Pindimar Abalone Farm
Stormwater Management Plan

For: Austasia Leefield Pty Ltd

September, 2013

Project Name:	Pindimar Abalone Farm – Stormwater Management Plan
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SMEC COMPANY DETAILS

SMEC Australia
PO Box 1346, Newcastle NSW 2300

Tel: (02) 4925 9619

Fax: (02) 4925 3888

Email: Chris.Kuczera@smec.com

www.smec.com

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ABBREVIATIONS

AHD	Australian Height Datum
ARQ	Australian Runoff Quality
BoM	Bureau of Meteorology
EMC	Event Mean Concentration
IEAust	Institution of Engineers Australia
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
NOW	NSW Office of Water
PET	Potential Evapotranspiration
SWMP	Surface Water Management Plan
TN	Total Nitrogen
TSS	Total Suspended Solids
TP	Total Phosphorus

1 INTRODUCTION

SMEC was engaged by Austasia Leefield Pty Ltd (the proponent) to prepare a Stormwater Management Plan (SWMP) for a proposed Abalone Farm at Pindimar. The proposal is for a land-based aquaculture farm for the production of about 60 tonnes per year of Blacklip Abalone for human consumption. The proposed farm will comprise a series of land-based tanks, sheds and ancillary structures to accommodate the quarantine, breeding and grow-out of Abalone. Abalone will be harvested and transported to market as live product, with no post-harvest processing on site.

The site comprises an area of approximately 51 ha, although only about 5 ha will accommodate farm development. The site is located within the Great Lakes Local Government Area, and the adjacent water is within the Port Stephens Local Government Area. The farm infrastructure will have a building footprint of approximately 1.1 ha (about 2.2% of the site). Construction will require the clearing of about 1 ha of native vegetation, and the partial clearing of an additional 1 ha. The balance of the site will remain as-is (i.e. bushland, agricultural consideration).

The site is located approximately 40 km north-east of Newcastle and is adjacent to the small coastal village of South Pindimar. With the exception of the village, the site and all surrounding land is zoned for rural purposes.

A plan showing the project location and layout is provided in **Figure 1**.

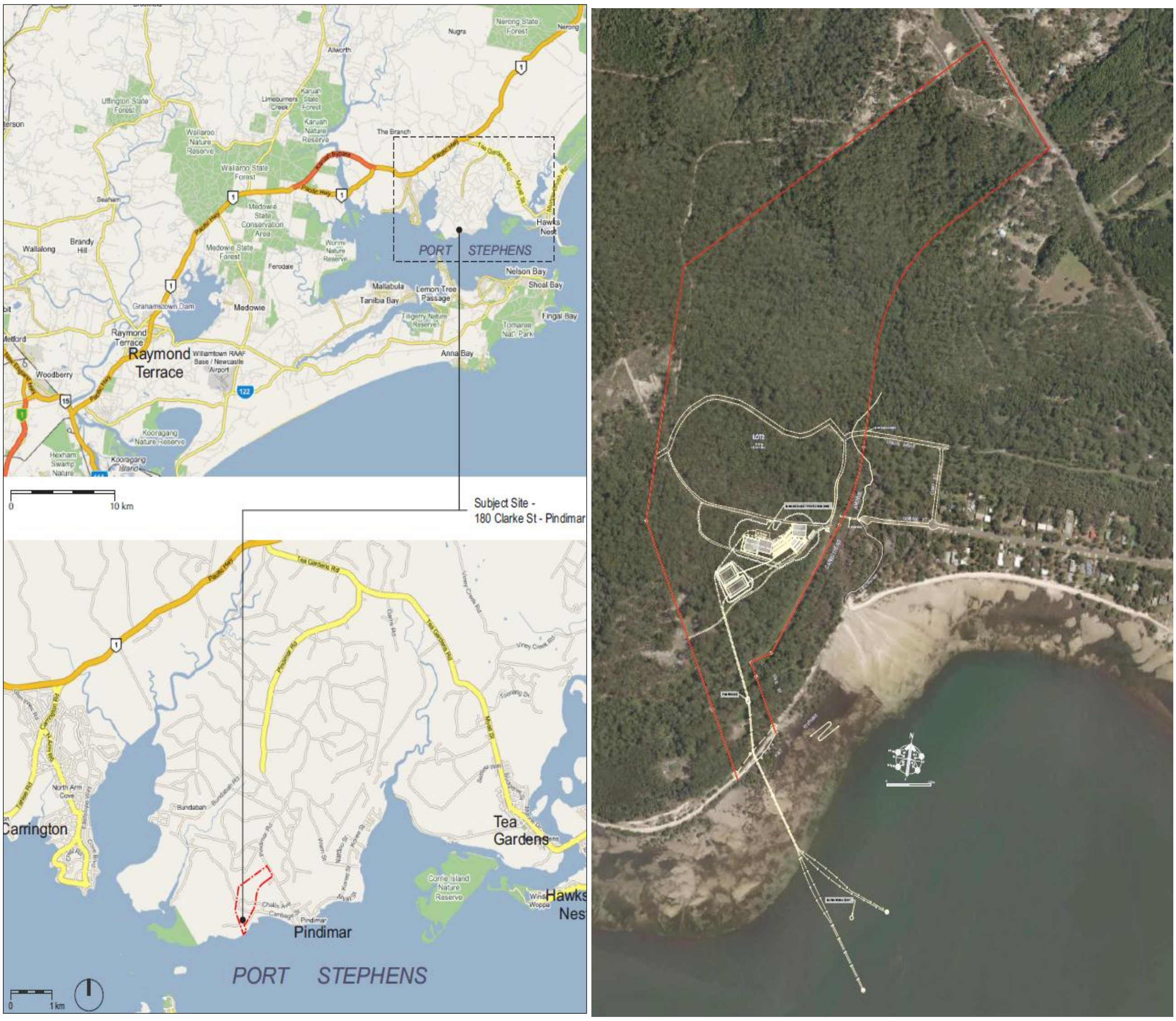

***Figure 1**- Site Locality and Project Layout*

1.1 Scope of this Report

This document details the SWMP for the project and is presented as follows:

- **Section 2** reviews applicable plans, policies and guidelines.
- **Section 3** provides a description of the existing environment.
- **Section 4** establishes and stormwater management strategy and plan for the project.
- **Section 5** documents the water quality modelling that was undertaken for the project.

