   until the ECIMP has been approved by the **Minister** in writing and pre-**commencement** eastern curlew density, foraging habitat quality and foraging habitat extent has been determined.

Water quality management

7. The **approval holder** must prepare and submit a Water Quality Management Plan (WQMP) to the **Minister** before **commencement**. In addition to the detail provided in *Shorelines Redland Water Quality Management Plan – June 2017,* the WQMP must accord with **national water quality guidelines** and include:

   a. a monitoring program sufficient to determine pre-**commencement** water quality within all catchments within the **site** and at a reference/control monitoring site;

   b. a rationale for the sampling effort undertaken to determine pre-**commencement** water quality and justify the selection of the reference/control monitoring site with respect to the potential impacts of the action and the objectives of the WQMP;

   c. details of ongoing monitoring locations and the parameters to be monitored;

   d. proposed early warning indicators, trigger thresholds and limits for detecting impacts on surface water quality;

   e. contingency measures to be implemented in the event that trigger thresholds are breached; and

   f. provisions to make monitoring results publicly available on the approval holder's website for the life of the project.

8. The WQMP, including any revised plans, must be peer reviewed by a **suitably qualified person**. The peer review must be submitted to the **Minister** together with the WQMP and a statement from the **suitably qualified person** stating that they carried out the peer review and evaluated the adequacy of the monitoring, mitigation and management measures proposed.

9. The **approval holder** must not **commence** until the WQMP has been approved by the **Minister** in writing. The approved WQMP must be implemented by the **approval holder**.

<u>General</u>

10. Within 20 days after the **commencement** of the **action**, the **approval holder** must advise the **Department** in writing of the actual date of **commencement**.

11. The **approval holder** must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement the management plans required by this approval, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act,** or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the **Department's** website. The results of audits may also be publicised through the general media.

12. Within three months of every 12 month anniversary of the **commencement** of the action, the **approval holder** must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans as specified in the conditions. Documentary evidence providing the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** at the same time as the compliance report is published. Reports must remain on the website for the period this approval has effect. The **approval holder** may cease preparing and publishing compliance reports required by this condition with written agreement of the **Minister** to do so.

13. Upon the direction of the **Minister**, the **approval holder** must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the commencement of the audit. Audit criteria must be agreed to by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister**.

14. The **approval holder** may choose to revise a plan approved by the **Minister** under Conditions 4 or 7 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised plan would not be likely to have a new or increased **impact**. If the **approval holder** makes this choice they must:

    i. notify the **Department** in writing that the approved plan has been revised and provide the **Department** with an electronic copy of the revised plan;

    ii. implement the revised plan from the date that the plan is submitted to the **Department**; and

    iii. for the life of this approval, maintain a record of the reasons the **approval holder** considers that taking the action in accordance with the revised plan would not be likely to have a new or increased **impact**.

14A. The **approval holder** may revoke its choice under Condition 14 at any time by notice to the **Department**. If the **approval holder** revokes the choice to implement a revised plan without approval under section 143A of the EPBC Act, the **approval holder** must implement the version of the plan most recently approved by the **Minister**.

14B. Condition 14 does not apply if the revisions to the approved plan include changes to environmental offsets provided under the plan in relation to a matter protected by a controlling provision for the action, unless otherwise agreed in writing by the **Minister**. This does not otherwise limit the circumstances in which the taking of the action in accordance with a revised plan would, or would not, be likely to have new or increased **impacts**.

14C. If the **Minister** gives a notice to the **approval holder** that the **Minister** is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new or increased impact, then:

i. Condition 14 does not apply, or ceases to apply, in relation to the revised plan; and

ii. the approval holder must implement the version of the plan most recently approved by the Minister.

iii. to avoid any doubt, this condition does not affect any operation of Conditions 14, 14A and 14B in the period before the day after the notice is given.

At the time of giving a notice under condition 14A, the **Minister** may also notify that for a specified period of time condition 14 does not apply for one or more specified plans required under the approval.

14D. Conditions 14, 14A, 14B and 14C are not intended to limit the operation of section 143A of the EPBC Act which allows the **approval holder** to submit a revised plan to the **Minister** for approval.

15. If, at any time after five years from the date of this approval, the **approval holder** has not **commenced** the **action**, then the **approval holder** must not **commence** the action without written agreement from the **Minister.**

16. Unless otherwise agreed to in writing by the **Minister**, the **approval holder** must publish all management plans referred to in these conditions of approval on its website. Each management plan must be published on the website within one month of being approved by the **Minister** or being submitted under conditions 4, 7 or 14.

Definitions

Approval holder: means the person to whom the approval is granted or any person acting on their behalf, or to whom the approval is transferred under section 145B of the EPBC Act.

Commence/commencement means the erection of a building or structure that is or is to be fixed to the ground and wholly or partially fabricated on-site; the alteration, maintenance, repair or demolition of any building or structure; preliminary site preparation work which involves breaking of the ground (including pile driving); the laying of pipes and other prefabricated materials in the ground, and any associated excavation work; excluding the installation of fences and signage.

