The Halloran Trust

Water Quality Monitoring Plan –

Mixed Use Subdivision, West Culburra, NSW

martens consulting engineers

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P1203365JR03V04
November 2016

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All enquiries regarding this project are to be directed to the Project Manager.

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1 Introduction

1.1 Overview

This Water Quality Monitoring Plan has been developed to support a Preferred Project Report (PPR) to the NSW Department of Planning and Environment (DoPE), for a mixed use subdivision at Lot 61 DP 755971, and parts of Lots 5, 6 and 7 DP 1065111, Culburra Road, West Culburra, NSW.

1.2 Document Production Overview

1.2.1 Environmental Assessment Submission

This document was initially developed to address stakeholder (NSW Fisheries and NSW Office of Environment and Heritage, OEH) response to the Concept Plan application as received June 21, 2013.

A stakeholder consultation meeting was held on August 13, 2013 and attended by:

- Local oyster farmers.
- Australia's Oyster Coast Inc.
- NSW Food Authority.
- Southern Rivers Catchment Management Authority.
- Shoalhaven Water.
- Shoalhaven City Council.
- NSW OEH.
- NSW Fisheries.
- The applicant and their consultants: Martens and Associates, and Allen Price and Associates.

The purpose of the meeting was to discuss stakeholder recommendations relating to monitoring of potential water quality impacts of the proposed development and specifically on the health of the estuary and aquaculture industry. It was resolved that a working group would meet to facilitate further stakeholder comment and input

into various aspects of the proposed development including the preparation of this WQMP.

Further to that meeting a draft of this document was circulated to stakeholders by Australia's Oyster Coast Inc. and a subsequent stakeholders meeting held on September 12, 2013. At that meeting additional stakeholder feedback was obtained and this monitoring program was amended accordingly.

1.2.2 Agency Submission Consultation

Subsequent to lodgement of the Environmental Assessment, a number of agencies have provided submissions to NSW DoPE in relation to the proposed development and, specifically, water quality monitoring and sediment and erosion control. Of particular relevance to this assessment were comments provided by NSW OEH (May 9, 2014) and BMT WBM (reviewed appointed by NSW DoPE) (March 6, 2014), who recommended this document be restructured to reflect a risk based approach. This approach has been adopted and other minor comments related to monitoring and management of the site integrated as appropriate.

1.3 Scope

The monitoring plan has been developed to address agency comments and stakeholders expectation. Specifically it:

- Completes a risk assessment considering likelihood and consequence of identified potential water quality impacts.
- Identify hazard monitoring and management measures to mitigate risks.
- Outline monitoring contingency plan and routine program review.
- Provide a Sediment and Erosion Control Plan (SECP) to manage impacts of construction on sensitive environmental receptors.

1.4 Proposed Development

The proposed development includes the following:

- Residential (including Torrens title lots, townhouses and 3-5 storey multiunit development).
- Commercial.
- Industrial.
- Tourist accommodation.
- Open space.

1.5 Reference Documents

This document has been prepared in accordance with, and should be read in conjunction with:

- SEPP 62 (2011) *Sustainable Aquaculture*.
- NSW DPI (2006) *NSW Oyster Industry Sustainable Aquaculture Strategy* (OISAS).
- Martens and Associates (October, 2016a) *Water Cycle Management Report* (Ref: P1203365JR01V07).
- Martens and Associates (August, 2016b) *Estuarine Management Study* (Ref: P1203365JR02V04).

1.6 Site Description

The development is located on the northern side of Culburra Road, West Culburra, within the SCC LGA on lots:

- Lot 61 DP 755971
- Part Lot 5 DP 1065111
- Part Lot 6 DP 1065111
- Part Lot 7 DP 1065111

The 109 ha site consists of undeveloped vegetated land and some agricultural areas in Lot 5 DP 1065111 and Lot 61 DP 755971 (Figure 1, Attachment A).

A detailed site description is provided in the Water Cycle Management Report (MA, 2016a).

1.7 Sensitive Environmental Receptors

Water quality impacts arising from the proposed development has the potential to affect the following sensitive environmental receptors:

- Oyster leases (Attachment B).
- Crookhaven estuarine environment including: SEPP 14 Wetlands; mangroves; riparian vegetation; and seagrass.
- Curleys Bay.
- Groundwater.

This WQMP has been developed to ensure the ongoing health of these receptors through the construction and operation of the proposed development.

1.8 Abbreviations

CC – Construction Certificate

CMA - Catchment Management Authority

DECCW – NSW Department of Environment, Climate Change and Water

DO – Dissolved oxygen

DoPE - NSW Department of Planning and Environment

DP – Deposited plan

EA - Environmental Assessment

EC – Electrical conductivity

EPA – NSW Environmental Protection Authority

GW - Groundwater

LGA – Local government area

MA – Martens & Associates Pty Ltd

mAHD – Metres, Australian Height Datum

NO_X – Oxidised nitrogen

NSW FA – NSW Food Authority

OCP – Organochloride pesticides

OEH – NSW Office of Environment and Heritage

OISAS - NSW Oyster Industry Sustainable Aquaculture Strategy

OPP – Organophosphate pesticides

PAH – Polycyclic aromatic hydrocarbons

PCB – Polychlorinated biphenyl

PQL – Practical quantification limit

SCC – Shoalhaven City Council

SECP – Sediment Erosion Control Plan

SEPP – State Environmental Planning Policy

SFEP – Stormfilter Enviropod

SQAP - Shellfish Quality Assurance Program

SQID – Stormwater quality improvement device

STP – Sewage treatment plant

TN – Total nitrogen

TP – Total phosphorus

TRH – Total recoverable hydrocarbons

TSS – Total suspended solids

WCMR – Water Cycle Management Report

WQ – Water quality

WQMP - Water Quality Monitoring Plan

2 Water Quality Risk Assessment

2.1 Overview

In accordance with comments from BMT WBM (March 6, 2014) and NSW OEH (May 9, 2014) this risk assessment has been prepared to identify potential water quality hazards arising from elements of the site's proposed treatment train (Section 2.3) and the risk these hazards present to the identified sensitive environmental receptors (Section 1.7).

Where required, monitoring and management measures are recommended to manage risks.

2.2 Methodological Approach

The following steps have been completed in undertaking this risk assessment:

1. Identify potential hazards to water quality for each element of the proposed treatment train. Hazards have been identified by considering each sensitive environmental receptor.
2. Assess consequence of each hazard (Table 1).
3. Determine likelihood of each hazard occurring (Table 2).
4. Classify risk as a combination of consequence and likelihood (Table 3).

Table 1: Adopted consequence definitions.

Descriptor (value[1])	Definition
Catastrophic (E)	Severe, permanent environmental impact or human health impacts.
Major (D)	Severe, long term environmental impact or possible human health impacts.
Moderate (C)	Localised, medium term environmental impact.
Minor (B)	Localised, short term environmental impact.
Insignificant (A)	No detectable environmental impact.

Note:

[1] Descriptors have been assigned values for the purposes of risk assessment (Attachment C).

Table 2: Adopted likelihood definitions.

Descriptor (value[1])	Definition
Almost certain (1)	Event is expected to occur often (several times per year).
Likely (2)	Event will probably occur often (once every 1 to 3 years).
Possible (3)	Event might occur (once every 3-10 years).
Unlikely (4)	Event could occur (once every 20 years).
Rare (5)	Event will occur only in rare circumstances (once every 100 years).

Note:

[1] Descriptors have been assigned values for the purposes of risk assessment (Attachment C).

Table 3: Adopted risk definitions.

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost certain	Low	Medium	High	Very High	Very High
	Likely	Low	Medium	High	Very High	Very High
	Possible	Low	Medium	Medium	High	Very High
	Unlikely	Low	Low	Medium	High	High
	Rare	Low	Low	Low	Medium	High

5. If hazard risk is defined as medium or greater, management measures including monitoring is recommended to manage the risk. Monitoring location, frequency and duration is outlined in each case as well as any additional monitoring or maintenance requirements.

2.3 Treatment Elements

This risk assessment has been completed for hazards identified at each of the following treatment elements of the site water quality treatment train:

- Sedimentation basins (construction phase element).
- Bioretention swales.
- Propriety devices (SFEP treatment train).
- Bioretention basins/constructed wetlands.
- Infiltration systems.

2.4 Risk Assessment

Risk assessment for water quality hazards identified for each treatment element is provided in Attachment C.

2.5 Monitoring and Management

Water quality hazards with a risk of medium or higher require monitoring and/or management measures as detailed in Attachment C and summarised in the following sections. The monitoring and other measures form part of a long term program which includes the following elements:

1. Sedimentation basin water quality (during construction).
2. Estuary water quality.
3. Shellfish monitoring.
4. Secondary indicator monitoring.
5. SQID monitoring.
6. Groundwater quality.

2.6 Sedimentation Basin

Construction phase sedimentation basins are required across the site to manage runoff quality (Section 3.4.2). Basins require monitoring to ensure appropriate operation and functioning ensuring discharge sediment loads does not exceed 50 mg/L. Monitoring of sedimentation basins is to include:

- Weekly visual inspection:
  - Check basin structural integrity.
  - Check weir and outlet for signs of scour/failure.
  - Check basin geotextile liner (where possible) for tears.
  - Check sediment volume.

- In the event of basin overflow:
    - Compare overflow sample to prepared 50 mg/L reference sample for initial screening.
    - Collect water sample from overflow and laboratory analyse for TSS.
    - Samples to not exceed 50 mg/L.

Reference samples are to be prepared using local sediment at 50 mg/L. These reference samples are to be held onsite to allow site staff to assess the quality of overflowing water and allow immediate action in the event of excessive TSS loads. Laboratory samples are to be used to verify site references sample process.

Preliminary sedimentation basin management requirements are outlined in Attachment C. Requirements are to be confirmed at CC stage when detailed basin design is completed.

2.7 Groundwater Monitoring

2.7.1 Overview

Groundwater monitoring shall be completed from 8 wells as shown in Attachment D. Note 'GW1', 'GW3' and 'GW5' are existing wells installed by MA in 2011 that may, depending on condition and final location of stormwater treatment devices, be utilised for on-going monitoring. Where required, wells shall be installed by hand to protect surrounding sensitive environment.

2.7.2 Proposed Monitoring

Groundwater monitoring is to include both continuous and quarterly monitoring of groundwater levels and quality (Table 4) at locations GW1 – GW8 (Attachment D).

Table 4: Proposed groundwater monitoring requirements.

Element	Parameters	Frequency	Duration
Water level monitoring	Groundwater level	Continuous with data loggers, collected quarterly. Quarterly dip monitoring.	Pre development: 12 months. Construction: throughout. Operation: Minimum 3 years. Monitoring may cease on review of data by environmental engineer who shall confirm groundwater quality is consistently below trigger criteria (Section 2.7.3).
Water quality monitoring	pH EC Salinity DO TN TP	Quarterly sampling and laboratory testing.	

Monitoring is to be undertaken by a specialist approved by the Minister of DoPE in consultation with SCC and other relevant stakeholders. Site developer shall be responsible for funding.

2.7.3 Trigger Criteria

If groundwater quality results during construction or operation differs from pre development levels by +/- 10% or more for 2 consecutive sampling events further sampling and investigation of site water quality treatment measures shall be undertaken by a suitably quality environmental engineer.

2.8 Estuary Water Quality Monitoring

2.8.1 Overview

Estuary water quality monitoring is designed to fulfil monitoring requirements from a human health, oyster health and estuarine environment health perspective. It has been designed to complement existing monitoring completed by SCC and the oyster industry.

2.8.2 Existing Monitoring

Water quality within the Crookhaven estuary is routinely tested by local oyster farmers as part of industry requirements. As shown in Attachment A (Figure 2) a number of these sampling locations are in close proximity to the site.

NSW FA advises the following water sampling and testing regime is completed as part of the SQAP:

- Location '9' and '10' (Figure 2, Attachment A):
  - Parameters: salinity, temperature, faecal coliforms.

- Frequency: following rainfall events of > 20mm in 24 hours (minimum 5 per annum) and in the event of a sewage spill from the adjacent Shoalhaven Water STP or pump stations.

- Location '35' (Figure 2, Attachment A):
  - Parameter: phytoplankton.
  - Frequency: fortnightly.
- Oyster harvest/lease area (OL 76/092, OL 89/045, OL 67/287, OL 84/105):
  - Parameters: Biotoxins, turbidity, pH.
  - Frequency: monthly, increasing to weekly in the event of an algal bloom.

Water sampling is also completed routinely by SCC as follows:

- Sites '454', '455' and '456' (Figure 3, Attachment A):
  - Parameters: DO, faecal coliforms, TP, TN.

2.8.3 Proposed Monitoring

Based on recommendations of NSW FA and NSW OEH additional monitoring (Table 5) is required as part of the proposed development.

Table 5: Proposed estuary water quality monitoring requirements.

Location[1]	Parameters	Frequency	Duration
WQ 1, WQ2, WQ3[2]	Salinity Temperature Faecal coliforms[4]	Following rainfall events of > 20mm in 24 hours (minimum 5 per annum). In the event of a sewage spill from Shoalhaven Water STP and pump stations.	Pre development: 12 months (including minimum 2 samples collected during rainfall events generating site runoff i.e. 'adverse event' monitoring). Construction: throughout. Operation: Minimum 3 years. Monitoring may cease on review of data by an appropriately qualified environmental engineer in consultation with NSW OEH and NSW FA who shall confirm who should ensure that water quality is consistent with SQAP and SCC data .
WQ4[3]	pH EC TSS TN TP Heavy metals PAHs Chlorophyll a Turbidity Orthophosphate Salinity Temperature DO Faecal coliforms[4]	Monthly	

Note:

[1] See Attachment D.

[2] Monitoring from WQ1 – WQ3 designed to complement SQAP monitoring.

[3] Monitoring from WQ4 designed to complement SCC estuarine health monitoring.

[4] Where NSW FA or SCC require it, additional bacterial analytes will be tested to address source of bacterial contamination.

2.8.4 Additional Recommendations and Trigger Criteria

In accordance with NSW OEH requirements:

- Sampling is to be completed by a party approved by the Minister of DoPE in consultation with stakeholders. Site developer shall be responsible for funding.
- Water sampling and analysis of chlorophyll a and turbidity shall be completed in accordance with NSW OEH (2013) *'Assessing Estuary Ecosystem Health: Sampling, data analysis and reporting protocols'*.
- Analysis of all results should be completed in a statistically appropriate manner allowing determination of any impacts of the development.

- Should monitoring data results be inconsistent with wider monitoring strategy completed by SCC and NSW FA for 2 or more consecutive sampling events, further sampling and investigation of site water quality treatment measures shall be undertaken by a suitably quality environmental engineer in consultation with SCC and NSW FA.

2.9 Shellfish Monitoring

2.9.1 Existing Monitoring

Oysters within the Crookhaven estuary are routinely tested by NSW FA as part of SQAP requirements. Four sampling locations (Site 25: OL 76/092 and OL 89/045; Site 23:OL 67/287 and OL 84/105) are in close proximity to the site (Figure 2, Attachment A). According to NSW FA, the following testing regime is completed at each location:

- E.Coli following rainfall events of > 20mm in 24 hours (minimum 5 per annum) and in the event of sewage spill.
- Monitoring for the following parameters on a 3-yearly basis (last completed 2011) for the following parameters with stated PQLs:
  - Aluminium (PQL = 0.2mg/kg)
  - Arsenic (PQL = 0.4 mg/kg)
  - Cadmium (PQL = 0.05 mg/kg)
  - Copper (PQL = 0.05 mg/kg)
  - Lead (PQL = 0.15 mg/kg)
  - Mercury (PQL = 0.01 mg/kg)
  - Selenium (PQL = 0.5 mg/kg)
  - Zinc (PQL = 0.2 mg/kg)
  - OCP & OPP (PQL = 0.1 mg/kg)
  - PCBs (PQL = 0.01 mg/kg)
  - PAHs (PQL = 0.01 mg/kg)

2.9.2 Proposed Monitoring

Based on recommendations of NSW FA, the following additional monitoring is required as part of the proposed development (Table 6). Monitoring has been designed to form part of NSW FA SQAP sampling and shall be completed in accordance with program requirements.

Table 6: Proposed shellfish monitoring requirements.

Location[1]	Parameters	Frequency	Duration
SF1	E. Coli	Following rainfall events of > 20mm in 24 hours (minimum 5 per annum). In the event of a sewage spill from Shoalhaven Water STP and pump stations.	Pre development: 12 months (including minimum 2 samples collected during rainfall events generating site runoff i.e. 'adverse event' monitoring). Construction: throughout. Operation: Minimum 3 years. Monitoring requirements may be revised after this on review of data by an appropriately qualified environmental engineer against wider SQAP data in consultation with NSW OEH and NSW FA.
TBC[2]	Heavy metals OPP OCP PCBs PAHs	In conjunction with NSW FA local testing program on approximately 3 yearly cycle.	

Note:

[1] See Attachment D.

[2] Location to be adjacent to development and be confirmed by NSW FA at time of testing.

2.9.3 Additional Recommendations and Trigger Criteria

In accordance with NSW FA requirements:

- Shellfish sampling is to be completed by NSW FA or a party approved by the Minister of DoPE in consultation with relevant oyster farmers. Site developer shall be responsible for funding.
- Sampling is to be completed in conjunction with NSW FA local testing program on approximately 3 yearly cycle.
- Should shellfish monitoring results not comply with wider SQAP criteria and monitoring results, further sampling and investigation of site water quality treatment should be undertaken by a suitably qualified environmental engineer in consultation with SCC and NSW FA.

2.10 Secondary Indicator Monitoring

2.10.1 Proposed Monitoring

Secondary indicator monitoring is recommended to assist in documenting changes in the local environment over time and to indicate if SQIDs are not operating effectively and require further investigation. Secondary indicator monitoring shall involve visual inspection every 3 months in accordance with Table 8.

Table 7: Proposed secondary indicator monitoring.

Element	Locations	Comments
Weed monitoring	Bioretention basins Parkland wetland Infiltration systems Bioretention swales Within 7(a) zone foreshore area	An indicator of elevated levels of nutrients and environmental disturbance. Assess the extent of weeds compared to native vegetation. Where identified weed management should be undertaken by an appropriately qualified professional.
Scour and erosion monitoring	Inlets and outlets of: Bioretention basins Parkland wetland Infiltration systems Bioretention swales	Indicates flow is not being dissipated effectively. Presence and extent of erosion and scour should be noted on a site plan during visual inspection and remediated as required. Remediation may include revegetation, placement of rip-rap or re-design of outlet structures.
Sediment plumes or deposition	Site discharge locations Within SEPP 14 wetlands Inlets and outlets of: Bioretention basins Parkland wetland Infiltration systems Bioretention swales	May be an indicator of upstream erosion or SQID failure. Sediment plumes/deposits should be noted on a site plan and field measurements (such as area, depth and volume) made. Site contractor should organise inspection of SQIDs and outlet structures to determine the cause of sedimentation and remediation (if required). Stormwater management system may need to be revised to improve sediment removal or dispersion of flows (as relevant).
Receptor health monitoring	Riparian vegetation Groundcover vegetation Seagrass Mangrove SEPP 14 Wetlands	Overall health of receptors to be noted by way mapping native vegetation extent, vegetation composition (exotic vs native) and any dying/dead vegetation. If extent of dying/dead vegetation increases over a 6 month period an additional water quality sampling round should be completed as for WQ4 (Section 2.8.3). If required, the stormwater management system shall be revised.

Secondary indicator monitoring shall be completed for the following durations:

- Pre development: 12 months.
- Construction: throughout (see Section 3.4.11 for further detail).
- Operation: Minimum 1 year. Monitoring requirements may be revised after this by an appropriately qualified environmental engineer based on outcomes of monitoring. Any changes to monitoring frequency and duration must be approved by SCC.

2.10.2 Additional Requirements

- To support visual inspections, photographs should be taken at designated photo points (Attachment D) to assist in quantifying any noted impacts.
- Inspections to be undertaken by a specialist approved by the Minister of DoPE in consultation with SCC and other relevant stakeholders. Site developer shall be responsible for funding.
- Secondary indicator monitoring shall be completed in accordance with NSW DECCW (2010) *New South Wales Natural Resources: Monitoring, Evaluation and Reporting Strategy 2010 – 2015.*
- Should secondary indicator monitoring detect that SQIDs are potentially not operating at required efficiencies, further investigation including water quality sampling at SQIDs shall be undertaken.

2.11 SQID Monitoring

SQID monitoring is to be completed in accordance with Table 8.

Table 8: SQID monitoring requirements.

Element	Location[1]	Frequency	Monitoring Requirements
Roadside bioretention swales	All roadside bioswales	Quarterly	Visual Inspection: o Check all swales for debris (e.g litter, bark, mulch and leaf) accumulation. o Check all swales for dead/dying vegetation and weed growth. o Check for swale damage.
Bioretention basin	SQID 1	Quarterly	Visual Inspection: o Note any sediment accumulation. o Check for debris (e.g litter, bark, mulch and leaf) accumulation. o Note dead/dying vegetation and weed growth. o Check for vandalism or system damage. o Check outlet for signs of erosion, scour and for sediment/debris accumulation.
Constructed parkland wetland	SQID 2	Quarterly	Visual Inspection: o Note any sediment accumulation. o Check for debris (e.g litter, bark, mulch and leaf) accumulation. o Note dead/dying vegetation and weed growth. o Check for vandalism or system damage. o Check outlet for signs of erosion, scour and for sediment/debris accumulation. o Observe flow patterns to identify any uneven flow distribution.
Infiltration Systems	SQID 3 – SQID 6	Quarterly	Visual Inspection: o Note any sediment accumulation. o Check for debris (e.g litter, bark, mulch and leaf) accumulation. o Note dead/dying vegetation and weed growth. o Check for vandalism or system damage. o Check outlet for signs of erosion, scour and for sediment/debris accumulation. o Observe flow patterns to identify any uneven flow distribution. o Check for excessive ponding/long term retention of water which may indicate infiltration capacity has reduced to media siltation.
SFEP	All devices	Monthly	Visual Inspection: o Check for litter/debris/sediment accumulation. o Check for vandalism or system damage. o Any other monitoring as required by manufacturer.

Note:

[1] Attachment D.

In accordance with NSW OEH requirements (May 9, 2014) the following monitoring is required in addition to that outlined in Table 8:

- Hydraulic conductivity of filter media and duration of inundation in bioremediation basin shall be monitored by approved party at SQID 1. We recommend this is completed every 6 months.

- Hydraulic conductivity of filter media and duration of inundation in swales shall be monitored at locations nominated by approved party at time of monitoring. We recommend this is completed every 6 months.

- Monitoring in Table 8 should also be completed for six wet weather events annually.

2.11.1 Additional Requirements and Trigger Criteria

- Inspections to be undertaken by a specialist approved by SCC. Site developer shall be responsible for funding.

- SFEP routine maintenance shall be completed in accordance with manufacturer's requirements and as per developer agreement with SCC.

- Visual inspection to be completed by a specialist approved by SCC who shall report results together with details of any completed/planned remedial works to SCC every 6 months.

- Any minor issues detected during visual inspection (sediment accumulation, dead/dying vegetation, debris accumulation) shall be remediated as required.

- Any major issues detected during visual inspection (vandalism, structural failure, system failure, illegal dumping) shall be reported immediately to SCC and any other relevant authority for immediate action.

- Operation of SQIDs to be certified every 5 years.

- In the event that secondary indicator monitoring indicates SQIDs are not operating effectively, visual inspection is to be supported by water quality sampling. Sampling is to be completed by a specialist approved by the Minister of DoPE in consultation with SCC and other relevant stakeholders.

- Preliminary SQID maintenance requirements are provided in Attachment C.

- A SQID Management Plan is to be prepared at CC stage once device specification, design and location are confirmed. It shall ensure that treatment measures required as part of WCMR (MA, 2016a) continue to provide to treat to site stormwater runoff to comply with water quality objectives, SEPP 62 and OISAS. This plan should detail:
    - SQID inspection, monitoring and maintenance schedule.
    - SQID maintenance requirements and maintenance responsibilities.
    - Details periodic maintenance of site landscaped areas including management of vegetation, walkways, removal of litter etc.
    - Detail periodic maintenance of 7(a) buffer and foreshore area.