2 RELEVANT PLANS AND GUIDELINES

This section provides an overview of Council, NSW Government and industry plans and guidelines that were considered when developing the SWMP.

2.1 Council Development Control Plans

Water Sensitive Urban Design: Development Control Plan 54

Development Control Plan (DCP) 54 was adopted by Great Lakes Council in December 2011 and applies to all land within the Great Lakes Council LGA. The DCP provides stormwater management control targets for both small scale (total development area <2,000m^2) and large scale (total development area >2,000m^2) developments. The proposed abalone farm is considered to be a large scale greenfield development under the DCP definitions.

The DCP recommends the following stormwater management objectives for large scale greenfield developments:

- **Water Quality Control**: the DCP requires stormwater controls to achieve a natural or beneficial effect on water quality. This is defined in Table 3 of the DCP as no net increase in:
  - Total Suspended Solids (TSS);
  - Total Nitrogen (TN); and
  - Total Phosphorous (TP).
- **Stormwater Flow Management**: The DCP recommends that reasonable management actions are taken to:
  - Reduce the impervious areas that are directly connected to the stormwater system; and to
  - Reduce the potential for erosion within downstream areas of natural bushland.

The stormwater management plan presented in subsequent sections of this report addresses the above DCP requirements.

2.2 NSW Office of Water Guidelines

NSW Office of Water (NOW, 2012) guidelines for controlled activities on waterfront land are addressed in the Environmental Assessment that has been prepared by City Plan Strategy & Development.

2.3 Industry Guidelines

Australian Runoff Quality

Australian Runoff Quality (ARQ) is an industry guideline document published in 2005 by the *Institution of Engineers Australia* (IEAust). The document provides guidance on all aspects of water sensitive urban design, including preventative measures, source controls conveyance controls and end of pipe controls.

3 EXISTING ENVIRONMENT

This section describes the existing site characteristics that are relevant to this stormwater assessment.

3.1 Existing Watercourses

Figure 2 locates the site area relative to local watercourses and associated catchment areas. As indicated in **Figure 2**, the majority of the 51 ha site area is within the Pig Station Creek Catchment. The proposed abalone farm will be located in the southern portion of the site, partially in the Pig Station Creek Catchment. Pig Station Creek and the southern portion of the site area drain into the Port Stephens Estuary. Former oyster leases (currently understood to be vacant) exist in the intertidal zone of the Port Stephens Estuary adjacent to the site.

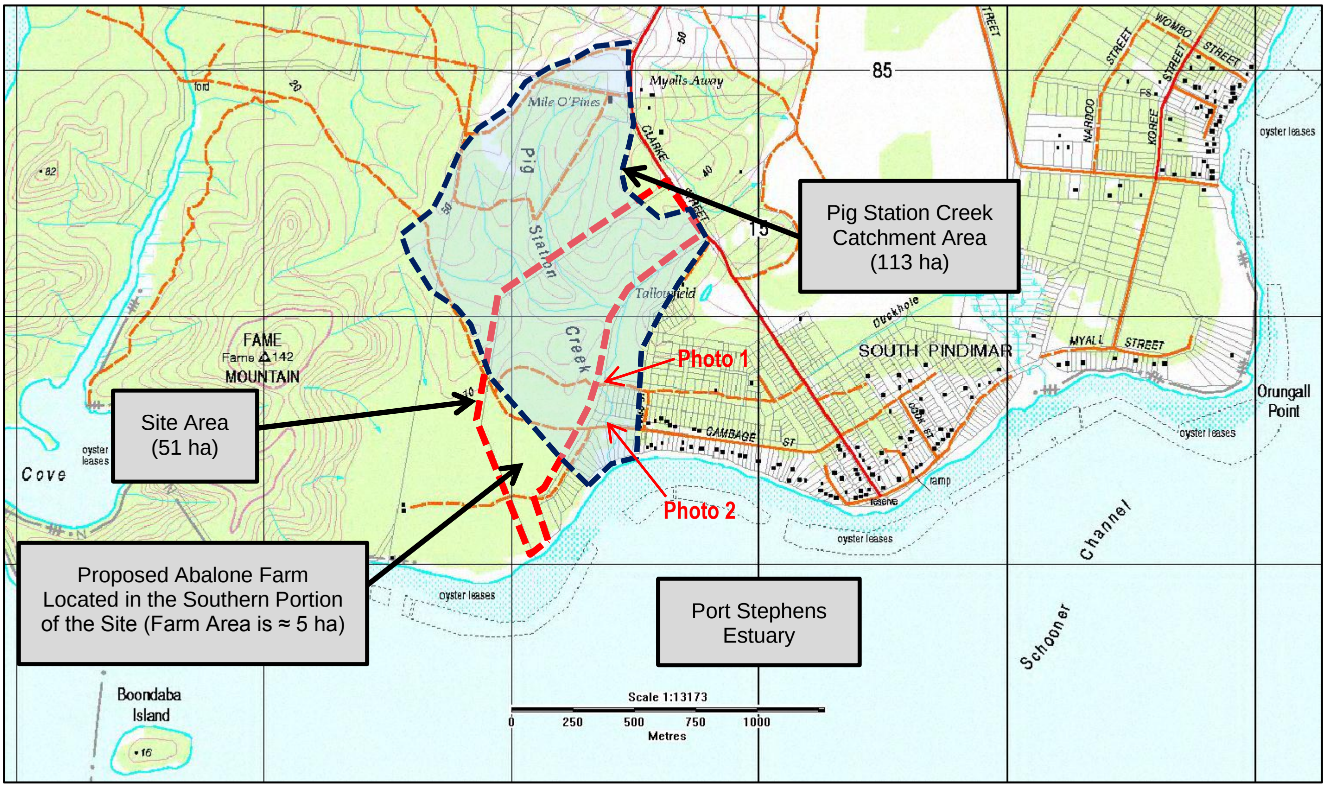

Figure 2 – Site Area Relative to Existing Watercourses.