Department means the Australian Government Department administering the *Environment Protection and Biodiversity Conservation Act 1999*.

EPBC/ EPBC Act means the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

Impact/s: as defined in section 527E of the EPBC Act.

Minister means the Minister administering the Environment Protection and Biodiversity Conservation Act 1999 and includes a delegate of the Minister**.**

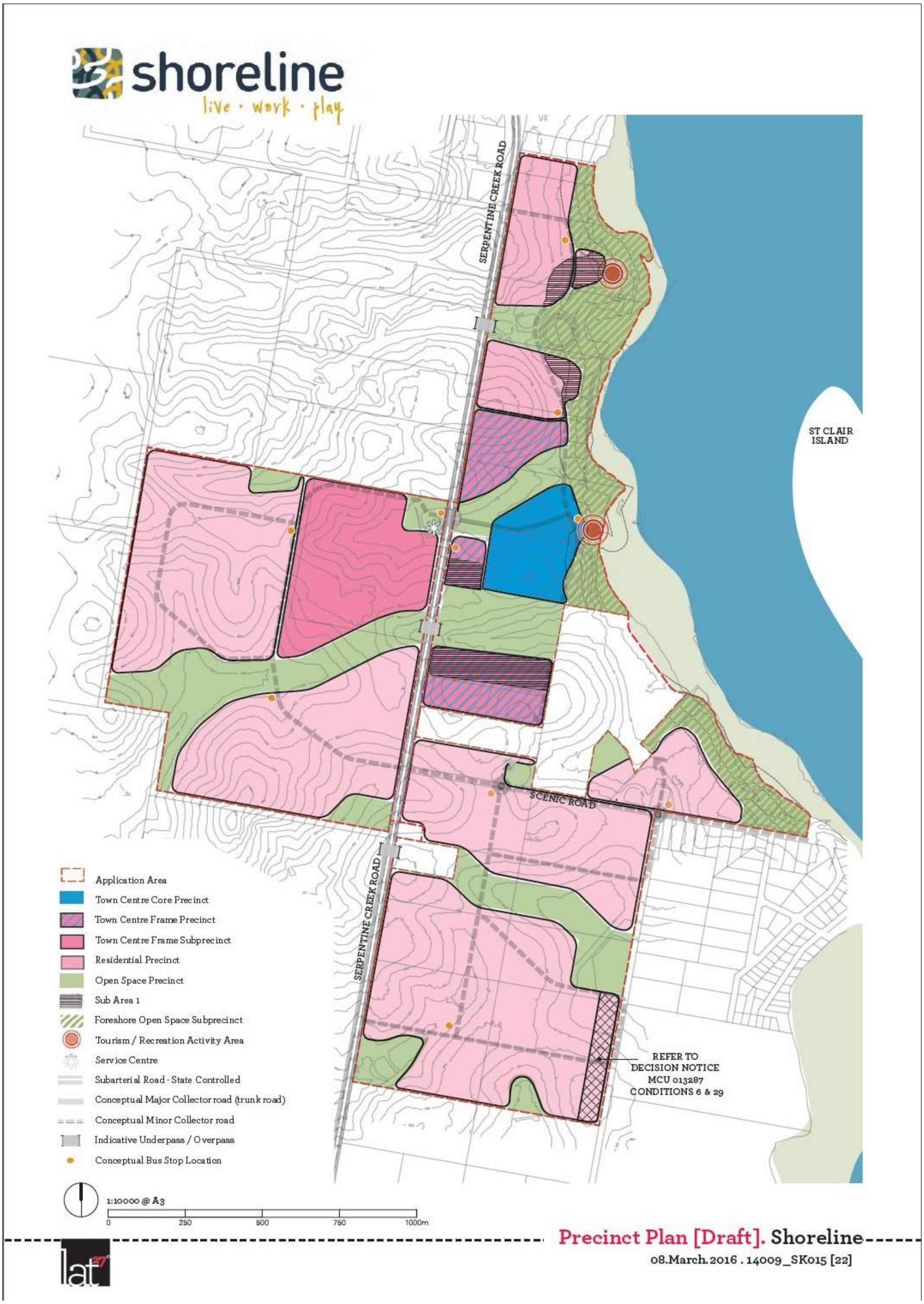
National water quality guidelines means guidelines under the *National Water Quality Management Strategy* including the *Australian and New Zealand guidelines for fresh and marine water quality – 2000* or future revisions of these guidelines*.*

Site means the area shown as the Application Area shown at Attachment A.

Suitably qualified person means a person who has professional qualifications, training, skills and/or experience related to the nominated subject matter and can give independent assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods and/or literature.

ATTACHMENTS

1. **Attachment A1**:



2. Attachment A2:

Local Authority: Redland City Council
Contour interval: 1.0m

Design is conceptual only and subject to detailed design and Council approvals for each relevant stage. Areas and dimensions are approximate only and are subject to final survey.

[illegible] approximate only and subject to detailed site survey.

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Date: 27/11/2017

3. Attachment A3: