Native Vegetation Clearance

Point Boston Wastewater System

Data Report

Clearance under the *Native Vegetation Regulations 2017*

February, 2021

Prepared by West Coast Revegetation NVC Accredited Consultant, Phil Landless
for Arris Pty Ltd

Table of contents

1. **Application information**
2. **Purpose of clearance**
    2.1 Description
    2.2 Background
    2.3 General location map
    2.4 Details of the proposal
    2.5 Approvals required or obtained
    2.6 Native Vegetation Regulation
    2.7 Development Application information (if applicable)
3. **Method**
    3.1 Flora assessment
    3.2 Fauna assessment
4. **Assessment outcomes**
    4.1 Vegetation assessment
    4.2 Threatened Species assessment
    4.3 Cumulative impacts
    4.4 Addressing the Mitigation hierarchy
    4.5 Principles of clearance
    4.6 Risk Assessment
    4.7 NVC Guidelines
5. **Clearance summary**
6. **Significant environmental benefit**
7. **Appendices**
    7.1 Flora species recorded during field survey
    7.2 Bushland Vegetation Assessment Scoresheets (to be submitted in Excel format).
    7.3 Point Boston Wastewater ABSORBS^{TM} Filters, Biodrain and Nutrient Balances Report to the EPA
    7.4 Letter of permission from the landholder (Point Boston Community Corporation 25691)
    7.5 Photolog

Figures

Figure 1. Location of the proposed clearance site at Point Boston
Figure 2. Proposed clearance area site map.
Figure 3. Design plan and layout of the waste water dispersal facility.
Figure 4. proposed clearance site in relation to existing SEB Offset areas and one Heritage Agreement area.
Figure 5. Site map showing proposed clearance area – *Acacia dodonaeifolia* Shrubland.
Figure 6. General location of the proposed SEB area.
Figure 7. Site plan of proposed SEB area.

Tables

Table 1. Flora species observed on site or recorded within a 5 km radius of the site since 1995, or the vegetation is considered to provide suitable habitat (Clearance area).
Table 2. Species observed on site, or recorded within 5km (50km in the arid zone) of the application area since 1995, or the vegetation is considered to provide suitable habitat (Clearance area).
Table 3. Flora species observed on site or recorded within a 5 km radius of the site since 1995, or the vegetation is considered to provide suitable habitat (SEB area).
Table 4. Species observed on site, or recorded within 5km (50km in the arid zone) of the application area since 1995, or the vegetation is considered to provide suitable habitat (SEB area).

1. Application information

Application Details

Applicant:	Arris Pty Ltd		
Key contact:	Jim Kelly (Arris Pty Ltd) Phone: 08 8313 6709 Mob 0427 821 625 Email: jkelly@arris.com.au		
Landowner:	(Point Boston) Community Corporation 25691. Letter of permission included in appendix.		
Site Address:	357 Sullivan Drive, Point Boston		
Local Government Area:	Lower Eyre Peninsula	Hundred:	Louth
Title ID:	CT6044/180	Parcel ID	C25691 FCP

Summary of proposed clearance

Purpose of clearance	Clearance required for the construction of a wastewater treatment and dispersal system to service the Point Boston residential development.
Native Vegetation Regulation	Schedule 1; Regulation 12(34) Infrastructure – in connection with the drainage, removal or treatment of wastewater or sewage.
Description of the vegetation under application	1.5 ha of *Acacia dodonaeifolia* Shrubland over mainly introduced grasses, in fairly poor condition.
Total proposed clearance - area (ha)	1.5 ha
Level of clearance	Level 4
Overlay (Planning and Design Code)	Overlays not available

<table>
<tr><td colspan="2">Proposed clearance area

</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Mitigation hierarchy</td><td>Avoidance:
Site selection has been undertaken with considerable thought to the environment. The selected/preferred site has been chosen based on a number of factors, including:

Depth to water table – it is a requirement of the SA Health Code for Onsite Wastewater systems that the depth to water table should be greater than 1.2 m. In the case of subsurface disposal the base of the trench should be greater than 500 mm above the highest level of the water table. The elevation of this site meets the design requirements of the SA Health Code.
Other sites – in terms of depth to water table there are sites on Point Boston which would provide advantage over the site selected. Other sites also supported native vegetation. Conversely, sites to the north-west of the selected site on cleared land are low-lying, have a smaller separation between the water table and the base of the dispersal beds and do not meet the requirements of the SA Health Code. The two wetland areas adjacent to the lagoons were avoided for the same reason and to prevent changing the wetlands’ hydrology.
Design – there is a significant design advantage in having greater head space above the water table for the beneficial reuse of water and nutrients.
Cost – Locating the water dispersal unit at this site makes use of as much of the existing Point Boston infrastructure as possible, minimizing cost and waste.

</td></tr>
</table>

	Minimisation: Measures to minimise the extent, duration and intensity of impacts of the clearance include: • Clearance and/or damage to native vegetation to be avoided during construction, • Excavated soil and cleared plant material to be stored on-site before removal, • Machinery, vehicles, workers and material deliveries will not impact on any vegetation except for the area under application. **Rehabilitation:** The proposed water dispersal unit will be a permanent structure. Rehabilitation or restoration of the site will not be possible. **Offset:** The applicants plan to make a payment to the NVC in combination with an on-ground offset to satisfy the SEB points required.
SEB Offset proposal	Payment of $45,053.70 plus administration fee of $2,252.69, plus 3.5 ha on-ground offset.

2. Purpose of clearance

2.1 Description

The purpose of the application, under Regulation 12(34) Infrastructure is to allow clearance of native vegetation in connection with the construction of a wastewater treatment and dispersal system to service the Point Boston residential development.

2.2 Background

Point Boston is a small peninsula situated approximately 12km north of Port Lincoln on the Eyre Peninsula in South Australia. In the early 2000s three Point Boston landholders (farmers) formed a partnership with an Adelaide based property developer and proposed a new, environmentally friendly residential development to the local council.

An Extractive Mining Lease (EML5774) was held by Eurasia Industries Pty Ltd. The operator was DK Quarries of North Shields. The lease expired in 2012.

The Point Boston Community Corporation Committee formed by lot holders is responsible for the management of common property - including land and infrastructure.

The original wastewater collecting and recycling system which services the development has proved to be unsuccessful. Arris Pty Ltd has been contracted to establish a sustainable wastewater management and dispersal system to service the residential development. Arris Pty Ltd offer water treatment and allied technologies, and agricultural and environmental services.

2.3 General location and site maps

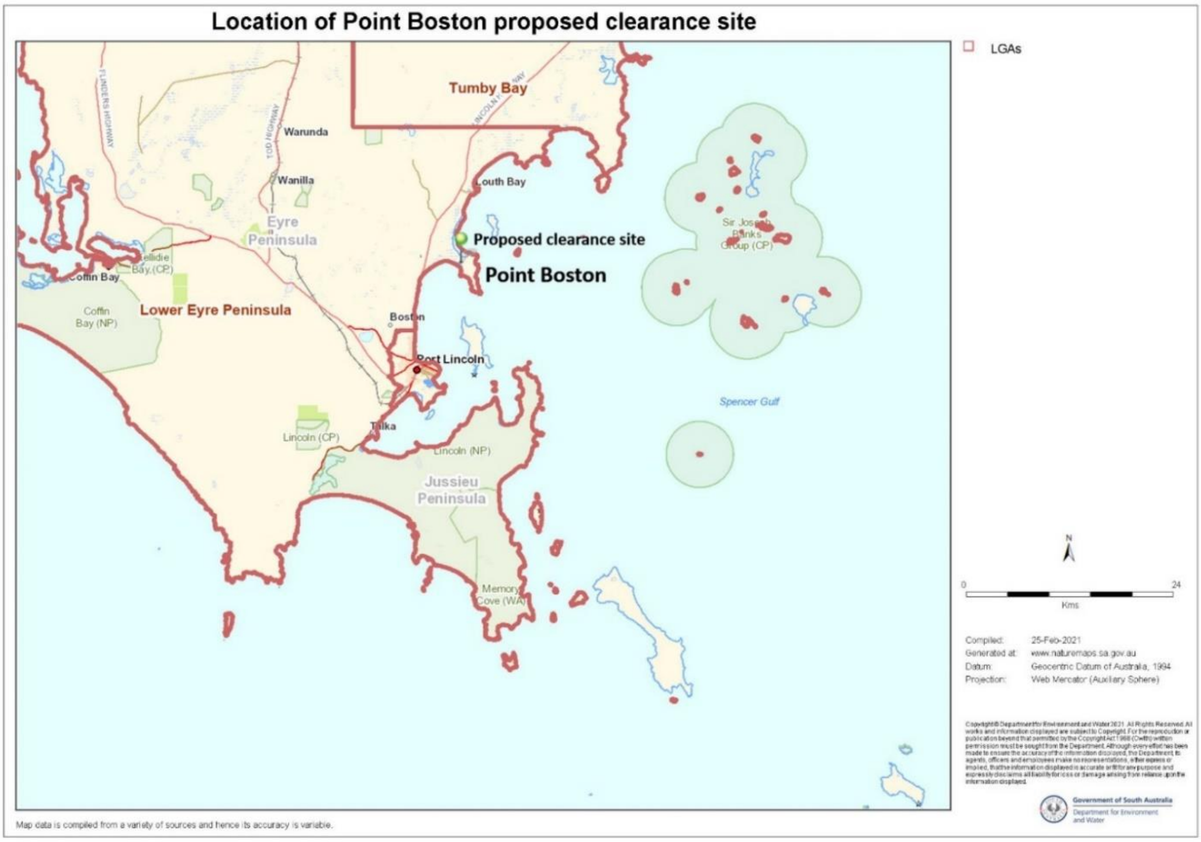


Figure 1. Location of the proposed clearance site at Point Boston

Figure 2. Proposed clearance area site map

2.4 Details of the proposal

Arris Pty Ltd has proposed a system of water dispersal based on their ABSORBS™ technology and plantings of high-water-use bamboo. This facility will have a 1.5 ha footprint and will be bordered on three sides by native vegetation (existing vegetation and supplementary planting). Figure 3 shows the design plan proposed by Arris. (see Appendix 3 - Point Boston Wastewater ABSORBS™ Filters and Biodrain and Nutrient Balances Report to the Environmental Protection Authority).

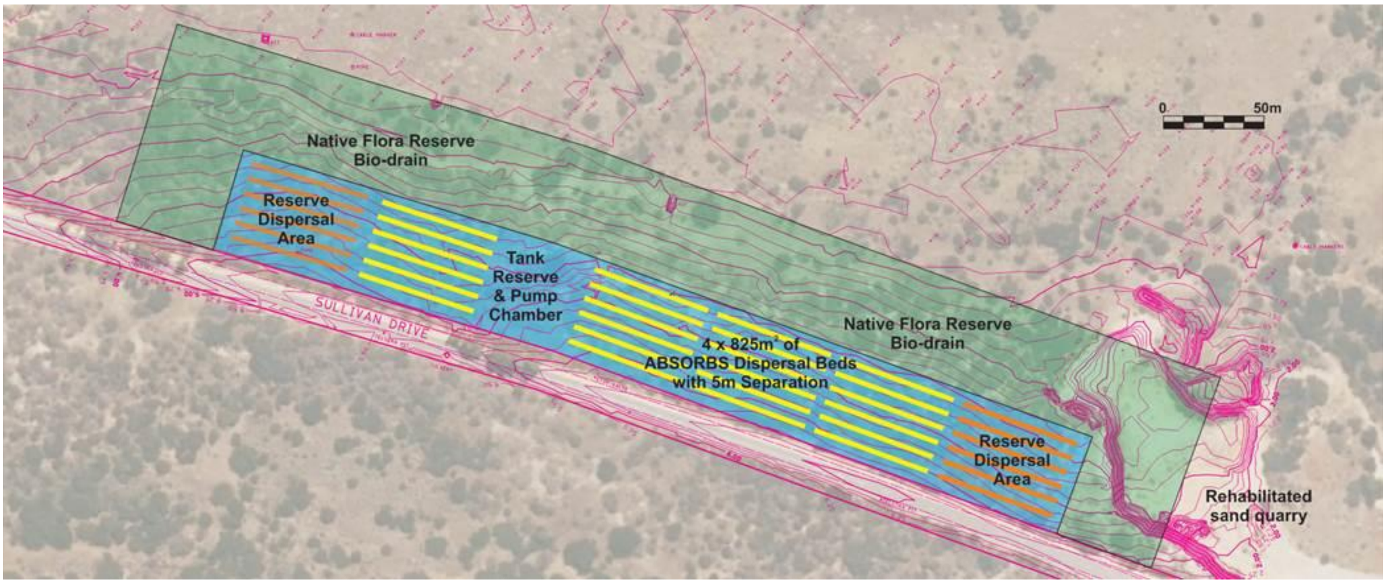


Figure 3. Design plan and layout of the of the waste water dispersal facility.

2.5 Approvals <u>required</u> *or* <u>obtained</u>

- Native Vegetation Act 1991. No previous approvals to clear native vegetation on this site have been granted. Clearance under the Native vegetation Act 1991 is the subject of this proposal.

2.6 Native Vegetation Regulation

The proposed clearance will be assessed under Regulation 12(34) Infrastructure – in connection with the drainage, removal or treatment of wastewater or sewage.

2.7 Development Application information (if applicable)

Under the Planning, Development and Infrastructure Act 2016 the land under application (Title CT6044/180) is zoned:

- Conservation (Zone ID Z0904)
- Infrastructure (Airfield) (Zone ID Z2702)
- Neighbourhood (Zone ID Z4201)
- Rural Aquaculture (Zone ID Z5411)
- Resource Extraction (Zone ID Z5416). An Extractive Mining Lease (EML5774) was held by Eurasia Industries Pty Ltd. The operator was DK Quarries of North Shields. The lease expired in 2012.
- Tourism Development (Zone ID Z6004)

Overlays were not available.

3. Method

3.1 Flora assessment

A desktop survey was conducted, prior to the field work, using the BDBSA on NatureMaps for the presence of plant species with state and/or national conservation status within a 5 km radius of the block. Results are included in Table 1.

The proposed clearance site was designated Block A, comprised of one vegetation association – Site A1.

Field work was carried out on 19 and 20 February 2021 by Phil Landless (NVC Accredited Consultant) following the methodology set out in the NVC Bushland Assessment Manual 2020. The entire 1.5 ha was surveyed, a species list prepared, and scores for the other attributes listed on the field data sheet were recorded. Plants with conservation status under the NP&W 1972 or the EPBC Act 1999 (as identified by the desktop survey) were actively searched for.

3.2 Fauna assessment

A desktop fauna survey was conducted prior to the field work, using the BDBSA on NatureMaps. The search included the surrounding area within a 5 km radius. Results are included in Table 2. During the flora survey field work all fauna species with conservation status under the NP&W 1972 or the EPBC Act 1999 (as identified by the desktop survey) and any sign of their presence (scats, nests, tracks, etc.) were searched for.

4. Assessment Outcomes

4.1 Vegetation Assessment

General description of the vegetation, the site and matters of significance

The site falls within the Peake Bay IBRA Association and the Eyre Hills IBRA Sub-region. The site is situated on a low sandy isthmus, approximately 3 m above sea level, which links the Point Boston Peninsula to the mainland near North Shields. Soil is sandy with little observable surface strew. Some moss was observed on the edges of the site. There are no landform features of significance.

The vegetation under application is made up of one vegetation association, *Acacia dodonaeifolia* Hop-bush Wattle Shrubland. The dominant understorey species is the introduced grass *Ehrharta calycina* Perennial Veldt Grass. The vegetation on the site is in poor condition. Much of the dominant shrub layer is dead and clearings between shrubs have been colonized by introduced grasses, precluding native species. Most of the smaller native shrubs recorded during the field survey were observed towards the edges of the site. A small number (no more than four) of emergent *Allocasuarina verticillata* Drooping Sheoaks were recorded on the site. Two small stands of introduced *Eucalyptus* trees have been planted on the roadside just outside the site.

Thirty plant species were recorded during the field survey, twenty native and ten introduced. One plant species of conservation significance, *Acacia dodonaeifolia* Hopbush Wattle, was recorded and noted as the dominant species on the site.

The site is close to areas already put aside as Significant Environmental Benefit Offset areas and one Heritage Agreement area (Figure 4).

Figure 4. Proposed clearance site in relation to existing SEB offset areas and one Heritage Agreement area.

Details of the vegetation proposed to be impacted

<table>
<tr><td>Vegetation Association</td><td>Site A1: Acacia dodonaeifolia Hop-bush Wattle Shrubland</td></tr>
<tr><td colspan="2">
Location: Site A1
Position: 53S 583764E 6169372N
Direction of photo: Looking west 270 degrees</td></tr>
<tr><td>General description</td><td>Dominant species: Acacia dodonaeifolia Hop-bush Wattle
Dominant understorey species: Ehrharta calycina Perennial Veldt Grass (introduced)</td></tr>
<tr><td>Threatened species or community</td><td>Threatened flora species:
The following flora species with state and/or national conservation status have been recorded within a 5 km radius of the block:
• Drosera stricticaulis (Erect Sundew)
• Acacia dodonaeifolia (Hop-bush Wattle)
• Acacia iteaphylla (Flinders Range Wattle)
• Wurmbea decumbens (Trailing Nancy)
• Billardiera sp. Yorke Peninsula (Lehmann's Apple-berry)
• Desmocladus diacolpicus (Bundled Cord-rush)
• Spyridium leucopogon (Silvery Spyridium)
• Anthocercis anisantha ssp. Anisantha (Port Lincoln Ray-flower)</td></tr>
</table>

<table>
<tr><td></td><td colspan="5">
Levenhookia stipitata (Common Stylewort).
Acacia dodonaeifolia was recorded during the field survey.

Threatened plant community: The vegetation association on the site, Acacia dodonaeifolia Hop-bush Wattle Shrubland, does not appear in the Provisional List of Threatened Ecosystems included in the NVC Bushland Assessment Manual 2020.

Threatened fauna species:
The following fauna species with state and/or national conservation status have been recorded within a 5 km radius of the block:

Biziura lobata menziesi (Musk Duck)
Bubulcus ibis coromandus (Eastern Cattle Egret)
Calidris tenuirostris (Great Knot)
Cereopsis novaehollandiae (NC) and C. novaehollandiae novaehollandiae (Cape Barren Goose)
Egretta garzetta nigripes (Little Egret)
Haemotopus fuliginosus fuliginosus (Sooty Oystercatcher)
Haemotopus longirostris (Pied Oystercatcher)
Haliaeetus leucogaster (White-bellied Sea Eagle)
Limosa lapponica (Bar-tailed Godwit)
Neophema petrophila zietzi (Rock Parrot)
Numenius madagascariensis (Far Eastern Curlew)
Pandion haliaetus cristatus (Eastern Osprey)
Psophodes leucogaster leucogaster (White-bellied Whipbird eastern ssp)
Spatula rhynchotis (Australasian Shoveler)
Stagonopleura guttata (Diamond Firetail)
Sternula nereis nereis (Fairy Tern)
Thinornis cucullatus cucullatus (Hooded Plover)
Tringa brevipes (Grey-tailed Tattler)
Turnix varius varius (Painted Buttonquail)
Zanda funereal whiteae (Yellow-tailed Black Cockatoo)
Dermochelys coriacea (Leatherback Turtle)

None of the threatened fauna species listed above were recorded during the field survey.
</td></tr>
<tr><td>Landscape context score</td><td>1.16</td><td>Vegetation Condition Score</td><td>51.32</td><td>Conservation significance score</td><td>1.14</td></tr>
<tr><td>Unit biodiversity Score</td><td>67.86</td><td>Area (ha)</td><td>1.5 ha</td><td>Total biodiversity Score</td><td>101.79</td></tr>
</table>

Site map showing areas of proposed impact

Figure 5. Site map, showing proposed clearance area – *Acacia dodonaeifolia* Shrubland.

Photo log

Photo log appears as Appendix 5.

4.2 Threatened Species assessment

Threatened flora

The vegetation association on the site, *Acacia dodonaeifolia* Shrubland, does not appear in the Provisional List of Threatened Ecosystems included in the NVC Bushland Assessment Manual 2020.

Nine plant species with conservation status under the NP&W Act and the EPBC Act were identified in the NatureMaps search as being previously recorded within a 5 km radius of the site. Only one species, *Acacia dodonaeifolia* Hop-bush Wattle, was recorded on the site. It was identified as the dominant shrub (Table 1). Another five of the nine plant species with conservation status were considered likely to occur on the site, but not recorded during the field survey.

Table 1. Flora species observed on site or recorded within a 5 km radius of the site since 1995, or the vegetation is considered to provide suitable habitat.

Species (common name)	NP&W Act	EPBC Act	Data source	Date of last record	Species known habitat preferences	Likelihood of use for habitat – Comments
Drosera stricticaulis (Erect	V		3	1995	Along	Possible

Sundew)					watercourses, granite outcrops	
Acacia dodonaeifolia (Hop-bush Wattle)	R		3,4	1995	Woodland, open forest	Highly likely. Recorded during field survey.
Acacia iteaphylla (Flinders Range Wattle)	R		3	1964	Hillsides among rocky outcrops, or in valleys along rocky creek banks	Possible
Wurmbea decumbens (Trailing Nancy)	R		3	1995	Rocky hills, mostly on sheltered southern slopes	Unlikely
Billardiera sp. Yorke Peninsula (Lehmann's Apple-berry)	E		3	1995	Coastal dunes	Possible
Desmocladus diacolpicus (Bundled Cord-rush)	V		3	1976	On sand in low open heath and mallee vegetation	Possible
Spyridium leucopogon (Silvery Spyridium)	R		3	1959	Mallee, on pale brown sand over limestone	Unlikely
Anthocercis anisantha ssp. Anisantha (Port Lincoln Ray-flower)	R		3	1959	Woodland or shrubland on undulating plains	Possible
Levenhookia stipitate (Common Stylewort)	R		3	1995	Winter-wet depressions on lateritic or granitic soils	Unlikely
Source; 1- BDBSA, 2 - AoLA, 3 – NatueMaps 4 – Observed/recorded in the field, 5 - Protected matters search tool, 6 – others NP&W Act; E= Endangered, V = Vulnerable, R= Rare EPBC Act; Ex = Extinct, CR = Critically endangered, EN = Endangered; VU = Vulnerable						

Threatened fauna

Twenty-one fauna species with conservation status under the NP&W Act and the EPBC Act were identified in the NatureMaps search as being previously recorded within a 5 km radius of the site. Six were deemed likely to occur on the site although none were observed during the field survey (Table 2).

Table 2. Species observed on site, or recorded within 5km (50km in the arid zone) of the application area since 1995, or the vegetation is considered to provide suitable habitat

Species (common name)	NP&W Act	EPBC Act	Data source	Date of last record	Species known habitat preferences	Likelihood of use for habitat – Comments
Biziura lobata menziesi (Musk Duck)	R		3	2020	Swamps, lakes, tidal inlets and bays	Unlikely
Bubulcus ibis coromandus (Eastern Cattle Egret)	R		3	1998	Pasture, shallow wetland	Possible

Calidris tenuirostris (Great Knot)	E	CR	3	2015	Tidal mudflats	Unlikely
Cereopsis novaehollandiae (NC) and *C. novaehollandiae novaehollandiae* (Cape Barren Goose)	R		3	2016	Offshore islands while breeding, improved pasture on mainland	Possible
Egretta garzetta nigripes (Little Egret)	R		3	2017	Wetlands, intertidal mudflats	Unlikely
Haemotopus fuliginosus fuliginosus (Sooty Oystercatcher)	R		3	2019	Rocky coastline, estuaries	Unlikely
Haemotopus longirostris (Pied Oystercatcher)	R		3		Sandy beaches, estuaries	Unlikely
Haliaeetus leucogaster (White-bellied Sea Eagle)	E		3	2004	Rivers, lakes, reservoirs, coast	Unlikely
Limosa lapponica (Bar-tailed Godwit)	ssp	ssp	3	2015	Tidal mudflats, rarely inland	Unlikely
Neophema petrophila zietzi (Rock Parrot)	R		3	2019	Coastal dunes, saltmarsh, rocky islands	Unlikely
Numenius madagascariensis (Far Eastern Curlew)	E	CR	3	1985	Coastal estuaries, mudflats, mangroves, sandspits	Unlikely
Pandion haliaetus cristatus (Eastern Osprey)	E		3	2019	Mangroves, rivers, estuaries, inshore seas, coastal islands	Unlikely
Psophodes leucogaster leucogaster (White-bellied Whipbird eastern ssp)	E	VU	3	1966	Dense coastal heath thickets, dense mallee scrub	Possible
Spatula rhynchotis (Australasian Shoveler)	R		3	2018	Heavily vegetated swamps, floodwaters	Unlikely
Stagonopleura guttata (Diamond Firetail)	V		3	2019	Grassy woodland, forests, mallee	Possible
Sternula nereis nereis (Fairy Tern)	E	VU	3	2018	Coasts, estuaries	Unlikely
Thinornis cucullatus cucullatus (Hooded Plover)	V	VU	3	2018	Ocean beaches, coastal lakes, marshes, lagoons	Unlikely
Tringa brevipes (Grey-tailed Tattler)	R		3	2015	Estuaries, mangroves, rocky coasts, reefs	Unlikely
Turnix varius varius (Painted Buttonquail)	R		3	2010	Grassy forests, woodlands	Possible

Zanda funereal whiteae (Yellow-tailed Black Cockatoo)	V		3	1970	Open forest, farms, pine plantations	Possible
Dermochelys coriacea (Leatherback Turtle)	V	EN	3	1991	Coastal waters	Unlikely. Marine animal.
Source; 1- BDBSA, 2 - AoLA, 3 – NatueMaps 4 – Observed/recorded in the field, 5 - Protected matters search tool, 6 – others NP&W Act; E= Endangered, V = Vulnerable, R= Rare EPBC Act; Ex = Extinct, CR = Critically endangered, EN = Endangered; VU = Vulnerable						

Criteria for the likelihood of occurrence of species within the Study area.

Likelihood	**Criteria**
Highly Likely/Known	Recorded in the last 10 years, the species does not have highly specific niche requirements, the habitat is present and falls within the known range of the species distribution or; The species was recorded as part of field surveys.
Likely	Recorded within the previous 20 years, the area falls within the known distribution of the species and the area provides habitat or feeding resources for the species.
Possible	Recorded within the previous 20 years, the area falls inside the known distribution of the species, but the area provide limited habitat or feeding resources for the species. Recorded within 20 -40 years, survey effort is considered adequate, habitat and feeding resources present, and species of similar habitat needs have been recorded in the area.
Unlikely	Recorded within the previous 20 years, but the area provide no habitat or feeding resources for the species, including perching, roosting or nesting opportunities, corridor for movement or shelter. Recorded within 20 -40 years; however, suitable habitat does not occur, and species of similar habitat requirements have not been recorded in the area. No records despite adequate survey effort.

4.3 Cumulative impact

Direct impact

The facility has a footprint of 1.5 ha. This area will be totally cleared. As the facility will be a permanent structure there will be no rehabilitation of the area. However, an area of 3.5 ha surrounding the development will be rehabilitated. Future work program will include weed control and removal, and supplementary planting with appropriate plant species.

Indirect and cumulative impacts

Arris has undertaken to identify and mitigate the risks to the environment of the proposed wastewater treatment and dispersal system proposed for the Point Boston Development. The system is accountable for mass balance of water and nutrients. Calculations can be seen in Appendix 3, Point Boston Wastewater ABSORBS™ Filters and Biodrain and Nutrient Balances Report (Appendix B).

The design of the facility has been significantly influenced by the following SA EPA site specific requirements:

- The site is within a sensitive marine environment and that the design should demonstrate negligible impact on the environment, and
- That there is beneficial reuse of treated effluent and nutrients (see Appendix 3, Point Boston Wastewater ABSORBS™ Filters and Biodrain and Nutrient Balances Report to the Environmental Protection Authority).

4.4 Address the Mitigation Hierarchy

When exercising a power or making a decision under Division 5 of the Native Vegetation Regulations 2017, the NVC must have regard to the mitigation hierarchy. The NVC will also consider, with the aim to minimize, impacts on biological diversity, soil, water and other natural resources, threatened species or ecological communities under the EPBC Act or listed species under the NP&W Act.

a) Avoidance – outline measures taken to avoid clearance of native vegetation

Site selection has been undertaken with considerable thought to the environment. The selected/preferred site has been chosen based on a number of factors, including:

- Depth to water table – it is a requirement of the SA Health Code for Onsite Wastewater systems that the depth to water table should be greater than 1.2 m. In the case of subsurface disposal the base of the trench should be greater than 500 mm above the highest level of the water table. The elevation of this site meets the design requirements of the SA Health Code.
- Other sites – in terms of depth to water table there are sites on Point Boston which would provide advantage over the site selected. Other sites also supported native vegetation. Conversely, sites to the north-west of the selected site on cleared land are low-lying, have a smaller separation between the water table and the base of the dispersal beds and do not meet the requirements of the SA Health Code. The two wetland areas adjacent to the lagoons were avoided for the same reason and to prevent changing the wetlands' hydrology and nutrient levels.
- Design – there is a significant design advantage in having greater head space above the water table for the beneficial reuse of water and nutrients.
- Cost – Locating the water dispersal unit at this site makes use of as much of the existing Point Boston infrastructure as possible, minimizing cost and waste.

b) Minimization – if clearance cannot be avoided, outline measures taken to minimize the extent, duration and intensity of impacts of the clearance on biodiversity to the fullest possible extent (whether the impact is direct, indirect or cumulative).

Measures to minimise the extent, duration and intensity of impacts of the clearance include:

- Clearance and/or damage to surrounding native vegetation to be avoided during construction,
- Excavated soil and cleared plant material to be stored on-site before removal,
- Machinery, vehicles, workers and material deliveries will not impact on any vegetation except for the area under application.
- Access to the site for construction purposes will be from the adjacent road (Sullivan Drive) and not from adjoining areas of vegetation.

c) Rehabilitation or restoration – outline measures taken to rehabilitate ecosystems that have been degraded, and to restore ecosystems that have been degraded, or destroyed by the impact of clearance that cannot be avoided or further minimized, such as allowing for the re-establishment of the vegetation.

The proposed water dispersal unit will be a permanent structure. Rehabilitation or restoration of the site will not be possible. . However, an area of 3.5 ha surrounding the development will be rehabilitated. Future work program will include weed control and removal, and supplementary planting with appropriate plant species.

d) Offset – any adverse impact on native vegetation that cannot be avoided or further minimized should be offset by the achievement of a significant environmental benefit that outweighs that impact.

The applicants plan to make a payment of $63,955.41 to the NVC in combination with an on-ground offset of 3.5 ha to satisfy the SEB points required.

4.5 Principles of Clearance (Schedule 1, *Native Vegetation Act 1991*)

The Native Vegetation Council will consider Principles 1(b), 1(c) and 1(d) when assigning a level of Risk under Regulation 16 of the Native Vegetation Regulations. The Native Vegetation Council will consider all the Principles of clearance of the Act as relevant, when considering an application referred under the *Planning, Development and Infrastructure Act 2016*.

Principle of clearance	**Considerations**
Principle 1a - it comprises a high level of diversity of plant species	**<u>Relevant information</u>** The number of plant species recorded (native and introduced): • Site A1: 30 plant species recorded (20 native, 10 introduced) Plant species diversity score: • Site A1: 24
	<u>Assessment against the principles</u> • Site A1: **Seriously at variance**
	<u>Moderating factors that may be considered by the NVC</u> 1.5 ha will be cleared for the infrastructure but an area bordering the site on three sides will undergo weed eradication and supplementary planting. This will enhance this small remnant.
Principle 1b - significance as a habitat for wildlife	**<u>Relevant information</u>** Threatened species recorded within 5 km which may use the vegetation: • *Biziura lobata menziesi* (Musk Duck) • *Bubulcus ibis coromandus* (Eastern Cattle Egret) • *Calidris tenuirostris* (Great Knot) • *Cereopsis novaehollandiae (NC)* and *C. novaehollandiae novaehollandiae* (Cape Barren Goose) • *Egretta garzetta nigripes* (Little Egret) • *Haemotopus fuliginosus fuliginosus* (Sooty Oystercatcher) • *Haemotopus longirostris* (Pied Oystercatcher) • *Haliaeetus leucogaster* (White-bellied Sea Eagle) • *Limosa lapponica* (Bar-tailed Godwit) • *Neophema petrophila zietzi* (Rock Parrot) • *Numenius madagascariensis* (Far Eastern Curlew) • *Pandion haliaetus cristatus* (Eastern Osprey) • *Psophodes leucogaster leucogaster* (White-bellied Whipbird eastern ssp) • *Spatula rhynchotis* (Australasian Shoveler) • *Stagonopleura guttata* (Diamond Firetail) • *Sternula nereis nereis* (Fairy Tern) • *Thinornis cucullatus cucullatus* (Hooded Plover) • *Tringa brevipes* (Grey-tailed Tattler) • *Turnix varius varius* (Painted Buttonquail) • *Zanda funereal whiteae* (Yellow-tailed Black Cockatoo) • *Dermochelys coriacea* (Leatherback Turtle) Threatened Fauna Score: • Site A1: 0.1 Unit biodiversity Score: • Site A1: 67.86

	Assessment against the principles Site A1: **Seriously at variance**
	Moderating factors that may be considered by the NVC 1.5 ha will be cleared for the infrastructure but an area bordering the site on three sides will undergo weed eradication and supplementary planting. This will enhance this small remnant and improve the quality of the remnant as habitat.
Principle 1c - plants of a rare, vulnerable or endangered species	Relevant information Threatened species that were recorded for the site: *Acacia dodonaeifolia* (Hop-bush Wattle) Threatened species that may be present but were not recorded at the time of assessment: *Drosera stricticaulis* (Erect Sundew) *Acacia iteaphylla* (Flinders Range Wattle) *Wurmbea decumbens* (Trailing Nancy) *Billardiera* sp. Yorke Peninsula (Lehmann's Apple-berry) *Desmocladus diacolpicus* (Bundled Cord-rush) *Spyridium leucopogon* (Silvery Spyridium) *Anthocercis anisantha* ssp. Anisantha (Port Lincoln Ray-flower) *Levenhookia stipitata* (Common Stylewort) Threatened Flora Score: - Site A1: 0.04
	Assessment against the principles Site A1: **At variance**
	Moderating factors that may be considered by the NVC 1.5 ha will be cleared for the infrastructure but an area bordering the site on three sides will undergo weed eradication and supplementary planting. This will enhance this small remnant and improve the quality of the remnant as habitat.
Principle 1d - the vegetation comprises the whole or part of a plant community that is Rare, Vulnerable or endangered:	Relevant information Not applicable
	Assessment against the principles Not applicable
	Moderating factors that may be considered by the NVC Not applicable
Principle 1e - it is significant as a remnant of vegetation in an area which has been extensively	Relevant information IBRA Association remnancy: - Site A1: 16% IBRA Sub-region remnancy: - Site A1: 29% Total Biodiversity Score: - Site A1: 101.79

cleared.	Assessment against the principles Site A1: **At Variance**
	Moderating factors that may be considered by the NVC
Principle 1f - it is growing in, or in association with, a wetland environment.	Relevant information Not applicable
	Assessment against the principles Not applicable
	Moderating factors that may be considered by the NVC Not applicable
Principle 1g - it contributes significantly to the amenity of the area in which it is growing or is situated.	Relevant information Not applicable
	Not applicable
	Moderating factors that may be considered by the NVC Not applicable

4.6 Risk Assessment

Determine the level of risk associated with the application

Total clearance	No. of trees	
	Area (ha)	1.5 ha
	Total biodiversity Score	101.79
Seriously at variance with principle 1(b), 1(c) or 1 (d)		1(b)
Risk assessment outcome		Level 4

5. Clearance summary

Clearance Area(s) Summary table

Block	Site	Species diversity score	Threatened Ecological community Score	Threatened plant score	Threatened fauna score	UBS	Area (ha)	Total Biodiversity score	Loss factor	Loadings	Reductions	SEB Points required	SEB payment	Admin Fee
A	A1	24	1	.04	0.1	67.86	1.5	101.79	1			106.88	$60621.24	$3334.17
						Total	**1.5**	**101.79**				**106.88**	**$60621.24**	**$3334.17**

Totals summary table

	Total Biodiversity score	Total SEB points required	SEB Payment	Admin Fee	Total Payment
Application	101.79	106.88	$60,621.24	$3,334.24	$63,955.48

Economies of Scale Factor	0.5
Rainfall (mm)	430mm

6. Significant Environmental Benefit

A Significant Environmental Benefit (SEB) is required for approval to clear under Division 5 of the *Native Vegetation Regulations 2017*. The NVC must be satisfied that as a result of the loss of vegetation from the clearance that an SEB will result in a positive impact on the environment that is over and above the negative impact of the clearance.

ACHIEVING AN SEB

Indicate how the SEB will be achieved by ticking the appropriate box and providing the associated information:

☒ Establish a new SEB Area on land owned by the proponent.

☐ Use SEB Credit that the proponent has established. Provide the SEB Credit Ref. No. __________

☐ Apply to have SEB Credit assigned from another person or body. The application form needs to be submitted with this Data Report.

☐ Apply to have an SEB to be delivered by a Third Party. The application form needs to be submitted with this Data Report.

☒ Pay into the Native Vegetation Fund.

PAYMENT SEB

The applicant is proposing to make a payment to the NVC in combination with an on-ground offset to satisfy the SEB points required, as follows:

- On-ground offset of 3.5 ha, surrounding the application site (delivering 25.68% of the SEB points required).
- Payment into the NVC Fund of $45,053.70 (74.32% of the total value of the amount calculated to satisfy SEB points required), plus Administration Fee of $2,252.69. Total payable is $47,306.39.

These figures have been calculated by the NVC consultant and may need modification by the NVC.

ON-GROUND SEB

Ownership:	(Point Boston) Community Corporation 25691		
Site Address:	357 Sullivan Drive, Point Boston		
Local Government Area:	Lower Eyre Peninsula	Hundred:	Louth
Title ID:	CT6044/180	Parcel ID	C25691FCPP

General description of the vegetation, the site and matters of significance

The site falls within the Peake Bay IBRA Association and the Eyre Hills IBRA Sub-region. The site is situated on a low sandy isthmus, approximately 3 m above sea level, which links the Point Boston Peninsula to the mainland near North Shields. Soil is sandy with little observable surface strew. Some moss was observed on the edges of the site. There are no landform features of significance.

The proposed SEB area borders the clearance application area described above.

The vegetation under application is made up of one vegetation association, *Acacia dodonaeifolia* Hop-bush Wattle Shrubland. The dominant understorey species is the introduced grass *Ehrharta calycina* Perennial Veldt Grass. The vegetation on the site is in poor condition. Much of the dominant shrub layer is dead and clearings between shrubs have been colonized by introduced grasses, precluding native species. Most of the smaller native shrubs recorded during the field survey were observed towards the edges of the site. A small number of emergent *Allocasuarina verticillata* Drooping Sheoak were recorded on the site.

Twenty-seven plant species were recorded during the field survey, twenty native and seven introduced. One plant species of conservation significance, *Acacia dodonaeifolia* Hopbush Wattle, was recorded and noted as the dominant species on the site.

The site is close to areas already put aside as Significant Environmental Benefit Offset areas and one Heritage Agreement area (Figure 4).

Information relating to the relevant land

The land was formerly agricultural land for cropping and grazing. In more recent years the land was used for grazing.

In the early 2000s three Point Boston landholders (farmers) formed a partnership with an Adelaide based property developer and proposed a new, environmentally friendly residential development to the local council.

The Point Boston Community Corporation Committee formed by lot holders is responsible for the management of common property - including land and infrastructure.

General location map and <u>Site map</u> showing areas of the proposed SEB

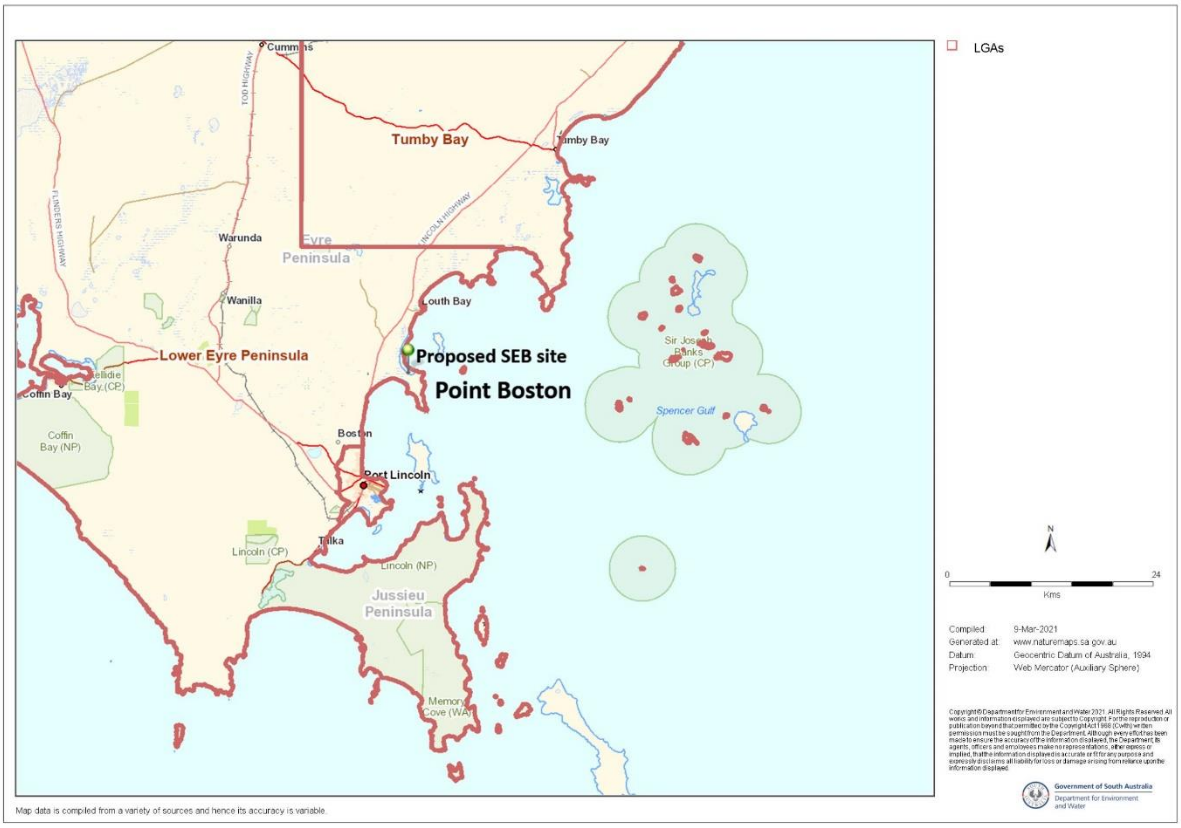


Figure 6. General location of proposed SEB site

Figure 7. Site plan of proposed SEB area.

Description of the vegetation

<table>
<tr><td>Vegetation Association</td><td>Site B1: Acacia dodonaeifolia Hop-bush Wattle Shrubland</td></tr>
<tr><td colspan="2">
Location: Site B1
Position: 53S 583262E 6169497N
Direction of photo: Looking E 85 deg. shows emergent Allocasuarina verticillata</td></tr>
<tr><td>General description</td><td>Dominant species: Acacia dodonaeifolia Hop-bush Wattle
Dominant understorey species: Ehrharta calycina Perennial Veldt Grass (introduced)</td></tr>
<tr><td>Threatened species or community</td><td>Threatened flora species:
The following flora species with state and/or national conservation status have been recorded within a 5 km radius of the block:
Drosera stricticaulis (Erect Sundew)
Acacia dodonaeifolia (Hop-bush Wattle)
Acacia iteaphylla (Flinders Range Wattle)
Wurmbea decumbens (Trailing Nancy)
Billardiera sp. Yorke Peninsula (Lehmann's Apple-berry)
Desmocladus diacolpicus (Bundled Cord-rush)
Spyridium leucopogon (Silvery Spyridium)
Anthocercis anisantha ssp. Anisantha (Port Lincoln Ray-flower)
Levenhookia stipitata (Common Stylewort).
Acacia dodonaeifolia was recorded during field survey.</td></tr>
</table>

	Threatened plant community: The vegetation association on the site, *Acacia dodonaeifolia* Hop-bush Wattle Shrubland, does not appear in the Provisional List of Threatened Ecosystems included in the NVC Bushland Assessment Manual 2020. **Threatened fauna species:** The following fauna species with state and/or national conservation status have been recorded within a 5 km radius of the block: • Biziura lobata menziesi (Musk Duck) • Bubulcus ibis coromandus (Eastern Cattle Egret) • Calidris tenuirostris (Great Knot) • Cereopsis novaehollandiae (NC) and C. novaehollandiae novaehollandiae (Cape Barren Goose) • Egretta garzetta nigripes (Little Egret) • Haemotopus fuliginosus fuliginosus (Sooty Oystercatcher) • Haemotopus longirostris (Pied Oystercatcher) • Haliaeetus leucogaster (White-bellied Sea Eagle) • Limosa lapponica (Bar-tailed Godwit) • Neophema petrophila zietzi (Rock Parrot) • Numenius madagascariensis (Far Eastern Curlew) • Pandion haliaetus cristatus (Eastern Osprey) • Psophodes leucogaster leucogaster (White-bellied Whipbird eastern ssp) • Spatula rhynchotis (Australasian Shoveler) • Stagonopleura guttata (Diamond Firetail) • Sternula nereis nereis (Fairy Tern) • Thinornis cucullatus cucullatus (Hooded Plover) • Tringa brevipes (Grey-tailed Tattler) • Turnix varius varius (Painted Buttonquail) • Zanda funereal whiteae (Yellow-tailed Black Cockatoo) • Dermochelys coriacea (Leatherback Turtle) None of the threatened fauna species listed above were recorded during the field survey.				
Landscape context score	1.19	Vegetation Condition Score	51.32	Conservation significance score	1.14
Gain Score	6.87	Area (ha)	3.5 ha	SEB Points of Gain	24.03

Photo log

Photolog appears as Appendix 5.

Fauna and Flora assessment

Threatened flora

The vegetation association on the site, *Acacia dodonaeifolia* Shrubland, does not appear in the Provisional List of Threatened Ecosystems included in the NVC Bushland Assessment Manual 2020.

Nine plant species with conservation status under the NP&W Act and the EPBC Act were identified in the Naturemaps search as being previously recorded within a 5 km radius of the site. Only one species, *Acacia dodonaeifolia* Hop-bush Wattle, was recorded on the site. It was identified as the dominant shrub (Table 3).

Table 3. Flora species observed on site or recorded within a 5 km radius of the site since 1995, or the vegetation is considered to provide suitable habitat.

Species (common name)	NP&W Act	EPBC Act	Data source	Date of last record	Species known habitat preferences	Likelihood of use for habitat – Comments
Drosera stricticaulis (Erect Sundew)	V		3	1995	Along watercourses, granite outcrops	Possible
Acacia dodonaeifolia (Hop-bush Wattle)	R		3,4	1995	Woodland, open forest	Highly likely. Recorded during field survey
Acacia iteaphylla (Flinders Range Wattle)	R		3	1964	Hillsides among rocky outcrops, or in valleys along rocky creek banks	Possible
Wurmbea decumbens (Trailing Nancy)	R		3	1995	Rocky hills, mostly on sheltered southern slopes	Unlikely
Billardiera sp. Yorke Peninsula (Lehmann's Apple-berry)	E		3	1995	Coastal dunes	Possible
Desmocladus diacolpicus (Bundled Cord-rush)	V		3	1976	On sand in low open heath and mallee vegetation	Possible
Spyridium leucopogon (Silvery Spyridium)	R		3	1959	Mallee, on pale brown sand over limestone	Unlikely
Anthocercis anisantha ssp. Anisantha (Port Lincoln Ray-flower)	R		3	1959	Woodland or shrubland on undulating plains	Possible
Levenhookia stipitate (Common Stylewort)	R		3	1995	Winter-wet depressions on lateritic or granitic soils	Unlikely
Source; 1- BDBSA, 2 - AoLA, 3 – NatueMaps 4 – Observed/recorded in the field, 5 - Protected matters search tool, 6 – others NP&W Act; E= Endangered, V = Vulnerable, R= Rare EPBC Act; Ex = Extinct, CR = Critically endangered, EN = Endangered; VU = Vulnerable						

Threatened fauna

Twenty-one fauna species with conservation status under the NP&W Act and the EPBC Act were identified in the Naturemaps search as being previously recorded within a 5 km radius of the site. None were observed during the field survey (Table 4).

Table 4. Species observed on site, or recorded within 5km (50km in the arid zone) of the application area since 1995, or the vegetation is considered to provide suitable habitat

Species (common name)	NP&W Act	EPBC Act	Data source	Date of last record	Species known habitat preferences	Likelihood of use for habitat – Comments
Biziura lobata menziesi (Musk Duck)	R		3	2020	Swamps, lakes, tidal inlets and bays	Unlikely
Bubulcus ibis coromandus (Eastern Cattle Egret)	R		3	1998	Pasture, shallow wetland	Possible
Calidris tenuirostris (Great Knot)	E	CR	3	2015	Tidal mudflats	Unlikely
Cereopsis novaehollandiae (NC) and *C. novaehollandiae novaehollandiae* (Cape Barren Goose)	R		3	2016	Offshore islands while breeding, improved pasture on mainland	Possible
Egretta garzetta nigripes (Little Egret)	R		3	2017	Wetlands, intertidal mudflats	Unlikely
Haemotopus fuliginosus fuliginosus (Sooty Oystercatcher)	R		3	2019	Rocky coastline, estuaries	Unlikely
Haemotopus longirostris (Pied Oystercatcher)	R		3		Sandy beaches, estuaries	Unlikely
Haliaeetus leucogaster (White-bellied Sea Eagle)	E		3	2004	Rivers, lakes, reservoirs, coast	Unlikely
Limosa lapponica (Bar-tailed Godwit)	ssp	ssp	3	2015	Tidal mudflats, rarely inland	Unlikely
Neophema petrophila zietzi (Rock Parrot)	R		3	2019	Coastal dunes, saltmarsh, rocky islands	Unlikely
Numenius madagascariensis (Far Eastern Curlew)	E	CR	3	1985	Coastal estuaries, mudflats, mangroves, sandspits	Unlikely
Pandion haliaetus cristatus (Eastern Osprey)	E		3	2019	Mangroves, rivers, estuaries, inshore seas, coastal islands	Unlikely
Psophodes leucogaster leucogaster (White-bellied Whipbird eastern ssp)	E	VU	3	1966	Dense coastal heath thickets, dense mallee scrub	Possible
Spatula rhynchotis (Australasian Shoveler)	R		3	2018	Heavily vegetated swamps, floodwaters	Unlikely
Stagonopleura guttata (Diamond Firetail)	V		3	2019	Grassy woodland, forests, mallee	Possible

Sternula nereis nereis (Fairy Tern)	E	VU	3	2018	Coasts, estuaries	Unlikely
Thinornis cucullatus cucullatus (Hooded Plover)	V	VU	3	2018	Ocean beaches, coastal lakes, marshes, lagoons	Unlikely
Tringa brevipes (Grey-tailed Tattler)	R		3	2015	Estuaries, mangroves, rocky coasts, reefs	Unlikely
Turnix varius varius (Painted Buttonquail)	R		3	2010	Grassy forests, woodlands	Possible
Zanda funereal whiteae (Yellow-tailed Black Cockatoo)	V		3	1970	Open forest, farms, pine plantations	Possible
Dermochelys coriacea (Leatherback Turtle)	V	EN	3	1991	Coastal waters	Unlikely
Source; 1- BDBSA, 2 - AoLA, 3 – NatueMaps 4 – Observed/recorded in the field, 5 - Protected matters search tool, 6 – others NP&W Act; E= Endangered, V = Vulnerable, R= Rare EPBC Act; Ex = Extinct, CR = Critically endangered, EN = Endangered; VU = Vulnerable						

Criteria for the likelihood of occurrence of species within the Study area.

Likelihood	Criteria
Highly Likely/Known	Recorded in the last 10 years, the species does not have highly specific niche requirements, the habitat is present and falls within the known range of the species distribution or; The species was recorded as part of field surveys.
Likely	Recorded within the previous 20 years, the area falls within the known distribution of the species and the area provides habitat or feeding resources for the species.
Possible	Recorded within the previous 20 years, the area falls inside the known distribution of the species, but the area provide limited habitat or feeding resources for the species. Recorded within 20 -40 years, survey effort is considered adequate, habitat and feeding resources present, and species of similar habitat needs have been recorded in the area.
Unlikely	Recorded within the previous 20 years, but the area provide no habitat or feeding resources for the species, including perching, roosting or nesting opportunities, corridor for movement or shelter. Recorded within 20 -40 years; however, suitable habitat does not occur, and species of similar habitat requirements have not been recorded in the area. No records despite adequate survey effort.

Environmental Benefits

Key environmental outcomes and associated benefits include:

- Preservation and rehabilitation, as a managed SEB on-ground offset, of a site containing a plant of conservation significance, i.e. *Acacia dodonaeifolia* Hopbush Wattle (NP&W Act rating of Rare),
- Removal of introduced weeds from the site,
- Rehabilitation of old sand mine site,
- Supplementary planting of appropriate plant species throughout the site,
- Improved vegetation condition,
- Increase in the population of the threatened flora species,
- Improved habitat for local fauna species.

Summary Table

Block	Site	Vegetation Association	UBS	Gain Score	Area (ha)	SEB Point of Gain
B	B1	*Acacia dodonaeifolia* Hop-bush Wattle Shrubland	69.62	6.87	3.5 ha	24.03
					Total	3.5 ha	24.03

SEB Management Plan

The Management Plan for the proposed SEB area is submitted as a separate PDF document.

7. Appendices

Appendix 1. Flora species recorded during the field survey (Sites A1 and B1).

Note: asterisk (*) denotes introduced species.

Family	Species	Common name
Aizoaceae	*Carpobrotus rossii*	Pigface
Asteraceae	**Conyza bonariensis*	Flax-leaf Fleabane
	Olearia axillaris	Coast Daisy Bush
	**Reichardia tingitana*	False Sowthistle
	**Sonchus oleraceus*	Sow Thistle
Campanulaceae	*Wahlenbergia gracilenta*	Annual Bluebell
Casuarinaceae	*Allocasuarina verticillata*	Drooping Sheoak
Chenopodiaceae	*Enchylaena tomentosa var. tomentosa*	Ruby Saltbush
	Rhagodia candolleana ssp. candolleana	Sea-berry Saltbush
Cyperaceae	*Ficinia nodosa*	Knobby Club-rush
Epacridaceae	*Leucopogon parviflorus*	Coastal Bearded Heath
	Stenanthera conostephioides	Flame Heath
Lauraceae	*Cassytha glabella f. dispar*	Slender Dodder-laurel
Liliaceae	**Asphodelus fistulosus*	Onion Weed
	Dianella revoluta var. revoluta	Black-anther Flax-lily
Limoniaceae	**Limonium companyonis*	Sea-lavender
Loranthaceae	*Lysiana exocarpi ssp. exocarpi*	Harlequin Mistletoe
Mimosaceae	*Acacia cupularis*	Coastal Umbrella Wattle
	Acacia dodonaeifolia	Hop-bush Wattle
	Acacia longifolia ssp. sophorae	Coastal Wattle
Myoporaceae	*Myoporum insulare*	Common Boobialla
Myrtaceae	*Hysterobaeckea behrii*	Silver Broombush
Poaceae	**Avena sp.*	Oat
	**Ehrharta calycina*	Perennial Veldt Grass
	**Lagurus ovatus*	Hare's Tail Grass
	**Rytidosperma setaceum*	Bristly Wallaby-grass
Pinaceae	**Pinus halepensis*	Aleppo Pine
Polygonaceae	*Muehlenbeckia gunnii*	Coastal Climbing Lignum
Santalaceae	*Exocarpus sparteus*	Slender Cherry
Solanaceae	**Lycium ferocissimum*	African Boxthorn

Appendix 2. Bushland Vegetation Assessment Scoresheets associated with the proposed clearance and SEB sites.

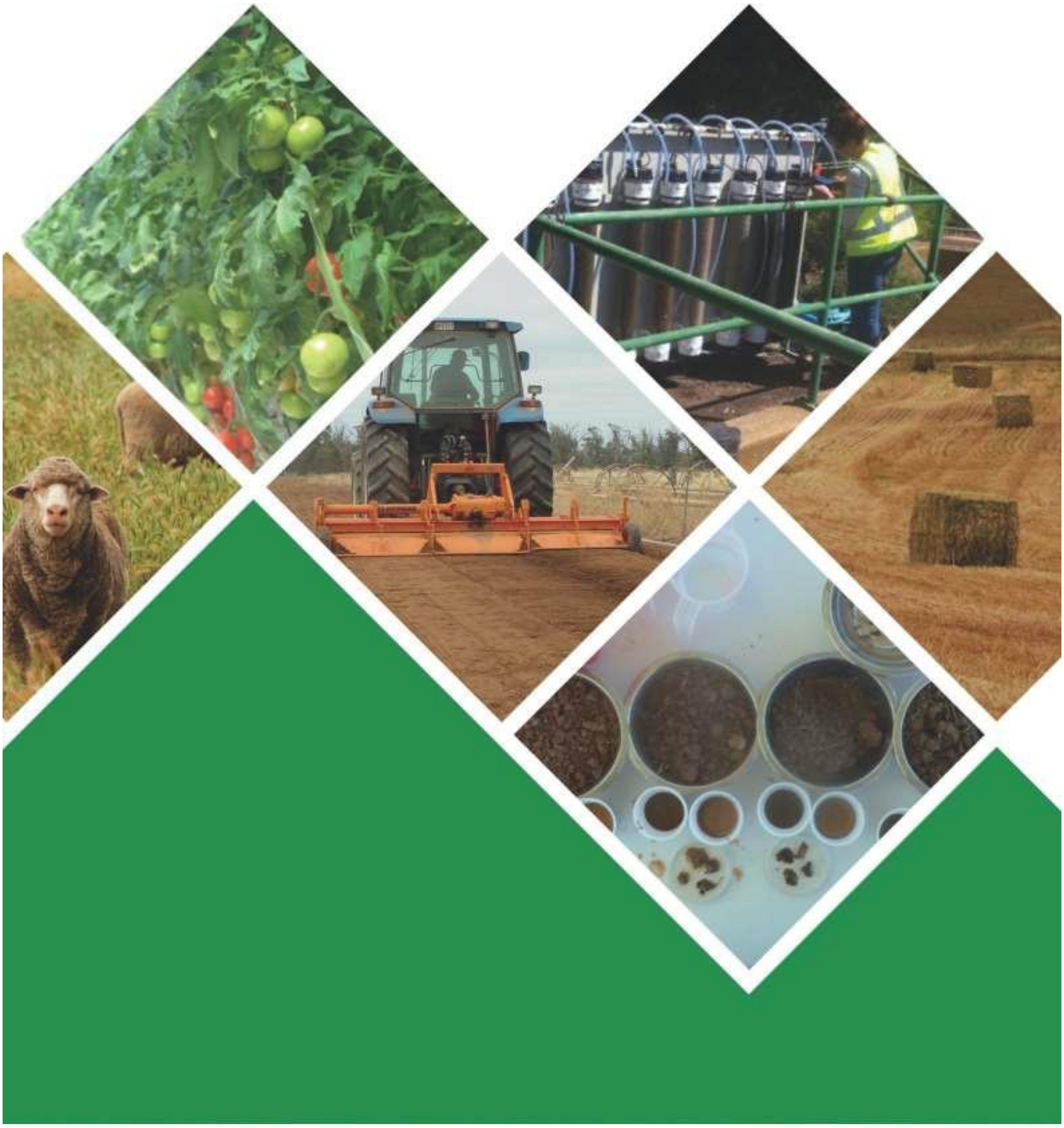
Block A, Site A1 and Block B, Site B1

Submitted separately in Excel format

Appendix 3. Point Boston Wastewater ABSORBS™ Filters and Biodrain and Nutrient Balances Report to the Environmental Protection Authority.

arris

agricultural & environmental



Point Boston Wastewater ABSORBS™ Filters and Biodrain Water and Nutrient Balances

For: Point Boston Community Corporation

Version	Date	Author/s	Reviewed	Issued By
Final	05/05/2020	Jim Kelly	Dr Carine Saison	Jim Kelly

Created by	Arris Pty Ltd	Bld 11b, Gate 2c Hartley Grove URRBRAE SA 5064 T 08 8313 6706 F 08 8313 6752 ACN 092 739 574
Client	Ian Crossland	
Name of Organisation	Point Boston Community Corporation	
Name of Project	Point Boston Wastewater System	
Name of Document	Point Boston Wastewater ABSORBS™ Filters and Biodrain Water and Nutrient Balances	
Project Number		
Document Version	Final	
Cover		
Sensitivity	This document and the information, ideas, concepts, methodologies, technologies and other material it contains remain the intellectual property of Arris Pty Ltd. The document is not to be copied without the express permission of at least one of the above parties.	
Disclaimer	This report is presented "as is" without any warrantees or assurances. Whilst all reasonable efforts have been made to ensure the information provided in this review is current and reliable, Arris Pty Ltd does not accept any responsibility for errors or omissions in the contents.	
Document Delivery	Arris Pty Ltd provides this document in either printed format, electronic format or both. Arris considers the printed version to be binding. The electronic format is provided for the client's convenience and Arris Pty Ltd requests that the client ensures the integrity of this electronic information is maintained. Storage of this electronic information should at a minimum comply with the requirements of the Commonwealth Electronic Transactions Act (ETA) 2000. Where an electronic only version is provided to the client, a signed hard copy of this document can be provided by Arris Pty Ltd if requested by the client.	

Table of Contents

List of Tables v

List of Figures v

Abbreviations vi

1 Introduction 1

1.1 Summary of Water and Nutrient Balances 2

2 Multi Barrier Approach to Water and Nutrients 4

2.1 Water Balance Model 4

2.2 Water Balance Modelling 5

2.2.1 Water Balance Modelling for the ABSORBS™ Filters 7

2.2.2 Water Balance Modelling for the Native Flora Reserve 9

2.2.3 Water balance for the Combined ABSORBS™ facility (bamboo) and Native Flora Reserve Biodrain 10

2.3 Nutrient Balances 11

2.4 Nutrient Inputs to the Biodrain 13

2.5 Nutrient Removal 13

2.6 ABSORBS™ Filter Nutrient Removal 14

2.6.1 ABSORBS™ Filter Nutrient Removal 15

2.6.2 Native Flora Reserve Nutrient Removal 16

2.6.3 Groundwater Nutrient Removal 16

2.6.4 Nutrient Removal/Assimilation Summary 19

3 References 21

List of Tables

Table 1 Summary water balance for the biodrain 2
Table 2 Nutrient assessment showing inputs and balances for nitrogen and phosphorus through the biodrain 3
Table 3 Design wastewater flows 5
Table 4 Key water cycle inputs and outputs for the biodrain 6
Table 5 Rainfall and water demand assessment for the ABSORBS™ facility 9
Table 6 Comparison of wastewater inputs and plant demand for design and theoretical flows for the ABSORBS™ filters 9
Table 7 Rainfall and water demand for the native flora reserve 10
Table 8 Comparison of wastewater inputs and plant demand for design and theoretical flows for the native flora reserve 10
Table 9 Water demand and percentage of wastewater volume for design and theoretical annual flows for the combined ABSORBS™ facility and native flora reserve 11
Table 10 Key nutrient inputs and outputs for the biodrain 11
Table 11 Nitrogen and phosphorus inputs into the biodrain applied through the ABSORBS™ filters 13
Table 12 Residual nitrogen after the ABSORBS™ filters 14
Table 13 ABSORBS™ filter secondary treatment (AS1546.3 compliance testing early results) .. 15
Table 14 Nutrient assimilation for mixed stand acacia and eucalyptus 16
Table 15 Groundwater water quality data 17
Table 16 Nutrient balances for the Point Boston biodrain system 20

List of Figures

Figure 1 Point Boston Phase 1 development 1
Figure 2 ABSORBS™ facility and biodrain layout 5
Figure 3 Schematic showing the FAO water demand model 6
Figure 4 Point Boston biodrain water cycle 7
Figure 5 Point Boston biodrain nitrogen cycle 12
Figure 6 Point Boston biodrain phosphorus cycle 12
Figure 7 Installation of ABSORBS™ bed trail at Hahndorf WWTP 15
Figure 8 Location of groundwater sampling sites 17
Figure 9 Point Boston cross section showing acacias groundwater sampling sites 18

Abbreviations

Abbreviation	Description
-	minus
%	percent
/	per
+	plus
>	greater than
>>	much greater than
±	plus or minus
µS	microsiemen
ABSORBS™	Aerobic Bottomless Sand Filter Open Release Basal System
ABSORBS™ facility	The wastewater infrastructure including: storage, treatment pumps, control system distribution manifold and dispersal equipment
AHD	Australian Height Datum
AS1546.3 standards	On-site domestic wastewater treatment units Secondary treatment systems
ASTM 33C	American Society for Testing and Materials Standards for filter sand
BOD	Biochemical Oxygen Demand
CF	crop factor
Cl	chloride
CWMS	Community Wastwater Management System
d	day
EPA	Environment Protection Authority
ET_c	crop evapotranspiration
ET_o	reference crop evapotranspiration
FAO	Food and Agriculture Organization
g	gram
ha	hectare
K	potassium
K_c	crop coefficient
kg	kilogram
L	litre
LGA	Local Government Association
m	metre
m^2	square metre
mg	milligram
ML	megalitre
mm	millimetre
N	nitrogen
N_2	nitrogen gas phase
N_2O	nitrous oxide
Net Eff RF	Net effective rainfall
NH_4	ammonium
NO_3	nitrate
NO_4	Peroxynitrate
P	phosphorus
p	person
PE	pan evaporation
PQL	practical quantitation limit
RF	rainfall
SA	South Australia
SA Health	South Australian Health and/or Department of Health and Wellbeing
SPSFs	Single Pass Sand Filters
t	ton
TN	total nitrogen

TSS	total suspended solids
WD	crop water demand
WWTP	wastewater treatment plant
yr	year

1 Introduction

It is understood that the Point Boston development is a significant residential development in the greater Port Lincoln region (Figure 1) and the largest new community development in South Australia. The development has been designed with 207 lots with the opportunity to build 247 residences. The location offers residents many advantages that are underpinned by the location on some of South Australia's most picturesque coastline.

Source: Kemp Real Estate, Pt Lincoln

Figure 1 Point Boston Phase 1 development

The Point Boston Phase 1 development has a wastewater gathering network, treatment plant, storage facility and recycled water network that has been approved by SA Health. This system has failed for a number of reasons that will not be discussed other than to say that the capital and operational costs of the waste and recycled water infrastructure has been a barrier to ongoing development of residential properties.

It is important to understand that this report relates to Phase 1 of the Point Boston development and has been developed to utilise existing pipe infrastructure to mitigate unnecessary additional costs. A key feature in the development of this report has been to keep in mind the core requirements of the South Australian EPA (SA EPA) as identified.

Note: the term Phase(s) relate to the property development and similarly Stage(s) relate to the development of the wastewater system discussed in this report.

This report outlines the approach to the sustainable treatment, management and dispersal of wastewater from the Point Boston Phase 1 development of 247 residences.

Following meetings with SA EPA and Point Boston Community Corporation (PBCC) it was very clear that the objectives of the regulator (SA EPA) and the PBCC were very closely aligned. To this end, the direction taken to the design of the wastewater treatment and dispersal system has been to:

- utilise as much of the current infrastructure as possible to minimise cost and waste;
- design a wastewater treatment and dispersal system that is compliant with the South Australian Community Wastewater Management System (LGA,2019) and the On-site Wastewater Management Codes (SA Health, 2013);
- be both cost effective and have low ongoing operational costs;
- have a beneficial reuse component albeit not domestic water recycling (the current approved practice); and
- have as low as practicable impact on the environment, on-site and off-site.

The approach taken has been to use a SA health approved primary treatment system, collected and transported through a mains network and pump station that already has SA Health approval, and further treatment and dispersal system (ABSORBS™) that SA Health has approved for other projects. This approach has been taken to simplify the approval process as it will only apply to the emergency storages and final treatment and dispersal area. For new installations, the primary treatment system will be installed.

To provide the level of environmental outcomes required for this project, primary treatment is to be Anerobic Baffle Reactors with the ABSORBS™ treatment and dispersal system. This will include a multi barrier approach to wastewater and nutrient capture around the dispersal area. The barriers include:

- the proposed wastewater treatment and dispersal system which has demonstrated to have a high level of BOD_5, TSS and nutrient removal;
- within the ABSORBS™ beds there will be interrow planting of Oldhamii bamboo to utilise as much water and nutrients as possible; and
- surrounding the ABSORBS™ beds and bamboo will be a native flora reserve to further utilise fugitive water and nutrients.

1.1 Summary of Water and Nutrient Balances

A detailed desktop assessment of the water and nutrient balances for the Point Boston wastewater treatment and dispersal system has been undertaken. There will be a biodrain installed to utilise both water and nutrients. The biodrain will be constructed with bamboo planted interrow with the ABSORBS™ filters and will be surrounded on three sides with a native flora reserve.

The water assessment has demonstrated, with a high degree of confidence, that the biodrain will utilise the additional water load (+ rainfall) which will be applied to the dispersal area. Only in the decile 9 (high) rainfall year does rainfall exceed biodrain removal (Table 1). This excess will assist in the maintenance of good soil conditions.

Table 1 Summary water balance for the biodrain

Parameter	Plant water demand (ML)	Water demand as a % of design flow 40ML/yr	Water demand as a % of annual flow 30ML/yr
Area (ha)	**5.0**	**5.0**	**5.0**
Decile 9	36.6	91.0	**122.0***
Average	41.6	**104.0***	**139.0***
Decile 1	49.5	**124.0***	**165.0***

* Indicates conditions where plant water demand exceeds wastewater flow

The nitrogen assessment has demonstrated, with a high degree of confidence, that the biodrain will utilise the additional nitrogen load which will be applied to the dispersal area. There is a net deficit in applied and removed nitrogen in all systems other than when there is low N reduction through the ABSORBS™ filters for design flows (Table 2).

Table 2 **Nutrient assessment showing inputs and balances for nitrogen and phosphorus through the biodrain**

System	Nutrient Supply	Nutrient Removal (kg/yr) Nitrogen Minimum 28-14% (84%)	Nitrogen Average 28% (72%)	Nitrogen Maximum 28+14% (58%)	Phosphorus
ABSORBS™ beds	40ML/yr, 2000kg N	280	560	840	
	30ML/yr, 1500kg N	210	420	630	
ABSORBS™ bamboo (1.5ha)	600kg/ha/yr N	900	900	900	
	90kg/ha/yr P				135
Native Flora Reserve (3.5ha)	175kg/ha/yr N	654	654	654	
	10kg/ha/yr P			105	
Nutrient removed	40ML/yr	1834	2114	2394	240
	30 ML/yr	1,764	1,974	2,184	
Nutrient Applied	40ML/yr	2000	2000	2000	400
	30 ML/yr	1500	1500	1500	300
Nutrient Balance	**40ML/yr**	**166**	**-114**	**-394**	**160**
	30ML/yr	**-264**	**-474**	**-684**	**130**

The assessment of phosphorus has shown there is a surplus of applied phosphorus over plant assimilation and removal. This surplus represents approximately 40% of the applied phosphorus regardless of the wastewater application rate for design and theoretical flow models.

Further evaluation of the surplus phosphorus can show that for a 50 year period, if the applied P was to stay within the confines of the 5ha biodrain, the additional application would represent 5.69g (P)/kg of soil for a 3m deep profile. At a paddock scale (100ha) this equates to 284mg (P)/kg of soil and for a farm scale (1000ha) the additional application equates to an additional 28mg (P)/kg of soil. Noting that these increases of soil P are total P and not extractable phosphorus, which would be significantly less.

Other elements that will be applied, including sodium, chloride and potassium, do not represent a significant environmental threat.

2 Multi Barrier Approach to Water and Nutrients

The system has been designed to utilise as much water and assimilate as much nutrient as practicable through a passive plant-based biodrain. This will be achieved through two systems:

- the ABSORBS™ facility planted with interrow planting of bamboo; and
- the native flora reserve.

The proposed biodrain is the combination of these two areas where the processes of interest are the plant-based use of water and nutrient assimilation in plant material.

Each of these systems have very different characteristics, with the ABSORBS™ facility utilising bamboo that has a high-water demand with a Crop Coefficient K_c 1.9 (Piouceau et al, 2014) and high nutrient requirement (Rose 2017). This area will be surrounded on three sides with a native flora reserve. The water balance modelling will demonstrate that the water demand will exceed the peak flow wastewater production.

When designing biodrains, there are a number of factors that need to be considered to ensure the critical success factors for water use and nutrient assimilation and/or removal are maximised.

The selection of plant species for the biodrain is based on several key attributes including:

- ability for rapid growth, critical to meet requirements early in the development,
- high rates of transpiration, critical for wastewater use and mitigating nutrient movement through mass flow;
- high tolerance to salinity, to mitigate risk of increased water and soil salinity that may accumulate due to salt importation in wastewater;
- high biomass production, critical for uptake of nutrients (N:P:K);
- nutrient scavenging abilities, mitigating the risk of off-site impacts through the assimilation of nutrients, and
- options for industrial end use, to provide a beneficial use opportunity (producing an economic resource from waste).

Other critical factors include:

- soil type and landform;
- groundwater system and depth to water table;
- water source (quality, reliability and volume);
- climate, including seasonal; and
- threats to native flora and fauna.

2.1 Water Balance Model

The peak application of water to the ABSORBS™ facility is in the order of 40ML/yr (Table 3) for the fully developed project. It is expected that the application rate will be significantly less than this as peak flows will not occur day in and day out.

To gain a better understanding of the likely wastewater production at Point Boston, a study of wastewater flows from Mannum, Port Augusta East and Gumeracha communities have been studied. These sites have been selected as they are without a significant amount of commercial and/or industrial wastewater and data was available. The average daily flow per person is 131.18L/p/d for the three sites (SA Water 2013). This would equate to a theoretical annual flow of 30ML, a 25% reduction on peak design flows, a significant buffer from the design flow.

Water and nutrient balance assessments will be undertaken for the design flow of 40ML/yr and the theoretical flow of 30ML/yr.
The strategy has been to develop a system that will have a water demand that meets the design daily flow. This has been undertaken through a plant-based system that includes the bamboo planted ABSORBS™ facility and the native flora reserve (Figure 2). The FAO 56 evapotranspiration model has been used to calculate the theoretical water demand for each area.

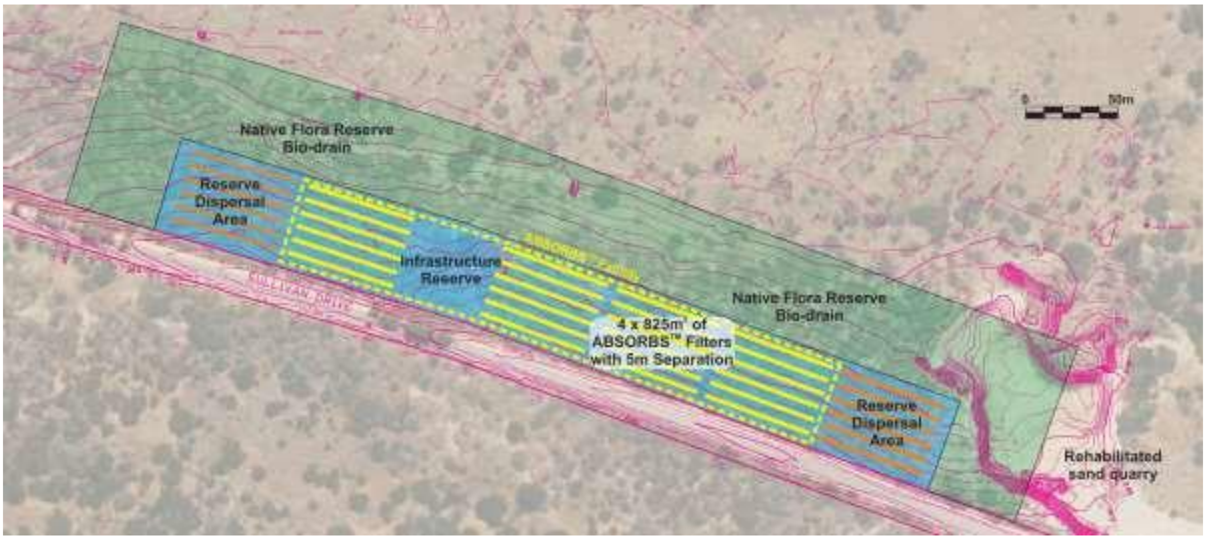
The ABSORBS™ facility is 1.5ha which will be planted with high water use bamboo that will be surrounded by the native flora reserve of 3.5ha (Figure 2). Using the 40ML/annum scenario, the ABSORBS™ facility of 1.4ML/ha equates to 28.6ML.

Note in Figure 2 that there is area set aside as a reserve to be used if and when required. This emergency reserve area is 50% of the required 3300m^2 of ABSORBS™ facility; this design feature has been included to mitigate risk of inadequate space if it is identified that design parameters are exceeded.

Table 3 Design wastewater flows

Parameter	Units	Value
Residential allotments		247
People per allotment		2.6
Volume of wastewater	L/p/d	170
Litres of wastewater	L/d	109,174
Wastewater per year	ML/yr	39.85 (40)

Modified from: SA LGA & SA Health (2019)



*The blue is the ABSORBS™ facility and the green is the native flora reserve

Figure 2 ABSORBS™ facility and biodrain layout

2.2 Water Balance Modelling

To understand the water balance comparisons between inputs and outputs it is important to understand the water cycle for the biodrain comprising of the ABSORBS™ facility and native flora reserve (Figure 2). It is understood that there is potential for ground water movement to impact the hydrological cycle for the biodrain (Figure 4). However, a study of the inputs and outputs that result from the wastewater system will provide significant insight into the water balance and the potential to create significant off-site impacts like rising groundwater, perched watertable and/or localised flooding, and also provide information necessary for biodrain design.

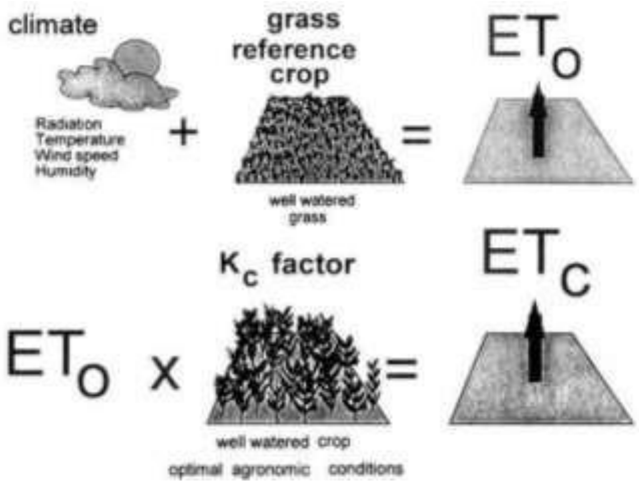
When regarding water inputs and outputs for the Point Boston biodrain (Table 4), it can be seen that there are two main inputs and two main outputs that need to be considered and they are ranked from high to low with respect to their significance. These are the key parameters used/examined when undertaking a mass balance assessment of water for the biodrain.

Table 4 Key water cycle inputs and outputs for the biodrain

Key water cycle inputs	Key water cycle outputs
• Treated wastewater	• Evapotranspiration from plants and soil
• Rainfall	• Groundwater migration

The water balance of the system can be modelled utilising a combination of the FAO Irrigation and Drainage Paper 56 (Allen et al, 1998).

The FAO (1998) methodology can be approximated as determining a reference value for a notational crop, referred to as the reference crop evapotranspiration (ET_o), and multiplying it by relevant factors, primarily the Crop Coefficient (K_c), to determine an estimated water demand for a situation (ET_c) (Figure 3). The FAO 56 methodology takes into consideration significant meteorological and climatic conditions, and some plant water consumption parameters.



(Source: FAO, 1998)

Figure 3 Schematic showing the FAO water demand model

The FAO (1998) model fundamental concept is applicable to the system operation, however the FAO 56 theory is intended for determining watering requirements primarily for agricultural purposes growing food crops.

ABSORBS™ filters differs from the FAO (1998) methodology in this regard in that:

- The system is supplied frequently with water in excess of the plant requirements. Plants can use a 'luxury' volume of water if it is available. The hydraulic design of the pipe work in the ABSORBS™ filters ensures that the soil in the rhizosphere surrounding the plant's roots is not waterlogged. This wetting and drying sequence in the rhizosphere is essential for plant health and increases the water usage.
- The FAO 56 methodology is primarily concerned with calculating the appropriate water requirements to sustain growth, eg minimum recommended watering practices. This type of dispersal technology allows for greater water usage volumes.
- The approach has been to utilise plant species and types that have large canopy areas and more significant height in comparison to the FAO 56 methodology, which primarily considers ground-level vegetation such as wheat crops, grasses and vegetable crops.

- The evapotranspiration model is based on the canopy and not the basal area of the crop. Selection of Oldhamii bamboo has been made to ensure that over time there will be full canopy coverage over the beds providing maximum evapotranspiration potential.

The FAO 56 method of estimating evapotranspiration is still applicable to the ABSORBS™ facility and will provide understanding of the end fate and balances between inputs and outputs.

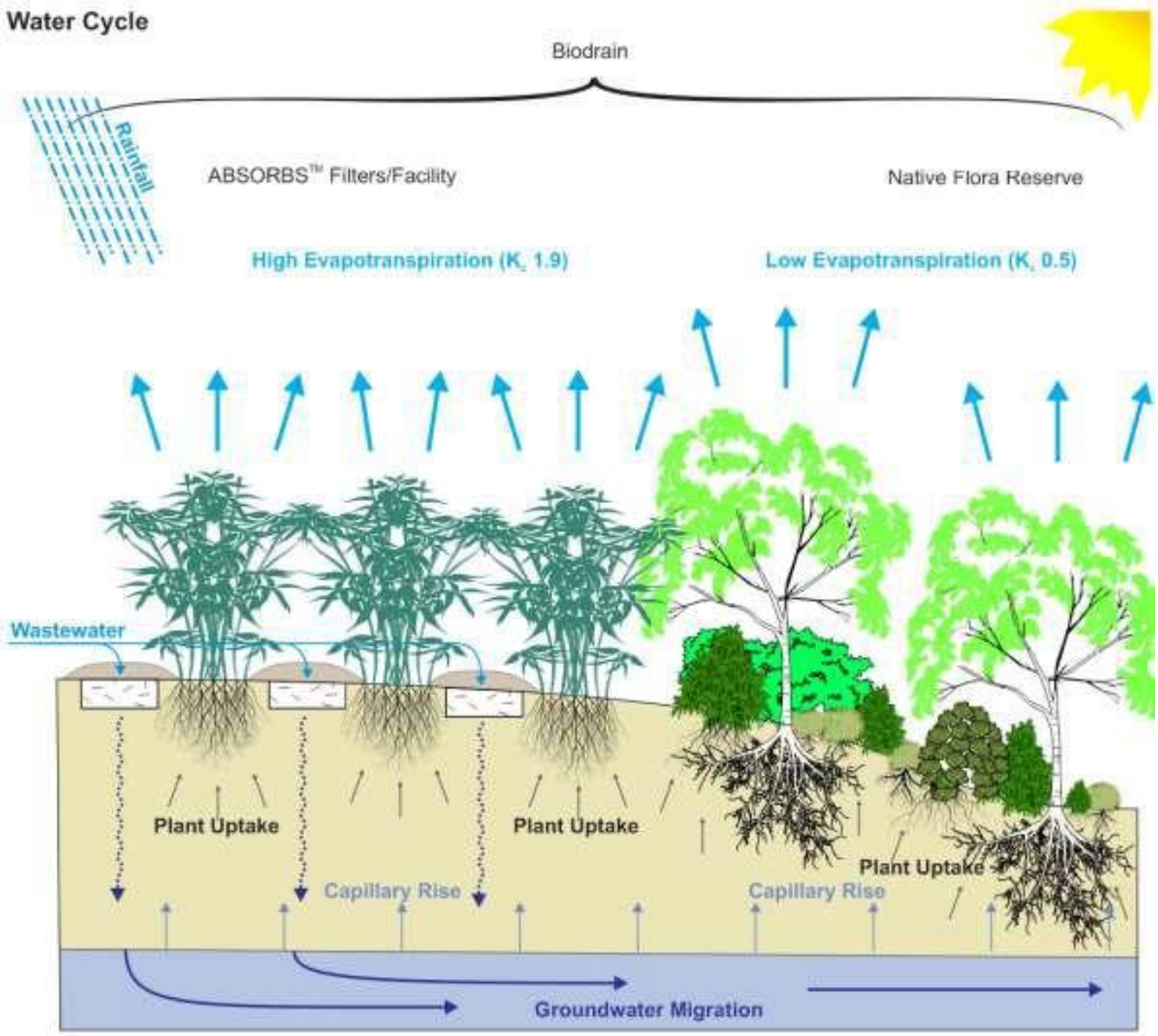


Figure 4 **Point Boston biodrain water cycle**

2.2.1 Water Balance Modelling for the ABSORBS™ Filters

The ABSORBS™ facility is 1.5ha, and will be planted in between the rows and around ABSORBS™ filters (Figure 2). The filters have been designed to be 2.5m wide and 55m long with 5m between each filter. The filters have been designed this way to maximise lateral movement of wastewater movement sideways from the base of each filter. This will increase the water treatment capacity for each filter while they are narrow enough for full canopy closure over the beds.

The preferred variety of bamboo to be planted interrow *is Bambusa Oldhamii* (Oldhamii) for its cultural properties that include:

- It is a clumping variety that is a negligible 'weed' risk. The bamboo is propagated by rhizomes and cut culms and not by seed;
- It has a high crop coefficient K_c 1.9. That is to say that it has a very high-water demand, approximately two times that of cut grass;
- It responds well to coppicing enabling the off-site removal of assimilated nutrients and income stream can be generated as dried culms can readily be sold;
- The canopy has demonstrated that it can spread greater than 4m wider than the base planting; and
- It has been demonstrated to grow well in South Australian climate. Plantings in Manoora SA have reached 10m height in three years and achieved more than 4m width greater than the base.

For the purpose of the mass balance assessment it is assumed mature bamboo that have achieved full canopy cover the beds. It is understood that full canopy cover will not be achieved until year three to four. This will not present a problem as the wastewater production will be very much lower than design flows until a further 40 residences have been built. Wastewater System for Point Boston — System Design CWMS Application to the SA Department of Health and Wellbeing (2020) highlights the system expansion model where new ABSORBS™ filters are timed to be installed where 10 residences are yet to be built in each stage. This will ensure adequate canopy development prior to elevated wastewater flows.

The rainfall and evapotranspiration have been modelled to establish the water demand for the ABSORBS™ filters. For the purpose of modelling, a conservative crop coefficient K_c 1.9 (Piouceau, 2014) has been used. Crop water demand has been calculated using 40 years of daily reference evapotranspiration data multiplied by the crop coefficient (Figure 3).

The rainfall and evapotranspiration have been assessed to stablish the water demand for the Oldhamii planted ABSORBS™ filters. The effective rainfall has been established using a mathematical model based on the Victorian EPA effective rainfall calculator. Effective rainfall is used due to losses from canopy capture, elevated evaporation from hot soil, runoff, etc.

Calculation of water demand has been undertaken for the decile 1 (dry year), average and decile 9 (wet year) rainfall years and shown in Table 5 where a crop coefficient (Kc) of 1.9 has been used. It can be seen for decile 1 (dry year), average and decile 9 (wet year) rainfall years the annual water demand is 21.6, 19.0 and 17.7ML/ha/yr for a design flow of 40ML/yr (Table 5).

It can be seen in Table 6 that the ABSORBS™ facility planted with Oldhamii will utilise a percentage of the design flow, the residual volume will leach to the watertable and maintain good soil conditions and mitigate accumulation of salt risks. If the theoretical annual flow of 30ML/yr is used then in the decile 1 year, bamboo water demand would exceed flow (Table 6).

Table 5 Rainfall and water demand assessment for the ABSORBS™ facility

1980-2019		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Decile 9 (2010)	RF (mm)	28.2	12.8	62.1	30.8	39.5	45.3	39.1	68.2	107.1	43.2	27	35.1	538.4
	Net Eff RF (mm)	22.2	9.4	49.8	19.2	25.9	33.3	26.3	49	76.9	30.1	11.3	19.4	372.8
	ETo (mm)	183.4	145.8	115.5	76.3	56.3	38.1	36.6	48.9	58.9	105.5	117.7	146.5	1129.5
	Bamboo Kc	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	
	ETCrop	348.46	277.02	219.45	144.97	106.97	72.39	69.54	92.91	111.91	200.45	223.63	278.35	2146.1
	Water Deficit (mm)	326.3	267.6	169.7	125.8	81.1	39.1	43.2	43.9	35.0	170.4	212.3	259.0	**1773.3**
	RF Percolation (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average (2017)	RF (mm)	46.4	9.8	14.9	7.5	19.1	11	61.5	97.2	39.2	19.1	54.9	30.3	410.9
	Net Eff RF (mm)	34.3	3.1	6	0.3	4.7	7.6	47.6	80.5	23	9	47.6	12.6	276.3
	ETo (mm)	156.2	116.3	122.8	77.1	55.3	45.8	47.4	49.9	77.5	116.3	131.7	147.5	1143.8
	Bamboo Kc	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	
	ETCrop	296.78	220.97	233.32	146.49	105.07	87.02	90.06	94.81	147.25	220.97	250.23	280.25	2173.2
	Water Deficit (mm)	262.5	217.9	227.3	146.2	100.4	79.4	42.5	14.3	124.3	212.0	202.6	267.7	**1896.9**
	RF Percolation (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decile 1 (2019)	RF (mm)	0	2.3	1.3	4.7	88.3	46.4	26.7	43	50.5	15.3	11.7	6.2	296.4
	Net Eff RF (mm)	0	0	0	0.7	59.9	32.2	14.6	29.5	35.2	7.3	5.4	0	184.8
	ETo (mm)	183.5	138.4	116.7	94.0	45.9	37.4	34.1	48.9	79.4	130.1	142.3	184.1	1234.8
	Bamboo Kc	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	
	ETCrop	348.7	263.0	221.7	178.6	87.2	71.1	64.8	92.9	150.9	247.2	270.4	349.8	2346.1
	Water Deficit (mm)	348.7	263.0	221.7	177.9	27.3	38.9	50.2	63.4	115.7	239.9	265.0	349.8	**2161.3**
	RF Percolation (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6 Comparison of wastewater inputs and plant demand for design and theoretical flows for the ABSORBS™ filters

Parameter	Plant water demand (ML)	Water demand as a % of design flow 40ML/yr	Water demand as a % of annual flow 30ML/yr
Area (ha)	**1.5**	**1.5**	**1.5**
Decile 9 (%)	26.6	66.0	89.0
Average (%)	28.5	71.0	95.0
Decile 1 (%)	32.4	81.0	**108.0***

* Indicates plant demand exceeds wastewater flow

2.2.2 Water Balance Modelling for the Native Flora Reserve

It can be seen in Table 6 for design flows (40ML/yr) and the theoretical flow (30ML/yr) that water input exceeds bamboo evapotranspiration output. To protect the environment from excessive leaching losses of water and associated soluble nutrients a native flora reserve will be planted alongside the ABSORBS™ facility to the areas where ground water will migrate.

The native flora reserve has an area of 3.5ha and lays to the west, north and east of the ABSORBS™ facility, north being the direction of groundwater migration. There is a gap between the road and the greater dispersal bed area that will also be planted to native vegetation but is not included in the water balance calculations.

The rainfall and evapotranspiration have been assessed to establish the water demand for the native flora reserve area. For the purpose of modelling, a conservative crop coefficient K_c 0.5 has been used (Aylmore *et al*, 1994). Crop water demand has been calculated using reference evapotranspiration (daily data for 40 years) and a crop coefficient of K_c 0.5 using the equation in (Figure 3).

Equation 1 Calculation of Crop Coefficient

$$WD = PE \ x \ CF$$
and
$$WD = ET_o \ x \ K_c$$
$$\therefore PE \ x \ CF = ET_o \ x \ K_c$$
$$\therefore K_c = \frac{PE}{ET_o} X \ CF$$

Where: WD = crop water demand, PE = pan Evaporation,
CF = Crop Factor,
ET_o = Reference Evapotranspiration, and
Kc = Crop Coefficient

Calculation of water demand has been undertaken for the decile 1 (dry year), average and decile 9 (wet year) rainfall years and shown in Table 7 where a crop coefficient of K_c 0.5 has been used as a balance over a range of native species. It can be seen for decile 1 (dry year), average and decile 9 (wet year) rainfall years the annual water demand is 4.9, 3.8 and 2.9ML/ha/yr.

It can be seen in Table 8 that the native flora reserve planted with endemic native species will utilise a percentage of the design flow. Both wastewater design flow and theoretical annual flow exceed plant water demand where plants use 43% to 57% of flow (Table 8). Therefore, on its own the native flora reserve will not utilise all of the design or theoretical annual flow of wastewater.

Table 7 Rainfall and water demand for the native flora reserve

1980-2019		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Decile 9 (2010)	RF (mm)	28.2	12.8	62.1	30.8	39.5	45.3	39.1	68.2	107.1	43.2	27	35.1	538.4
	Net Eff RF (mm)	22.2	9.4	49.8	19.2	25.9	33.3	26.3	49	76.9	30.1	11.3	19.4	372.8
	ETo (mm)	183.4	145.8	115.5	76.3	56.3	38.1	36.6	48.9	58.9	105.5	117.7	146.5	1129.5
	Native plant K_c	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
	ETCrop	91.7	72.9	57.75	38.15	28.15	19.05	18.3	24.45	29.45	52.75	58.85	73.25	564.8
	Water Deficit (mm)	69.5	63.5	7.9	19.0	2.3	0.0	0.0	0.0	0.0	22.7	47.6	53.9	**286.2**
	RF Percolation (mm)	0.0	0.0	0.0	0.0	0.0	14.3	8.0	24.6	47.5	0.0	0.0	0.0	94.3
Average (2017)	RF (mm)	46.4	9.8	14.9	7.5	19.1	11	61.5	97.2	39.2	19.1	54.9	30.3	410.9
	Net Eff RF (mm)	34.3	3.1	6	0.3	4.7	7.6	47.6	80.5	23	9	47.6	12.6	276.3
	ETo (mm)	156.2	116.3	122.8	77.1	55.3	45.8	47.4	49.9	77.5	116.3	131.7	147.5	1143.8
	Native plant K_c	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
	ETCrop	78.1	58.15	61.4	38.55	27.65	22.9	23.7	24.95	38.75	58.15	65.85	73.75	571.9
	Water Deficit (mm)	43.8	55.1	55.4	38.3	23.0	15.3	0.0	0.0	15.8	49.2	18.3	61.2	**375.1**
	RF Percolation (mm)	0.0	0.0	0.0	0.0	0.0	0.0	23.9	55.6	0.0	0.0	0.0	0.0	79.5
Decile 1 (2019)	RF (mm)	0	2.3	1.3	4.7	88.3	46.4	26.7	43	50.5	15.3	11.7	6.2	296.4
	Net Eff RF (mm)	0	0	0	0.7	59.9	32.2	14.6	29.5	35.2	7.3	5.4	0	184.8
	ETo (mm)	183.5	138.4	116.7	94.0	45.9	37.4	34.1	48.9	79.4	130.1	142.3	184.1	1234.8
	Native plant K_c	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
	ETCrop	91.8	69.2	58.4	47.0	23.0	18.7	17.1	24.5	39.7	65.1	71.2	92.1	617.4
	Water Deficit (mm)	91.8	69.2	58.4	46.3	0.0	0.0	2.5	0.0	4.5	57.8	65.8	92.1	**488.1**
	RF Percolation (mm)	0.0	0.0	0.0	0.0	37.0	13.5	0.0	5.1	0.0	0.0	0.0	0.0	55.5

Table 8 Comparison of wastewater inputs and plant demand for design and theoretical flows for the native flora reserve

Parameter	Plant water demand (ML)	Water demand as a % of design flow 40ML/yr	Water demand as a % of annual flow 30ML/yr
Area (ha)	**3.5**	**3.5**	**3.5**
Decile 9	10.0	25.0	33.0
Average	13.1	33.0	44.0
Decile 1	17.1	43.0	57.0

2.2.3 Water balance for the Combined ABSORBS™ facility (bamboo) and Native Flora Reserve Biodrain

The combination of the ABSORBS™ facility and the native flora reserve has the capacity for the plant water demand to exceed the design and theoretical annual wastewater flows (Table 9) in other than decile 9 rainfall years with peak design flow. The total combined area of 5ha would have an effective average crop coefficient of K_c 0.95.

Table 9 Water demand and percentage of wastewater volume for design and theoretical annual flows for the combined ABSORBS™ facility and native flora reserve

Parameter	Plant water demand (ML)	Water demand as a % of design flow 40ML/yr	Water demand as a % of annual flow 30ML/yr
Area (ha)	**5.0**	**5.0**	**5.0**
Decile 9	36.6	91.0	**122.0***
Average	41.6	**104.0***	**139.0***
Decile 1	49.5	**124.0***	**165.0***

* Indicates plant demand exceeds wastewater flow

In practical terms there needs to be some flow through of excess water to maintain good soil conditions. It is through deep percolation of water in soils that salts are leached out of the root zone. It can be seen that the inflow into the ABSORBS™ filters (bamboo) is greater than plant demand (Table 6). It is therefore expected that good soil condition would be maintained.

In the native flora reserve the water over and above the requirement of the ABSORBS™ filters will be available to augment the supply of water to plants. It is expected that in time an equilibrium between the water used by pants and the salinity of the soil will be achieved. That is when the osmotic pressure of soil salinity meets and exceeds plant demand, rainfall will pass through the system reducing salinity and hence a balance between plant water uptake, soil salinity, and rainfall leaching will occur.

It is therefore a critical design feature that plants with higher salt tolerances be selected for the native flora reserve to ensure that the plants can survive and thrive at the new soil equilibrium salinity. Plant selection is to be made from the State Flora Nursery Catalogue.

2.3 Nutrient Balances

Nutrient balances for the biodrain need to be assessed. The ABSORBS™ facility and the native flora reserve need to be considered to ensure that nutrient balances are sustainable, broadly meeting plant demand while not causing environmental harm. This will be undertaken through a mass balance assessment of inputs and plant assimilation of nitrogen (N) and phosphorus (P). Other end fate of nutrients will not be considered in the mass balance assessment because if plant assimilation of nutrients exceeds input then it is highly likely that nutrients will be beneficially reused and not pose a significant off-site impact threat. This will be discussed in greater detail in the report.

Before the assessment of the nutrient balances, it is important to gain greater understanding of the N and P nutrient cycles (Figure 5 and Figure 6). For the discussion on nutrient balances it will consider main pools shown in Table 10.

Table 10 Key nutrient inputs and outputs for the biodrain

Key nutrient cycle inputs	Key nutrient cycle outputs
• Treated wastewater	• Assimilation into bamboo and removal by harvesting • Assimilation into native vegetation • Soil sorption (phosphorus)* • Groundwater losses

* Soil sorption is only significant for phosphorus

In Table 10, nutrient outputs have been arranged in their respective order of significance, that is to say that losses from assimilation into bamboo and removal by harvesting > assimilation into native vegetation > soil sorption >> groundwater losses.

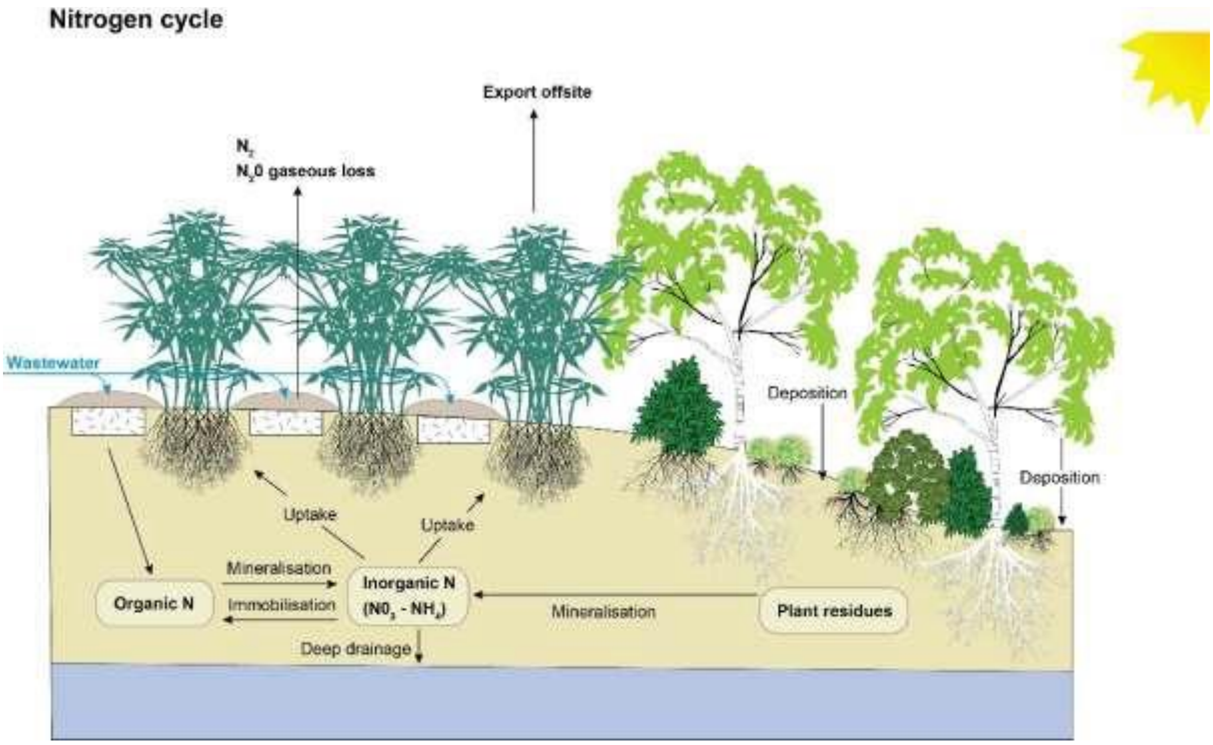


Figure 5 Point Boston biodrain nitrogen cycle

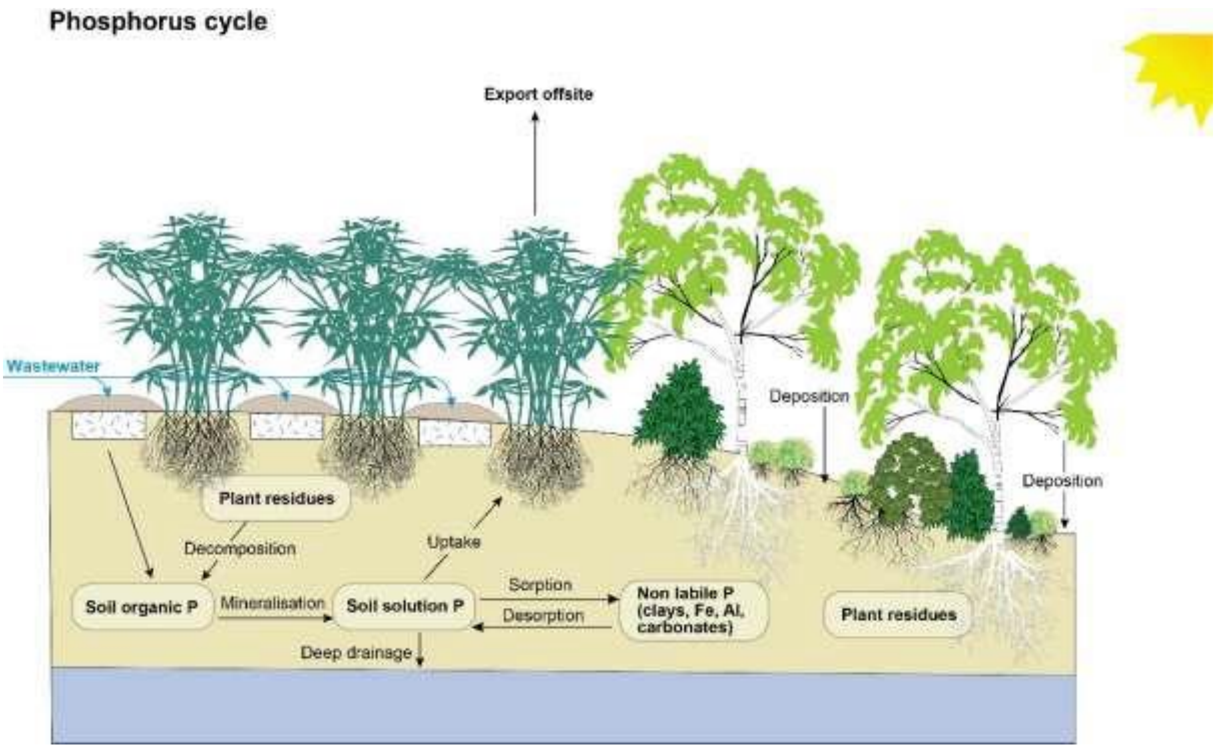


Figure 6 Point Boston biodrain phosphorus cycle

The main nutrients considered as causing environmental harm are nitrogen (N), phosphorus (P), sodium (Na), chloride (Cl) and potassium (K).

Sodium and chloride are major contaminants of wastewater and are of importance with irrigated projects as the accumulation of sodium and chloride increases salinity which can impact plant health. They can also have direct toxicity impacts on plants. Sodium can also cause soil sodicity which affects soil structure to an extent where sustainable percolation cannot be maintained. Typically, the decline in soil structure can lead to reduced infiltration rates and hence increased runoff in intense rainfall episodes. However, as the soils at Point Boston are sandy with poor cohesion (poor structure), the potential for impact on the soil is negligible and end point will be the transmission to ocean (massive sink for Na and Cl) through the groundwater system which does not warrant any further consideration.

The N and P contained in wastewater can cause localised and off-site impacts and requires further investigation. The most sustainable way to mitigate nutrient risks is for the plants to assimilate these potential pollutants into biomass for removal from site.

Eutrophication resulting from excess P can cause offsite impacts in terrestrial waterways and bodies through the promotion of algal blooms as it is often the limiting element (Lee, 1973; Carpenter, 2005). Typically, in natural ecosystems terrestrial water is low in P so addition of P from agriculture industry and wastewater can cause algal blooms. However, in the case of Point Boston where there are not any terrestrial water bodies, fugitive P is unlikely to cause any harm. The low soil mobility and calcareous nature of the soil at Point Boston will further mitigate the risk of off-site impacts of P. However, mass balance nutrient modelling has been undertaken.

Conversely, N is the nutrient of eutrophication in marine waters. Howarth (2006) states the N is the primary cause of eutrophication in many coastal ecosystems. Due to the high mobility of N in soil, the relative shallowness of the water table and the close proximity of the ocean means that the risk of N migrating to ocean water bodies is significant. Mass balance nutrient modelling has been undertaken.

2.4 Nutrient Inputs to the Biodrain

It is important to understand the nutrient inputs into the biodrain area to be able to assess the balance between inputs and outputs. It can be seen in Table 11 the total loads of N and P are 2000kg/yr and 400kg/yr respectively for the Point Boston Phase 1 development with 40ML/yr design flow (Wastewater System for Point Boston — System Design CWMS Application to the SA Department of Health and Wellbeing, 2020).

Table 11 Nitrogen and phosphorus inputs into the biodrain applied through the ABSORBS™ filters

Element		Annual Flow	
		40ML/yr	30ML/yr
Nitrogen (N)	Concentration (mg/L)	50	50
	Annual Load (kg)	2000	1500
Phosphorus (P)	Concentration (mg/L)	10	10
	Annual Load (kg)	400	300

2.5 Nutrient Removal

There are going to be three main methods/places of nutrient assimilation and removal including:

- ABSORBS™ filters: they have demonstrated significant nutrient removal capability;
- The bamboo biodrain (interrow with the ABSORBS™ filters) has been selected due to its capacity to assimilate nutrients. Bamboo will be able to be coppiced (harvested) with assimilated nutrients being removed from site; and
- The native flora reserve: this is a 3.5ha biodrain that surrounds the ABSORBS™ facility to assimilate fugitive nutrients that are not taken up by the bamboo.

There are other mechanisms of nutrient losses that need brief discussion: groundwater denitrification; soil denitrification and soil P sorption.

There is evidence that groundwater denitrification occurs and is discussed in the section 'Ground Water Nutrient Removal' (section 2.6.3).

Soil denitrification can lead to significant losses of gaseous nitrogen. The process occurs where soils are wet with an abundance of nitrogen (IPNI, 2015). The design of the ABSORBS™ filter will provide ideal conditions, wet soil with elevated N, where atmospheric N losses could be significant. It is difficult to quantify these losses and they will not be considered further other than to understand that they can be a further loss from the system.

P sorption can provide a significant buffer to applied P due to fixation. P is much slower moving in soils than nitrogen and is less of an environmental threat to the marine environment, hence is only discussed briefly.

2.6 ABSORBS™ Filter Nutrient Removal

Nitrogen removal performance of the ABSORBS™ filter is currently being validated with testing underway at the Hahndorf Compliance Testing facility. Given the physical and operational similarities between the ABSORBS™ system and other equivalent proven technologies such as Single Pass Sand Filters (SPSFs), it is considered that published nitrogen removal performance data for SPSFs will give a very good indication of ABSORBS™ system performance. Data for SPSFs receiving septic tank effluent were reviewed and indicate that total nitrogen removals for ABSORBS™ treatment are on average in the order of 28% (±14%) (Gardner et al., 1997; Converse et al., 1999; US EPA, 1999). Early results from AS1546.3 compliance testing of the ABSORBS™ N nutrient removal falls within this range (Table 13).

From Table 12 with a 28% N reduction and flows of 40ML and 30ML, there will be a reduction in the total nitrogen load to 1440kg/yr and 1080kg/year respectively. It also calculates the N reduction for the upper and lower limits on N removal discussed.

Table 12 Residual nitrogen after the ABSORBS™ filters

Nitrogen supply	Residual Nitrogen		
	28-14% (84%)	Average 28% (72%)	28+14% (58%)
40ML/yr, 2000kg N	1680kg	1440kg	1160kg
30ML/yr, 1500kg N	1260kg	1080kg	870kg

(x%) residual nitrogen percentage

Preliminary testing at Hahndorf using lysimeters has shown an average 27% nitrogen and 54% phosphorus reduction. This preliminary trial, which has been running for four months, has been undertaken using the same configuration that would be used at Point Boston, ie ASTM 33C grade sand with a minimum depth of 500mm. However, the dosing rate was much higher at 83.3L/m^2/d. In this trial the high loading rate was chosen to provide confidence that a loading rate of 35L/m^2/d was not going to be problematic.

The phosphorus reduction was observed using a calcareous sand that would precipitate water soluble phosphorus. This filter sand may not be available at Point Boston and hence will not be included in the nutrient removal.

This preliminary trial has now been expanded to a full ABSORBS™ filter trial for AS1546.3 Compliance Testing (Constructions of the ABSORBS™ filter at Hahndorf Figure 7). N and P removal will be validated during the compliance testing at Hahndorf and results will be used to inform the

Point Boston secondary treatment and dispersal system design. Early test results support secondary treatment capacity and N and P reduction (Table 13).

Figure 7 **Installation of ABSORBS™ bed trail at Hahndorf WWTP**

This will be further validated in situ at Point Boston with the installation of lysimeters below the ABSORBS™ filters where sampling and analysis of wastewater quality can be undertaken, as discussed in the 'Wastewater System for Point Boston — System Design CWMS Application to the Department of Health and Wellbeing' report (2020).

Table 13 **ABSORBS™ filter secondary treatment (AS1546.3 compliance testing early results)**

Water	TSS	BOD	Ammonia	Nitrate-N	Nitrite-N	TN	TP
Sewage	258	300	65	0	0	76	11
ABSORBS	<5	7	12	18	29	60	6.3
% reduction	**98%**	**98%**				**21%**	**43%**

2.6.1 ABSORBS™ Filter Nutrient Removal

As discussed in the water balance model the ABSORBS™ filters will be planted interrow with a fast-growing bamboo, Oldhamii. It is recognised that it will take three years or greater for the bamboo to grow to significant size. Over that time its nutrient requirement will increase.

Domestic and international studies on bamboo show the increased growth is defined by the increase in bamboo culms and not from expansion of mature culms (Piouceau et al, 2014; Kleinhenz,2001).
This growth habit will make the bamboo ideal for coppicing for the removal of assimilated nutrients as culms will be replaced as they are harvested. Additionally, research on Oldhamii bamboo has

shown that there was a significant increase on biomass production of up to 63% increase for high nutrient supply over low nutrient supply (Piouceau et al, 2014).

A trial, Piouceau et al. (2014), showed that Oldhamii bamboo had the highest uptake of N and P in the culms and leaves. In Australian research and trials Kleinhenz (2001) reported N accumulation of 619kg/ha and P accumulation of 97kg/ha (Gardner, 2003), and Rose (2017) predicted that Oldhamii bamboo when used for bioremediation of wastewater would potentially use in the order of 540 and 60kg/ha of N and P respectively.

To model the N and P assimilation for Oldhamii bamboo, 600kg (N)/ha and 90kg (P)/ha has been used. The 1.5ha Oldhamii bamboo orchard will use 900kg (N)/ha/yr and 135kg (P)/ha/yr after the first three years as canopy closure occurs.

2.6.2 Native Flora Reserve Nutrient Removal

The native flora reserve has been designed to surround the ABSORBS™ filters to further capture nutrients from treated wastewater. Native plants have been selected as they have evolved to thrive in highly variable rainfall conditions experienced in the region. However, they do not have the nutrient assimilation capacity of bamboo used in the ABSORBS™ filters.

Notwithstanding this, they can capture nutrients that may move through the system with N and P uptake of 175kg/ha/yr and 10kg/ha/yr respectively (Table 14).

Table 14 Nutrient assimilation for mixed stand acacia and eucalyptus

Species	N kg/ha	P kg/ha	K kg/ha
Acacia	222.47	7.34	181.04
Eucalyptus (Ali, 2017)	127	13	65
Eucalyptus (Gardner, 2003)	175	91	
Average eucalyptus	151	52	
Average nutrient assimilation for combined acacia and eucalyptus plantation	187	30	123.

Source: Shanmughavel, Fransis (2002) and Ali et al (2017)

Research showed that when irrigating Eucalyptus Robusta with sewage effluent, trees up to 20 years old had major biomass development in trunks and branches rather than leaves post full canopy development (Gardner, 2003). The N and P concentration in the wood is about 0.25% and 0.13% respectively with a production rate of 70t/ha. Assimilation of nutrients in older eucalyptus trees still occurs and is in the order of 175kg/ha (N) and 91kg/ha (P).

It is noted that N and P assimilation by eucalyptus trees is higher in the Gardner (2003) research than the Ali et al (2017) research. This may have been impacted by available water, Gardner (2003) research was not water limited and with species variation whereas Ali et al (2017) research did not advise of irrigation relative to plant demand.

For the purpose of modelling N and P nutrient assimilation by the native flora reserve it will be taken to be 187kg/ha/yr and 30kg/ha/yr respectively. For 3.5ha of native flora reserve the N and P assimilation would be 654kg/ha/yr and 105kg/ha/yr.

2.6.3 Groundwater Nutrient Removal

While undertaking the soil assessment at Sites 1 through to 4 (Figure 8), the soil pits were excavated through to the standing watertable which enabled the opportunity to sample both groundwater and assess the depth to watertable. The results of the groundwater analysis for P and N showed low level of N under the acacia (Table 15). The results are indicative only, as they were derived from the sampling that occurred post excavation. However, piezometers have been installed to enable on-going sampling.

Groundwater was measured at all four sites at 0m AHD, equivalent to sea level, with depth to the groundwater table approximately 7m at Site 1. Evidence of tidal influence over groundwater levels was also identified during the field visit. Groundwater at this location is recharged from rainfall, however the tidal influence is expected to be the more dominant factor on water table levels. The direction of groundwater flow in this area is primarily vertical due to the depth to groundwater, high permeability of the deep sands (high infiltration) and no groundwater gradient differences between the sites. The only expected exception is when the root zone (soil water zone) becomes saturated (from rainfall) creating a local interflow which moves in a lateral direction, down slope towards the coast (Nototny, 1994).

Figure 8 Location of groundwater sampling sites

Table 15 Groundwater water quality data

Sample Units PQL	pH	Electrical Conductivity µS/cm 1	TN in water mg/L 0.005	Ammonia as N in water mg/L 0.005
Site 1	7.7	1600	4.6	0.21
Site 2	8	5900	0.008	<0.005
Site 3	8	1800	<0.005	<0.005
Site 4	7.6	50000	<0.005	<0.005

Total Nitrogen (TN) in the groundwater at Site 1 was measured at 4.6mg/L and within 400m, TN at Site 3 had decreased to <0.005mg/L (Table 15). The only activity occurring at Site 1 that could explain the elevated N levels is the presence of acacia woodlands (only at Site 1) as acacias are known to be nitrogen fixing.

It appears that nitrogen fixing is occurring in the root zone of the acacia woodland. Symbiotic nitrogen fixation converts N_2 into ammonium, these forms of nitrogen are used by the plant (acacia in this case). During periods of heavy rainfall, the root zone becomes saturated creating interflow and water infiltrates into the groundwater table mobilising the nitrogen.

Nitrogen fixation in acacia species is well documented, with reported N fixation rates varying from less than 1kg/ha/year to values in the order of 50–100kg/ha/year. Variations in reported N fixation rates stem from differences in trial conditions (*in situ* field trials vs. controlled glasshouse conditions) as well as differing rates of colonisation by N-fixing symbionts (fungal mycorrhizae and bacterial rhizobia) (Brockwell et al., 2005). In Australia, *Acacia harpophylla* is almost always associated with soils of high nitrogen status, but it is unclear whether this is a result of N fixation and enrichment by acacia, or whether this association is circumstantial and acacia requires nitrogen-rich soil to grow (Brockwell et al., 2005). A schematic representation of the landscape for the Point Boston site showing the acacias and the groundwater nitrogen is shown in Figure 9.

Site 3 did not demonstrate the high groundwater nitrogen concentration found at site 1. It is believed that this is due to the low density of acacias in this location that was interplanted with other native species potentially utilising the nitrogen produced under the acacia.

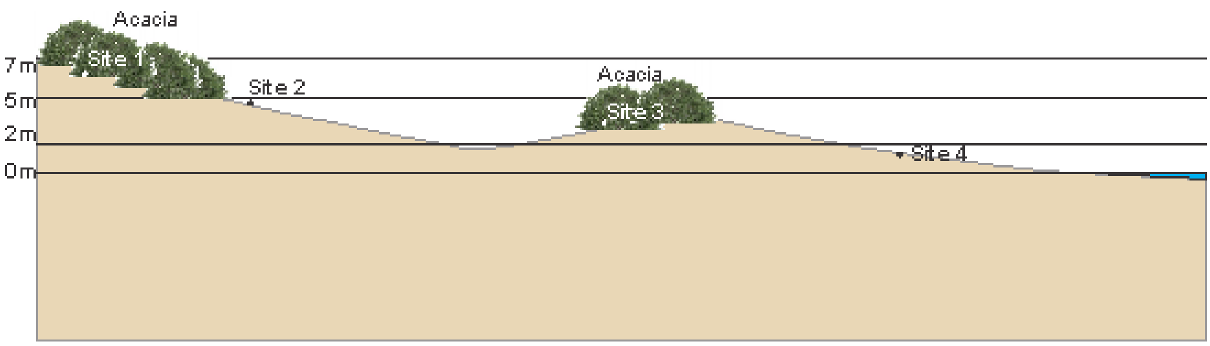


Figure 9 **Point Boston cross section showing acacias groundwater sampling sites**

While there is clear evidence of positive associations between acacia species and high soil N content, there is much less information regarding N levels in groundwater beneath acacia. Evidence of elevated groundwater N (nitrate; 10–20 mg/L) concentrations beneath groves of mulga (*Acacia aneura*) has been reported in the Northern Territory, with the source of this N assumed to originate from the acacia (Bolger and Stevens, 1999). Elsewhere, there are also reports of elevated nitrogen (nitrate) concentrations in groundwater (average 3mg/L; range 1–6mg/L) in South African landscapes with a high density of acacias compared to native (fynbos) lands (average 0.2mg/L; range 0–1mg/L) (Jovanovic et al., 2009).

This seasonal wetting of the soil profile leaches nitrogen to the groundwater and mobilises it through the root zone where under these anoxic conditions (when the voids and pores in the soil are saturated), NO_3^--N denitrifies to gaseous forms including N_2 and N_2O (Novotny, 1994).

As no hydraulic gradient is present at this site, the measurement of N at Site 1 and the almost total lack of N at Site 2 (and Sites 3 and 4) can be explained by the seasonal nitrogen fixing and leaching (NO_3^- - N readily moves with the soil moisture front) and the ongoing denitrification (Novotny, 1994).

These conclusions have been based on desktop investigations along with the onsite investigations. While further extensive field testing would be required to prove conclusively what processes are occurring in the water table in relation to nitrogen at this location, Arris contends that it is not required for the following reasons:

- the nitrogen fixing occurring as a result of the acacias is a natural process generating 4.6mg/L TN in groundwater at Site 1;
- nitrogen levels are below detectable limits at Site 4 (just 400m from Site 1) on the coast demonstrating that currently levels of nitrogen are not migrating towards the bay;
- this proposal requires the removal of the acacias (removing the nitrogen fixing process) to allow for Native Flora Reserve that will be irrigated with the treated wastewater;
- the Native Flora Reserve will be planted in a strip along the north east line of the road to a total of approximately 2.5ha and will be irrigated with treated wastewater that has a TN of 40mg/L. This spreads the application of the nitrogen preventing concentrations within a small area. Nitrogen use modelling will be undertaken in the 'Detailed Design' phase. Area of irrigation and plant demand will be managed to ensure that no adverse effects on the environment are observed;
- a row of deep-rooted native trees will be planted along the north-eastern edge of the orchard which will keep the water table at depth and utilise any nitrogen contained within the rootzone (bio-drain).

Piezometers have been installed at all four sites and will continue to be used to monitor TN levels.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality provide trigger values for Marine ecosystems relating to nitrogen (ANZECC 2000):

- TN < 1mg/L
- NO_x < 0.05mg/L
- NO_4 < 0.05mg/L

Should any significant changes to TN be recorded, further investigations might be warranted and as discussed, changes in the wastewater treatment system will be installed.

Under the proposed irrigation scheme, the soil moisture zone can be maintained saturated to induce a lateral interflow towards scavenging biodrain (deep rooted native trees) immediately down-slope of the orchard.

2.6.4 Nutrient Removal/Assimilation Summary

The multi barrier approach to nutrient removal from the proposed ABSORBS™ treatment and dispersal system and the biodrain is compounded. However, it can be seen that the nutrient removal and assimilation (Table 16) can be achieved with the proposed design and area of biodrain.

It can be seen for N that the system has the potential to assimilate and/or remove the N load from wastewater in all conditions other than for 40ML/yr flow when the allocated N reduction for the ABSORBS™ filters is the lowest (16%).

It can be seen for P that the system has the potential to assimilate and/or remove 60% of the P load from wastewater in both peak design flow or theoretical flow. However, there has been no P reduction allocated to the ABSORBS™ filters. Early research results on the P reduction performance of the ABSORBS™ filters at Hahndorf indicate > 40% P reduction (Table 13). Assuming these results are further validated, the system has the potential to assimilate and/or remove the P load from applied wastewater.

Table 16 **Nutrient balances for the Point Boston biodrain system**

System	Nutrient Supply	Nutrient Removal (kg/yr)			
		Nitrogen			Phosphorus
		Minimum 28-14% (84%)	Average 28% (72%)	Maximum 28+14% (58%)	
ABSORBS™ beds	40ML/yr, 2000kg N	280	560	840	
	30ML/yr, 1500kg N	210	420	630	
ABSORBS™ bamboo (1.5ha)	600kg/ha/yr N	900	900	900	
	90kg/ha/yr P			135	
Native Flora Reserve (3.5ha)	175kg/ha/yr N	654	654	654	
	10kg/ha/yr P				105
Nutrient removed	40ML/yr	1834	2114	2394	240
	30 ML/yr	1764	1,974	2184	
Nutrient applied	40ML/yr	2000	2000	2000	400
	30 ML/yr	1500	1500	1500	300
Nutrient Balance	**40ML/yr**	**166**	**-114**	**-394**	**160**
	30 ML/yr	**-264**	**-474**	**-684**	**130**

3 References

Ali A, Naeem, M. Ahmad Dar, T., Idrees, M., Masroor, M., Khan, A., Uddin, M., Dantu, P., Singh, T. (2017) **Nutrient Uptake, Removal, and Cycling in Eucalyptus Species**. In: Naeem M., Ansari A., Gill S. (eds) Essential Plant Nutrients. Springer, Cham

Allen, R., Pereira, L., Raes, D., Smith, M. (1998) **FAO Irrigation and Drainage Paper No. 56: Crop Evapotranspiration, guidelines for computing crop water requirements**. http://www.fao.org/tempref/SD/Reserved/Agromet/PET/FAO_Irrigation_Drainage_Paper_56.pdf

ANON (1997) **National Water quality Management Strategy: Australian Guidelines for Sewage Systems, Effluent Management** https://www.waterquality.gov.au/sites/default/files/documents/effluent-management.pdf

Anon (2014) **State Flora: Nursery Catalogue.** https://www.stateflora.sa.gov.au/buy-plants/how-to-order/catalogue

Aylmore, P., Luke, G., Hauck, E. (1994) **Crop Irrigation Requirement Program.** Plant Industries AD Dept Ag. South Perth

Brockwell, J., Searle, S.D., Jeavons, A.C., Waayers, M. (2015) ***Nitrogen Fixation in Acacias: an Untapped Resource for Sustainable Plantations, Farm Forestry and Land Reclamation***. Australian Centre for International Agricultural Research (ACIAR) Monograph No. 115, 132 p. ISBN: 1 86320 490 3.

Carpenter, S. (2006) **Eutrophication of Aquatic Ecosystems: Bistability and Soil Phosphorus**. PNAS July 19, 2005 102 (29) 10002-10005; https://doi.org/10.1073/pnas.0503959102

Carruthers, R., Mark Skewes, M., Brian Latcham, B., Pudney, S. (2006) **Volumetric Conversion in the South East of South Australia: Calculation of the Crop Adjustment Factor**. SA gov, Dept. Water, Land and Biodiversity Consevation Adelaide SA.

Converse, M. M. and J. C. Converse (1999). **Sand Filter Evaluation in a Northern Climate**. Available at: https://soils.wisc.edu/sswmp/SSWMP_2.37.pdf

Kleinhenz V, Midmore DJ. 2001. **Aspects of bamboo agronomy**. In: Adv Agron. Academic Press. p. 99–153. doi: 10.1016/S0065-2113(01)74032-1.

Lee, F. (1973) **Role of Phosphorus In Eutrophication and Diffuse Source Control**. Phosphorus in Fresh Water and the Marine Environment Progress in Water Technology. Pages 111-128

Gardner, T.E.D., Geary, P. and Gordon, I.A.N. (1997) **Ecological Sustainability and On-Site Effluent Treatment Systems**. Australian Journal of Environmental Management 4(2), 144-156.

Gardner, T. (2003) **The WC Fields project. An examination of sustainable irrigation of trees and pasture using treated sewage effluent.** Report from the Department of Natural Resources and Mines, Queensland Government, June 2003.

Howarth, R., Marino, R., **Nitrogen as the Limiting Nutrient for Eutrophication in Coastal Marine Ecosystems: Evolving Views Over Three Decades**. Limnol. Oceanogr.,51(1, part 2), 2006, 364–376.

International Plant Nutrition Institute (IPNI) (2015) **Nitrogen Notes Number 5**. http://www.ipni.net/publication/nitrogen-en.nsf/0/668099AE825517CB85257DD600054B8C/$FILE/NitrogenNotes-EN-5.pdf

Jovanovic, N.Z., Israel, S., Tredoux, G., Soltau, L., Maitre, D. Le, Rusinga, F., Rozanov, A., van der Merwe, N. (2009). ***Nitrogen dynamics in land cleared of alien vegetation (Acacia saligna) and impacts on groundwater at Riverlands Nature Reserve (Western Cape, South Africa)***. *Water SA*, 35(1), 37-44.

Novotny, V. (1994). ***Water Quality: Prevention, Identification and Management of Diffuse Pollution***. New York: Van Nostrand-Reinhold Publishers. ISBN 978-0442005597

Piouceau, J., Panfilia, F., Bois, G., Anastasea, M., Dufosséb, L., Arfia, V. (2014). **Actual evapotranspiration and crop coefficients for five species of three-year-old bamboo plants under a tropical climate**. Agricultural Water Management J. V137, pg. 15-24 http://www.sciencedirect.com/science/article/pii/S0378377414000432

Piouceau, J., Bois, G., Panfilia, F., Anastasea, M., Dufosséb, L., Arfia, V. (2014) **Effects of High Nutrient Supply on the Growth of Seven Bamboo Species.** International Journal of Phytoremediation, 16:10, 1042-1057, DOI: 10.1080/15226514.2013.810583

Rose, T., Barkla, B. (2017) **Identification of suitable crops for sustainable bio-remediation of wastewater from a bovine service abattoir**. https://www.mla.com.au/download/finalreports?itemId=3493

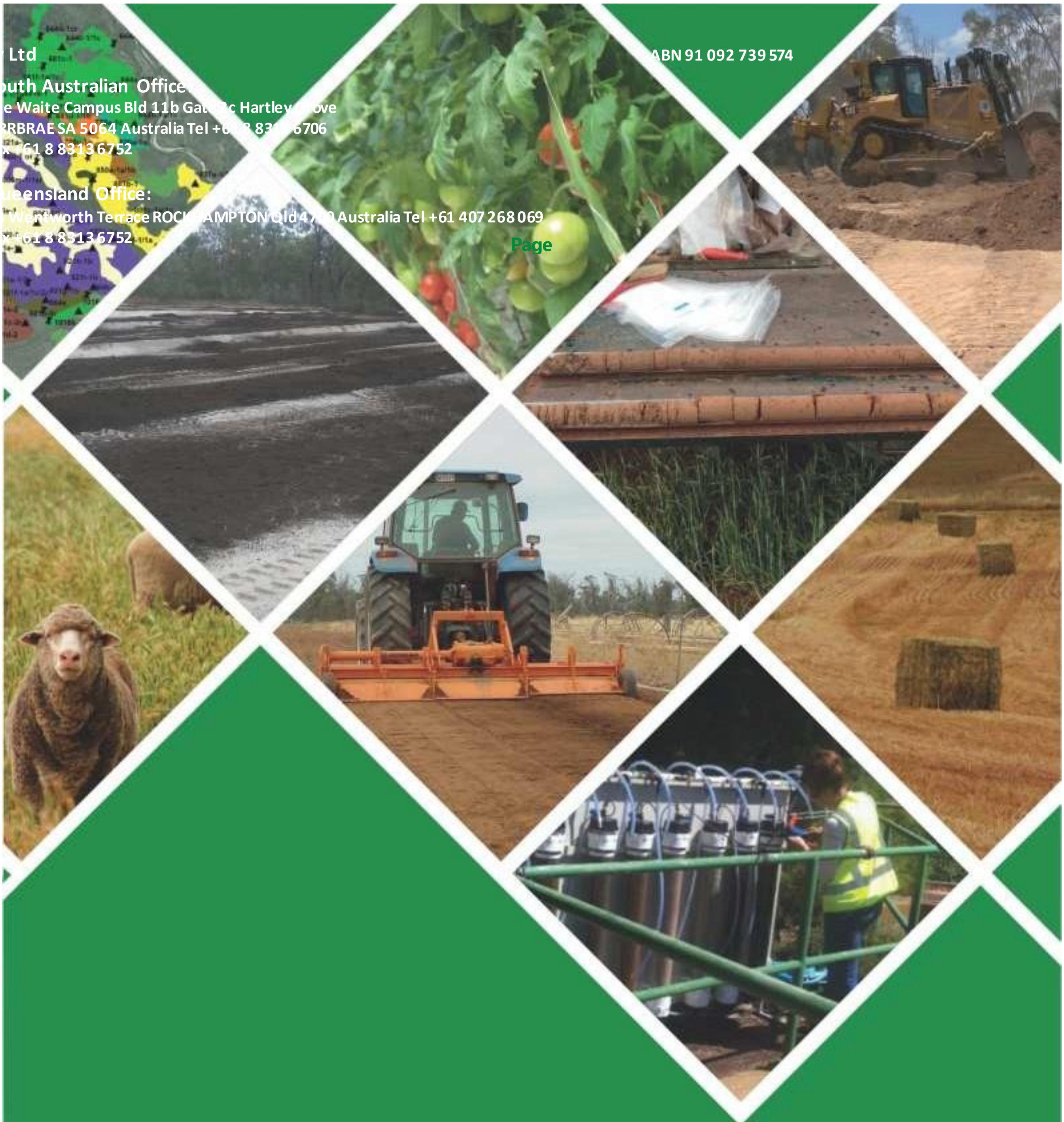
SA Health (2013) **Onsite Wastewater Systems Code** https://www.sahealth.sa.gov.au/wps/wcm/connect/ba6ead0048f0d8ab828287f25a3eb7d6/2013SA Health_On-site_Wastewater_Systems_Code_April.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-ba6ead0048f0d8ab828287f25a3eb7d6-mMH7r2z

SA LGD & SA Health (2019) **South Australian Community Wastewater Management System (CWMS) Design Criteria** http://www.lga.sa.gov.au/webdata/resources/files/South%20Australian%20Community%20Wastewater%20Management%20System%20(CWMS)%20-%20Design%20Criteria.pdf

SA Water (2013) **SA Water Wastewater Treatment Plants and Catchments** https://www.escosa.sa.gov.au/ArticleDocuments/482/121011-E2_SAWaterWastewaterTreatmen.pdf.aspx?Embed=Y

Shanmughavel, P., Francis, K. (2001) **Bioproductivity and Nutrient Cycling in Bamboo and Acacia Plantation Forests**. Jour Bioresource Technology 80 (2001) 45-48.

US EPA (1999) Wastewater Technology Fact Sheet: **Intermittent Sand Filters**. United States Environmental Protection Agency. Office of Water Washington D.C.



Ltd
uth Australian Office:
e Waite Campus Bld 11b Gat 3c Hartley ove
RBRAE SA 5064 Australia Tel +6 8 83 6706
x +61 8 8313 6752
ueensland Office:
Wentworth Terrace ROC AMPTON Qld 47 0 Australia Tel +61 407 268 069
x +61 8 8313 6752
ABN 91 092 739 574
Page

Appendix 4. Written permission (email) for Arris Pty Ltd to submit an NVC Application on behalf of the Community Corporation.

From: Steve Geyer <Steve.Geyer@whittles.com.au>
Sent: Friday, 27 August 2021 1:21 PM
To: Jim Kelly <jkelly@arris.com.au>
Cc: 'Ian Crossland' <icrossland@bigpond.com>
Subject: Native Vegetation Application

HI Jim,

Please be advised that Community Corporation 25691(Point Boston) hereby authorises Jim Kelly (Arris) to submit a Native Vegetation Clearance application on behalf of Community Corporation 25691.

The land concerned in this application is owned by Community Corporation 25691.

Regards

Whittles
Strata and Community Title Services

Steve Geyer | Body Corporate Manager
176 Fullarton Rd Dulwich SA 5065
P: 08 8291 2300 | **D:** 08 8291 2325
E: Steve.Geyer@whittles.com.au
Supported by
Mathew Altamura | Assistant Manager
P: 08 8291 2300 | **D:** 08 8291 2314
E: Mathew.Altamura@whittles.com.au

strata community association
SA member

Appendix 5. Photo log

Position: 53S 583575E 6169331N

Direction of photo: Looking north-west 310 degrees

Site A1: Showing native vegetation and weed invasion.

Position: 53S 583767E 6169372N

Direction of photo: Looking south-west 245 degrees

Site A1: Showing native vegetation and weed invasion.

Position: 53S 583674E 6169337N

Direction of photo: Looking north-north-east 30 degrees

Site A1: Showing native vegetation, weed invasion and emergent *Allocasuarina verticillata* Drooping Sheoak.

Position: 53S 583262E 6169497N

Direction of photo: Looking east 85 degrees

Site A1: Showing native vegetation, weed invasion and emergent *Allocasuarina verticillata* Drooping Sheoak.

Position: 53S 583274E 6160497N

Direction of photo: Looking north 0 degrees

Site B1: Showing native vegetation, weed invasion (*Lycium ferocissimum* African Boxthorn top left corner).

Position: 53S 583313E 6169446N

Direction of photo: Looking north-north-east 75 degrees

Site B1: Showing native vegetation, weed invasion.

Position: 53S 583713E 6169363N

Direction of photo: Looking north-west 300 degrees

Site B1: Showing native vegetation, weed invasion.

Position: 53S 583470E 6169394N

Direction of photo: Looking north-west 320 degrees

Site A1: From the road, showing site edge.

Position: 53S 583505E 6169384N

Direction of photo: Looking east 85 degrees

Site A1: From the road, showing site edge and planted stands of non-local *Eucalyptus*.

Position: 53S 584128E 6168711N

Direction of photo: Looking south-east 120 degrees

Site A1: From the road, showing site edge.