Pig Station Creek is a 3rd order watercourse with an estimated 113 ha catchment area. **Photo 1** shows the Pig Station Creek adjacent to the existing site entrance (adjacent to Challis Avenue) and **Photo 2** shows the creek at the proposed board walk location. Refer to **Figure 2** for photo locations. The riparian vegetation (Swamp Mahogany) at the **Photo 1** location indicates this section of the creek is above the tidal range. The mangroves evident in **Photo 2** indicate that this portion of the watercourse is below the tidal range.


Photo 1 *on the left shows Pig Station Creek near the proposed site entrance (adjacent to Challis Avenue). The riparian vegetation (Swamp Mahogany) indicates this section of the watercourse is above the tidal range.* ***Photo 2*** *on the right shows Pig Station Creek at the proposed board walk location (190 m downstream of* ***Photo 1****). The riparian vegetation (Mangroves) indicates that this section of the watercourse is below the tidal range.*

3.2 Climatic Conditions

Table 3-1 presents key information and statistical data from Bureau of Meteorology (BoM) operated rainfall gauges that are located in close proximity to the site and / or have a long term rainfall record. The rainfall records from these gauges are considered to be indicative of likely rainfall conditions at Pindimar.

***Table 3-1** –Rainfall Statistics from Local Gauges*

Statistics	Nelson Bay (60154)	Tahlee (Carrington House) (61072)	Williamtown (RAAF Base) (61078)
Rainfall Record	1881 to Present	1897 to 2012	1942 to Present
Distance from site	8km to the south-east	7km to the west	25km to the south-west
Elevation (m AHD)	25	3	3
Average Rainfall (mm/year)	1,347	1,201	1,125
Lowest Annual Rainfall (mm/year)	417	565	541
5th Percentile Rainfall (mm/year)	770	744	760
10th Percentile Rainfall (mm/year)	907	829	797
Median Rainfall (mm/year)	1,294	1,154	1,088
90th Percentile Rainfall (mm/year)	1,896	1,535	1,493
95th Percentile Rainfall (mm/year)	2,062	1,631	1,559
Highest Annual Rainfall (mm/year)	2,336	2,093	1,794

Source: Bureau of Meteorology

Table 3-2 presents the average monthly evaporation and areal Potential Evapotranspiration (PET) rates for the Newcastle area. This data was extracted from the monthly climate maps provided by the BoM.

Table 3-2 - *Average monthly evaporation and potential evapotranspiration in the Newcastle Region*.

Month	Average Monthly Pan Evaporation	Average Monthly Areal Potential Evapotranspiration
	(mm/Month)	(mm/Month)
January	200	190
February	150	149
March	150	149
April	100	97
May	80	65
June	60	52
July	80	56
August	100	71
September	125	100
October	175	138
November	175	163
December	200	181
Annual	**1595**	**1411**

Source: Bureau of Meteorology Climate Data Maps

3.3 Geotechnical Conditions

Information provided by the proponent indicates that geotechnical conditions within the proposed development area are characterised as follows:

- The soil landscape in the upper (northern) portion of the development area is characterised as shallow conglomerate bedrock with minimal topsoil cover. **Photo 3** shows a typical section of the northern portion of the development area. Infiltration based stormwater systems would not be suitable in this soil landscape.

- The soil landscape in the lower (southern) portion of the development area is characterised as sandy estuarine soils. **Photo 4** shows a typical section of the southern portion of the development area. Infiltration based stormwater systems would be suitable in this soil landscape.

The spatial distribution of the abovementioned soil landscapes is indicated in **Figure 5**.

Photo 3 *on the left shows the shallow conglomerate bedrock in the northern portion of the development area.* ***Photo 4*** *on the right shows the sandy soils in the southern portion of the development area*

4 PROPOSED STORMWATER MANAGEMENT PLAN

This section describes the development proposal and proposed stormwater management strategy and plan. **Section 5** documents water quality modelling that was undertaken to assess the effectiveness of the proposed stormwater management controls in meeting Council's DCP targets.

4.1 Description of the Proposed Development

The proposed abalone farm includes the following infrastructure that is relevant to this stormwater management assessment:

- Numerous sheds housing abalone cultivation facilities;
- External juvenile area comprising covered plastic tanks;
- Settlement ponds to hold and treat marine water (note: these ponds are not part of the stormwater management system);
- Site office; and
- Car park and access road.

Figure 3 details the proposed development layout.

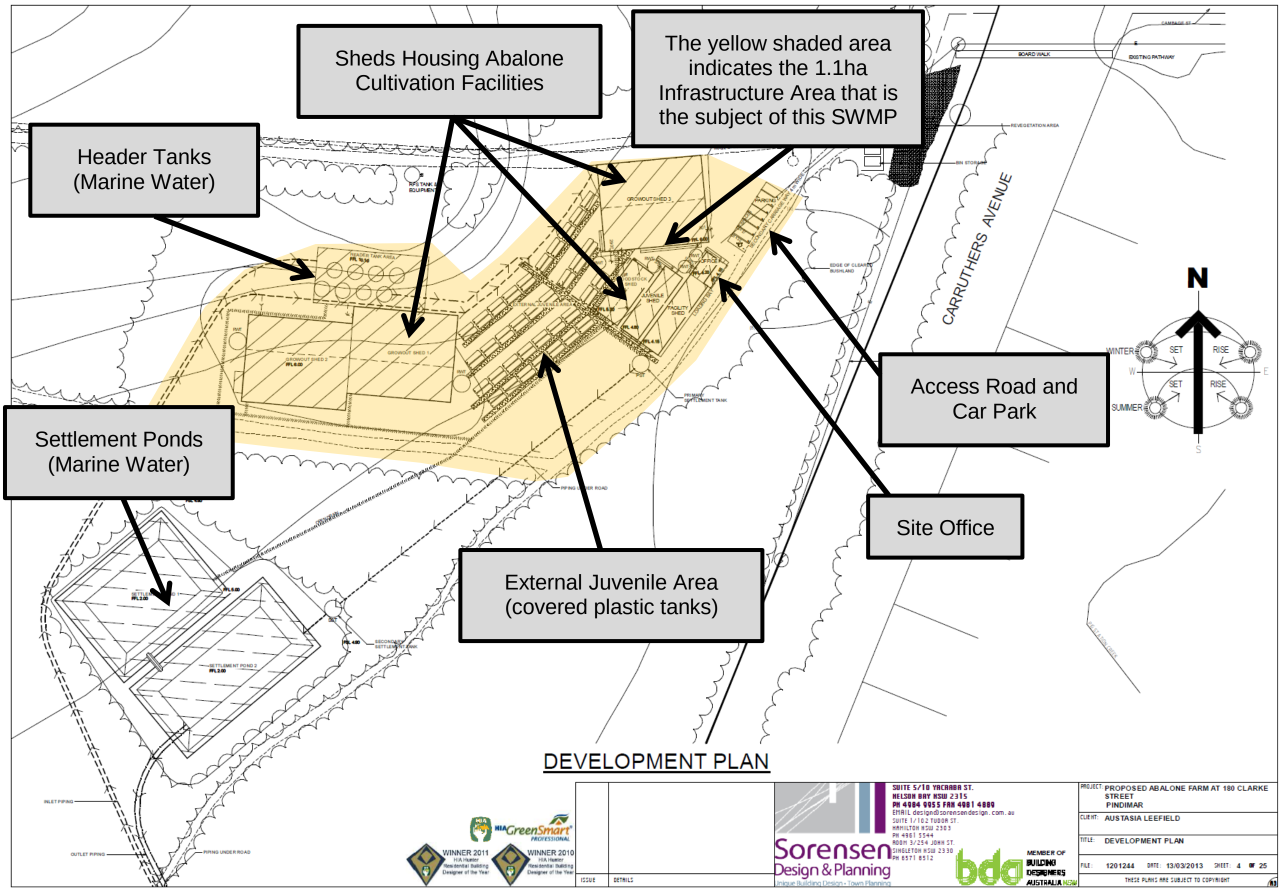

***Figure 3 –** Proposed Development Layout (Source EA Architectural Drawings)*

4.2 Stormwater Management Strategy

A stormwater management system incorporating the principles of Water Sensitive Urban Design is proposed to control runoff from a 1.1 ha area that will incorporate the majority of the farm infrastructure. This area, which is referred to as the Infrastructure Area, is indicated in **Figure 3**. No stormwater controls are proposed for areas outside of the 1.1 ha Infrastructure Area as these areas will predominantly comprise managed native vegetation. It is noted that the marine water settlement ponds indicated in **Figure 3** are part of the marine water circuit and are not part of the stormwater management system.

The stormwater management strategy for the 1.1 ha Infrastructure Area is presented diagrammatically in **Figure 4** and is described as follows:

- **Rainwater Harvesting:** With reference to **Figure 3**, a number of large sheds are proposed to house the abalone cultivation facilities. The majority of runoff from roof areas will be collected in one of six 10 KL rainwater tanks. Harvested rainwater will be re-used for toilet flushing and operational water uses such as the wash-down of raceways and hides. Expected water harvesting rates are discussed further in **Section 5**.

- **Vegetated Infiltration Swale**: The sandy soils located in the southern portion of the development area are suitable for infiltration based stormwater controls. Hence, it is proposed to construct a vegetated infiltration swale to collect and treat all runoff from the Infrastructure Area. The swale will be constructed at approximately 0.5% grade to promote infiltration. Given the sandy soils and the minimal grade, it is expected that the majority of runoff from the Infrastructure Area will infiltrate from the swale into the underlying sandy soils.

- **Diversion Swales:** Drainage swales will be constructed at select locations to divert surface runoff around the Infrastructure Area.

The stormwater management strategy is applied to water quality modelling (refer to **Section 5**) and to a Stormwater Management Plan for the project (refer to **Section 4.3**).

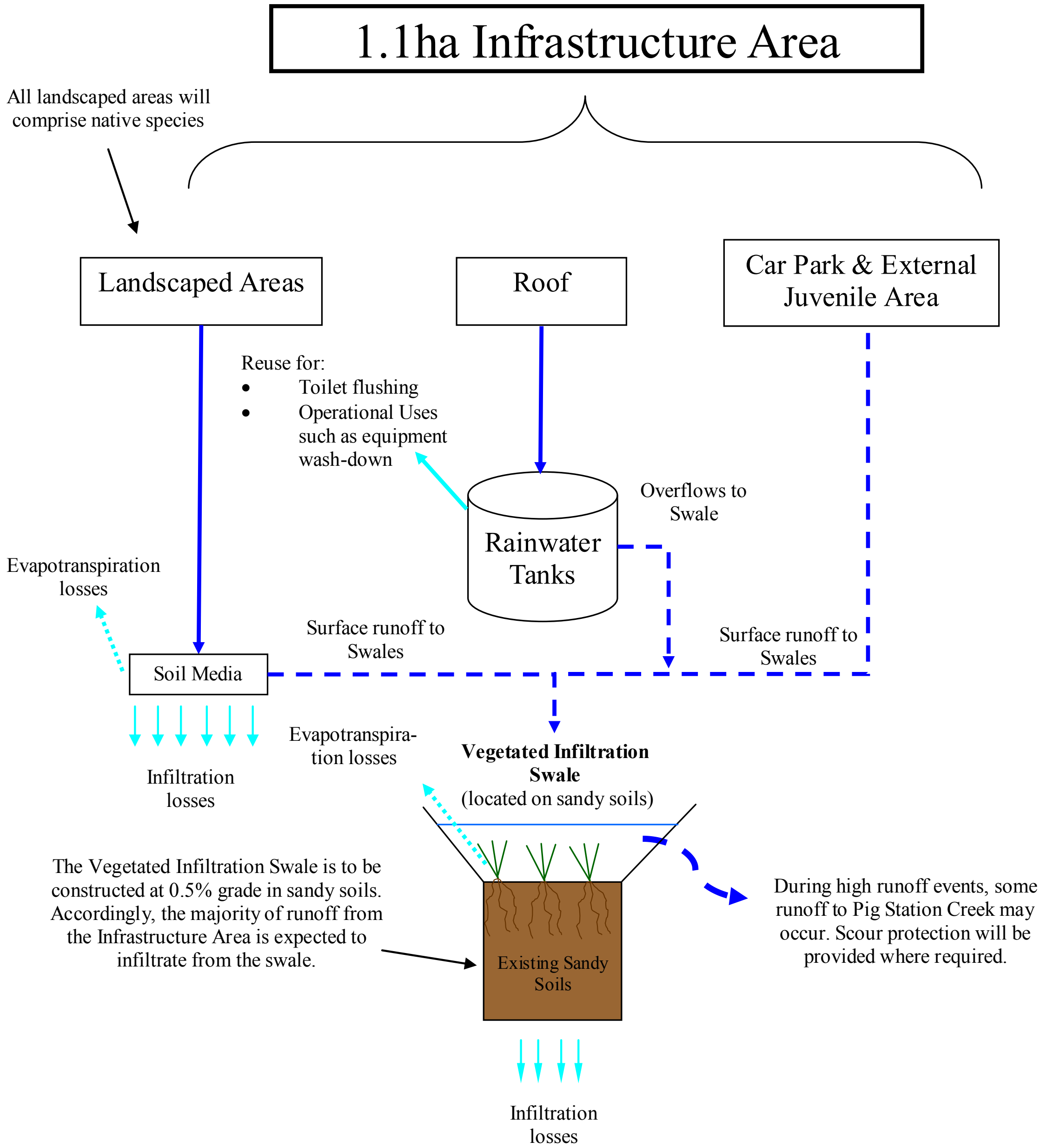

***Figure 4 –** Proposed Stormwater Management Strategy*

4.3 Stormwater Management Plan

A conceptual Stormwater Management Plan (SWMP) for the project was established based on the stormwater management strategy described in **Section 4.2**. The conceptual SWMP is illustrated in **Figure 5**, which shows the following information:

- The indicative soil landscape divided (between sandy soils and shallow conglomerate bed rock) as discussed in **Section 3.3**.
- Indicative locations of diversion swales that will be positioned up gradient of the Infrastructure Area to capture and divert surface flows around farm infrastructure.
- The location of the six 10KL rainwater tanks.

- The indicative location of the vegetated infiltration swale that will be constructed down gradient of the Infrastructure Area in sandy soils. This swale will collect and treat all runoff from the Infrastructure Area. The swale will be constructed on a relatively flat (0.5%) grade to promote infiltration. During high flow conditions, some runoff will discharge into Pig Station Creek, downstream of the proposed board walk crossing. It is noted that, as established in **Section 3.1**, Pig Station Creek is tidal at the board walk crossing. Hence, any fresh water discharge from the swale is not expected to disturb the existing hydrologic regime.

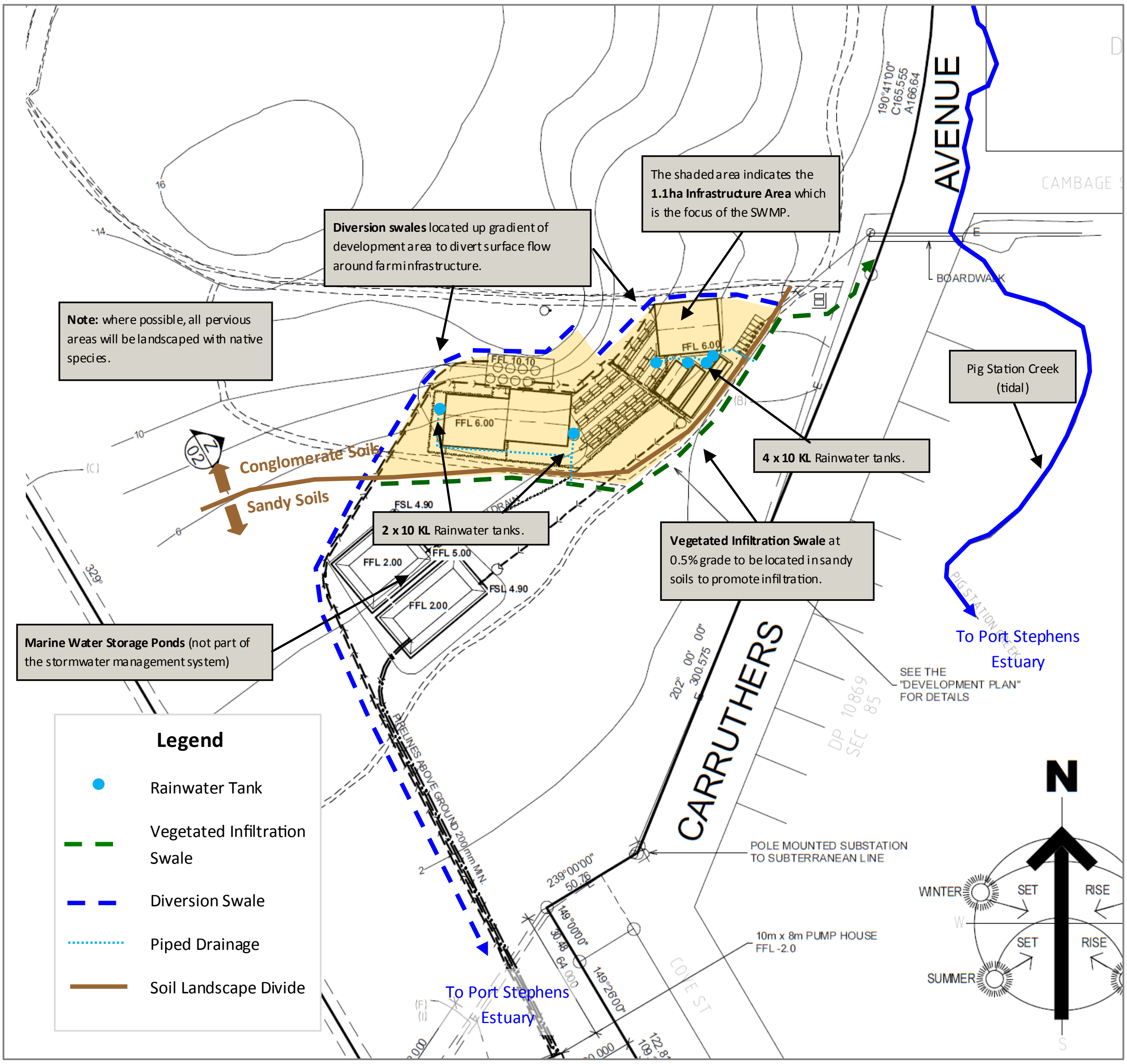

***Figure 5 –** Proposed Stormwater Management Plan*

4.4 Water used in Farm Operations

The abalone farm will use approximately 50 ML/day of marine water that will be sourced from the Port Stephens Estuary. All marine water used within the farm will be separated from the stormwater system. Refer to the Environmental Assessment for further details regarding the marine water circuit.

4.5 Waste Water Management

All waste water produced on site will be held in a sealed retention tank and removed from site by a licenced contractor on an as needed basis.

5 WATER QUALITY MODELLING

Water quality modelling was undertaken to demonstrate the effectiveness of the stormwater strategy and to determine the key design parameters of the proposed water quality controls. The following sections outline the modelling approach, key assumptions and model results.

5.1 Modelling Approach

The performance of the SWMP was assessed using the *Model for Urban Stormwater Improvement Conceptualisation* (MUSIC) software (Version 5.1) developed by eWater. MUSIC has been specifically designed to model the effectiveness of stormwater management systems in achieving pollutant reduction targets and mitigating hydrologic impacts, such as increases in runoff volume.

5.2 Meteorological Template

The MUSIC meteorological template includes rainfall and aerial potential evapotranspiration data. The template forms the basis for hydrologic calculations.

MUSIC Modelling Guidelines (WBM, 2010) recommend that MUSIC simulations are undertaken at a 6 minute time step. Hence, 6 minute pluviograph rainfall data is required. The nearest regional rain gauges that have 6 minute pluviograph data are located at the Newcastle University (BoM 61390) and the RAAF base at Williamtown (BoM 61078). The five year record between 1972 and 1976 from the Williamtown gauge was considered the most appropriate for use in MUSIC modelling as it contains a continuous record of typical rainfall conditions for the Port Stephens area. The average rainfall recorded over the 5 year period was 1,192 mm/year, which is in line with the average rainfall reported in **Table 3-2**. The average monthly areal potential evapotranspiration rates reported in **Table 3-2** were applied to the MUSIC model.

5.3 Catchment Parameters

The catchment nodes in MUSIC simulate the runoff quantity and quality from a catchment. This section describes the catchment modelling approach and associated assumptions.

5.3.1 Catchment Areas

For the purposes of MUSIC modelling, the Infrastructure Area was divided into the following land surface types based on the expected hydrologic responses and runoff quality:

- **Landscaped Areas**: refers to all landscaped areas within the 1.1 ha Infrastructure Area. As discussed in Section 4, landscaped areas will comprise managed native vegetation.
- **Roof Areas**: refers to all roof areas within the 1.1 ha Infrastructure Area
- **Car Park Areas**: refers to the car park located to the east of the site office.
- **Open Work Area**: refers to the uncovered work areas such as the external juvenile tanks (covered plastic tanks) and header tanks.

Figure 6 indicates the extents of the above land surface types and **Table 5-1** provides a breakdown of the total areas of each land surface type and the assumed percentage of the total area that will comprise impervious surfaces. It is noted that the 1.1ha Infrastructure area is primarily located within the conglomerate soil type.

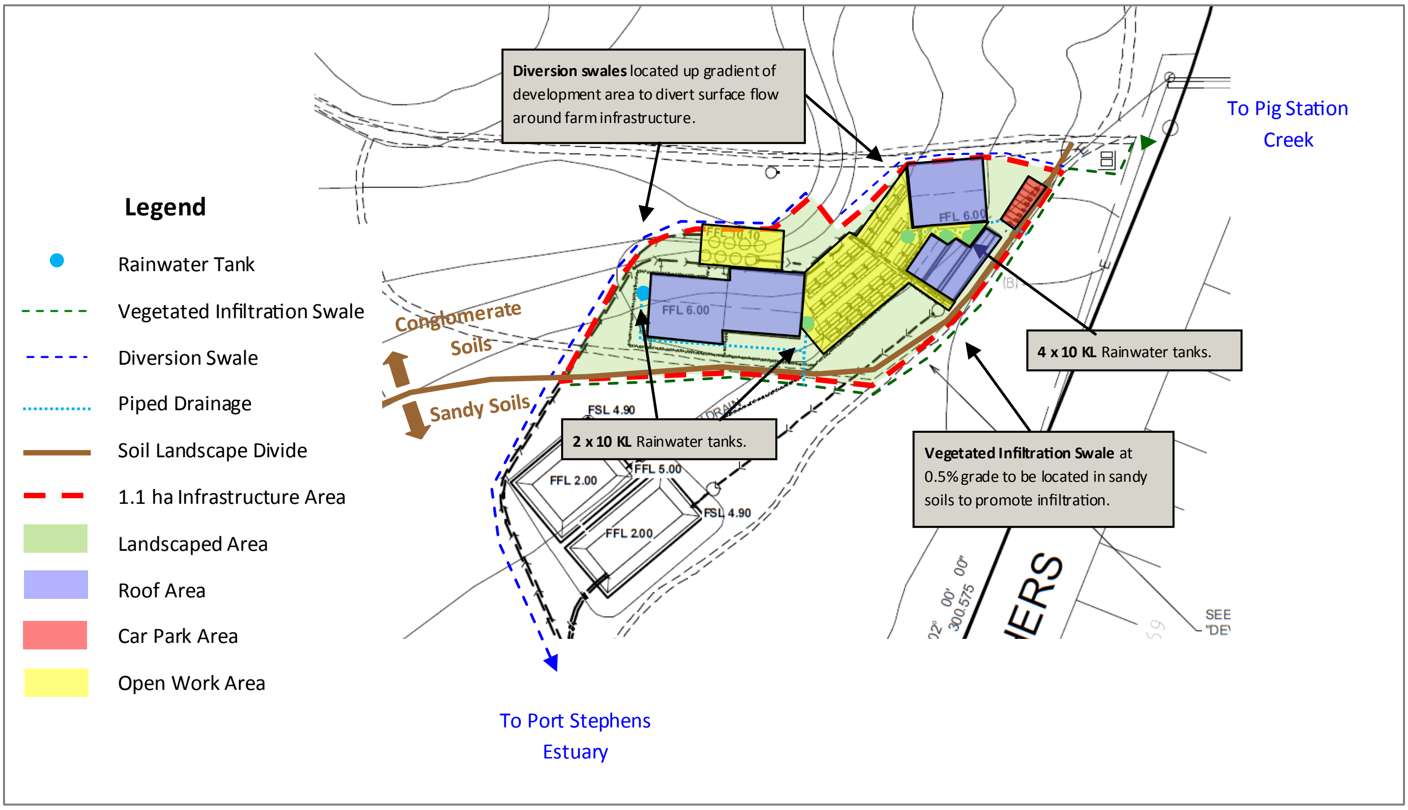

***Figure 6** – Catchment Extents*

***Table 5-1** – Catchment area assumptions*

Land Surface Type	Net Area (within 1.1ha Infrastructure Area)	Assumed Impervious Percentage
Landscaped Areas	5,740 m^2	0%
Roof Area	2,760 m^2	100%
Car Park Areas	120 m^2	100%
Open Work Areas	2,380 m^2	50%

5.3.2 Rainfall Runoff Parameters

MUSIC applies a rainfall runoff model to estimate surface runoff and baseflow from pervious surfaces. The model estimates surface runoff as a function of soil moisture storage with the infiltration rate of the soil being defined as an exponential function of the soil moisture storage. Evapotranspiration is subtracted from the soil moisture store based on the prevailing areal potential evapotranspiration rate. Surface runoff occurs when the rainfall exceeds the infiltration rate of the soil (infiltration excess runoff) and when the soil moisture store has reached its maximum capacity (soil saturation excess runoff).

Soil moisture recharges groundwater whenever the soil moisture store exceeds field capacity. Recharge is calculated as a constant percentage of the storage above field capacity. Baseflow from groundwater is simulated using a linear recession of the groundwater store.

As there is no site specific data available to calibrate the rainfall runoff model, model parameters were selected to achieve an expected average annual runoff coefficient for a catchment in the Port Stephens Region that comprises shallow topsoil with underlying conglomerate bedrock. Due to the minimal top soil cover and shallow bed rock, the conglomerate soil type would be considered a low permeability soil. The *Constructed Wetlands Manual* (*DLWC, 1998*) indicates that the range in average annual runoff coefficients values for catchments with low permeability soils would be between 0.15 to 0.25. Accordingly, the rainfall runoff model was parameterised to achieve an average annual runoff coefficient of 0.20, in the middle of the above-mentioned range.

Runoff from impervious surfaces is estimated by applying a daily threshold (or loss) value.

Table 5-2 presents the adopted rainfall runoff parameters for pervious and impervious surfaces.

***Table 5-2** – Adopted rainfall runoff model parameters*

Parameter	Adopted Value
Impervious Area Parameters	
- *Rainfall Threshold*	1.5
Pervious Area Parameters	
- *Soil Storage Capacity (mm)*	135
- *Initial Storage (% of Capacity)*	30
- *Field Capacity*	115
- *Infiltration Capacity Coefficient – a*	150
- *Infiltration Capacity Coefficient – b*	3.5
Groundwater Parameters	
- *Initial depth (mm)*	10
- *Daily Recharge Rate (%)*	25
- *Daily Baseflow Rate (%)*	10
- *Daily Deep Seepage Rate (%)*	0

5.3.3 Runoff Quality Parameters

MUSIC applies Event Mean Concentration (EMC) values for TSS, TP and TN to simulated runoff from the catchment area. EMC values are assigned to estimated surface runoff and baseflow. EMC values for each of the land surface categories established in **Section 5.3.1** were selected based on recommended values in Fletcher et all. (2004) and Australian Runoff Quality (IEAust, 2005). Adopted values are presented in **Table 5-3**.

***Table 5-3** – Adopted pollutant Event Mean Concentrations*

Land Surface Type	TSS (mg/l)		TN (mg/l)		TP (mg/l)	
	Base Flow	*Wet Weather*	*Base Flow*	*Wet Weather*	*Base Flow*	*Wet Weather*
Roof Area	N/A	36	N/A	2.0	N/A	0.13
Car Park Area	N/A	270	N/A	2.2	N/A	0.50
Native Landscaping	6	79	0.3	0.8	0.03	0.08
Open Work Area	16	140	1.3	2.0	0.14	0.25
Existing Site	6	79	0.3	0.8	0.03	0.08

Note: no base flow will occur from fully impervious surfaces such as roofs or roads.

5.4 Treatment Node Parameters

One of the key objectives of MUSIC modelling is to determine the appropriate size of water quality controls required to meet the stormwater management objectives. MUSIC facilitates assessment of a range of controls and contains generic algorithms that estimate the pollutant removal efficiencies and runoff load reductions for each control. MUSIC enables controls to be modelled in series, allowing for the collective effect of all controls to be estimated. The following sections describe the key assumptions applied to the MUSIC modelling of the proposed stormwater controls.

Rainwater Tanks

For water quality modelling purposes, it was assumed that runoff from the 2,760 m^2 roof area will be collected in six 10 KL rainwater tanks. Captured rainwater will be reused for the following uses:

- **Amenities (toilet flushing and hand washing) 345 l/ working day –** based on typical water usage rates for 15 full time equivalent staff.
- **Washing of Hides and Raceways 120 l/ working day –** Estimated use rates provided by the proponent.
- **Kitchen Use 20 l/ working day –** Estimated daily use rates for non-potable water use in the staff kitchen.

Applying the above daily demand rates, the average daily demand is estimated to be 485 l/working day. As the farm will only be staffed from Monday to Saturday, the average daily use was adjusted to 346 l/day. Model results indicate that the estimated demand (126 KL / year) is equivalent to only 5% of average annual runoff volume (2,800 KL / year) into the tanks, indicating that the tanks will be full the majority of the time. The proponent has indicated that surplus tank water could be spayed on roof areas to provide temporary cooling during the summer months. This would improve the effectiveness of the rainwater tanks as a stormwater control.

Vegetated Infiltration Swale

As established in **Section 4**, the sandy soils located immediately to the south of the Infrastructure Area are suitable for infiltration based stormwater controls. Hence, it is proposed to construct a vegetated infiltration swale to collect and treat all runoff from the Infrastructure Area. The swale will be constructed at approximately 0.5% grade to promote infiltration. Given the sandy soils and the minimal grade, it is expected that the majority of runoff from the Infrastructure Area will infiltrate from the swale into the underlying sandy soils. The vegetated infiltration swale was modelled using the "Swale" treatment node in MUSIC with the following key assumptions applied:

- The swale is 250 m long, has a 1 m base width and a 3 m top with (total footprint of 750 m^2).
- The swale has an average longitudinal grade of 0.5%.
- The swale will be vegetated with appropriate plant species to provide scour resistance, improve pollutant removal and reduce clogging of the infiltration media.
- An infiltration rate of 50 mm/hour was assumed as a conservative estimate based on a description of the sandy soils provided by the proponent. At detailed design, infiltration testing will be undertaken to confirm the infiltration rates. If rates are lower than expected the swale width can be increased to maintain the required infiltration rate by increasing the infiltration area.

5.5 Modelling Results

Table 5-4 reports the MUSIC modelling results for existing conditions, developed unmitigated and developed mitigated conditions. Estimated pollutant load reductions achieved by the proposed controls are expressed as a percentage. Predicted changes to annual loads (i.e. developed mitigated loads less existing loads) are also reported.

Table 5-4 – *MUSIC modelling results*

	Existing Conditions	Developed Conditions			Change in Annual Load *(After Mitigation)*
		Unmitigated	*Mitigated*	*Percentage Reduction*	
Runoff Volume (ML/yr)	2.7	5.9	1.5	74%	-1.2
TSS (Kg/yr)	203	456	22	95%	-181
TP (Kg/yr)	0.2	0.9	0.2	79%	No change
TN (Kg/yr)	2.2	10.1	2.2	78%	No change

Note: all results are mean annual loads

MUSIC modelling results indicate that:

- Developed conditions runoff volumes from the Infrastructure Area will be similar or less than existing conditions volumes. This is primarily due to the high infiltration rates expected from the vegetated infiltration swale.
- Developed conditions TSS, TP and TN loads in runoff from the Infrastructure Area will be similar or less than existing loads. This is primarily due to the above mentioned reductions in runoff volumes due to infiltration losses from the vegetated infiltration swale.

The model results indicate that from a stormwater management perspective, the project will have a natural or beneficial effect on water quality, achieving the water quality management objectives outlined in Great Lakes Council's DCP 54. Refer to **Section 2.1** for further information on DCP 54.

6 SUMMARY AND CONCLUSION

SMEC were engaged by Austasia Leefield Pty Ltd to prepare a Stormwater Management Plan (SWMP) for a proposed Abalone Farm at Pindimar. The proposal is for a land-based aquaculture farm for the production of about 60 tonnes per year of Blacklip Abalone for human consumption. The proposed farm will comprise a series of land-based tanks, sheds and ancillary structures to accommodate the quarantine, breeding and grow-out of Abalone.

The site comprises an area of approximately 51 ha, although only about 5 ha will accommodate farm development. The farm infrastructure will have a building footprint of approximately 1.1 ha (about 2.2% of the site). A SWMP including the following key controls was established for this 1.1 ha farm infrastructure area.

- **Rainwater Harvesting:** Runoff from roof areas will be collected in six 10 KL rainwater tanks. Harvested rainwater will be re-used for toilet flushing and operational water uses such as the wash-down of raceways and hides.

- **Vegetated Infiltration Swale**: A vegetated infiltration swale will be constructed in the sandy soils that exist down gradient of the farm infrastructure area. The swale will collect and treat all runoff from the Infrastructure Area. Given the sandy soils and the minimal grade, it is expected that the majority of runoff from the infrastructure area will infiltrate from the swale into the underlying sandy soils.

Water quality modelling was undertaken to assess the performance of the proposed stormwater management controls. Model results indicate that from a stormwater management perspective, the project will have a neutral or beneficial effect on water quality, achieving the water quality management objectives outlined in Great Lakes Council's DCP 54. Refer to **Section 2.1** for further information on DCP 54.

In conclusion, the proposed SWMP has been established based on Council's guidelines. The SWMP implements best practice stormwater management measures that will mitigate the project's potential impacts to the receiving waters.

7 REFERENCES

1) Bureau of Meteorology Website *(Climatic Information):* *http://www.bom.gov.au/climate/*

2) Department of Land and Water Conservation NSW (1998), *'The Constructed Wetlands Manual'*

3) Fletcher et all. (2005), *'Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures – A Review and Gap Analysis'*

4) Institution of Engineers Australia (2005), *'Australian Runoff Quality'*

5) Institution of Engineers Australia (1987), '*Australian Rainfall and Runoff – A Guide to Flood Estimation'*

6) Landcom (2004), *'Managing Urban Stormwater; Soils and Construction: 4th Edition'*

7) WBM BMT (2010), *'Draft NSW MUSIC Modelling Guidelines'*