2.12 Reporting

It is recommended that the results of water quality monitoring be documented in 6-monthly report (starting on commencement of construction works). Report to be provided to NSW DoPE, NSW OEH, NSW FA and SCC. Documentation shall be prepared by a professional approved by the Minister of DoPE in consultation with stakeholders and shall include:

- Results of all water quality monitoring completed within the 6 months.
- A comparison of water quality results with collected baseline monitoring results and results from previous construction/operation monitoring period.
- Summary of weather conditions, including rainfall, during the reporting period.
- Outline of any remediation works completed within the reporting period (e.g. modifications to SQIDs, revegetation works).
- Documentation of any contamination events (e.g. spills, erosion events, vandalism, illegal dumping).
- Recommendations for future monitoring.

When water quality monitoring is considered to be no longer required, a final report shall be prepared and issued to SCC, NSW OEH, NSW FA

and NSW DoPE summarising the above and providing justification as to why the water quality monitoring program is no longer required.

It is intended that NSW FA shall, as they consider appropriate, make available results of monitoring as data is developed. This information may be made available through an industry portal or through other means as acceptable to NSW FA.

2.13 Contingencies and Program Review

Attachment C provides contingencies in the event that trigger criteria are exceeded or environmental impact resulting from water quality is detected.

In the event that water quality impacts are identified during the construction phase, site works must cease pending assessment by an appropriately qualified environment professional and revision of site SEC (Section 3) as required. Once operational, any potential impacts detected may require further investigation including inspection, supplementary sampling and laboratory testing and revision of the site stormwater treatment train if required. The water quality monitoring program for individual monitoring elements shall be reviewed and revised as required.

It is intended that this WQMP be maintained as a living document and be updated in consultation with the stakeholders. Review of the WQMP shall be undertaken annually in response to the findings of the monitoring for the year prior. Amendments to the plan shall be made and, once approved by the project's consent authority, implemented as required.

Various elements of the monitoring plan proposed are intended to cease or be reviewed once development is "completed". As it is common for some lots within a development not to be built on for extended periods of time it was agreed, in consultation with stakeholders, that the development or stages thereof shall be "complete" once 70 % of lots are built upon and the remainder are grassed.

3 Sediment and Erosion Control Plan

3.1 Management Principles

This SECP has been prepared in accordance with the design guidelines provided in *Managing Urban Stormwater, Soils and Construction Volume* 1, 4th Edition (Landcom, 2004). It reflects current best management practices to mitigate the overall impact of the development during the construction phase. The following principles will apply to all areas and stages of the construction program:

1. Minimise extent of ground disturbance.
2. Implement erosion control strategies to prevent generation of sediment.
3. Implement sediment control strategies to prevent off-site pollution.
4. Progressive stabilisation following completion of each work area.
5. Monitoring of controls and strategies including maintenance requirements.

3.2 Engineering Plans

Concept engineering plans containing relevant erosion control measures are provided in Attachment E. These plans should be referred to for the location and detailed design of sediment and erosion control measures detailed in Section 3.3.

3.3 Staging

The proposed development will be constructed in 5 stages. This SECP is therefore provided as an outline only and shall be refined during subsequent stage consents and CCs.

A water quality assessment of each stage of development has been completed as part of the WCMP (MA, 2016a). This document should be read in conjunction with this SECP.

3.4 Sediment and Erosion Control Measures

3.4.1 Overview

Sediment and erosion control structures have been designed and located in accordance with Landcom (2004). It has been agreed by BMT WBM (acting as DoPEs peer reviewer) that this is the appropriate means for treating construction site runoff and adequately mitigates construction site water quality effects. Measures shall be installed prior to commencement of any upslope construction works and remain in place until the upslope catchment is stabilised.

3.4.2 Sediment Detention Basins

Nine sediment detention basins are required to manage site runoff during the staged site construction. Basins have been located where water quality features (basins, wetlands etc.) are proposed for the ultimate development (Attachment E).

Sediment detention basins have been sized (Table 9) in accordance with Section 6.3.4 of Landcom (2004) and based on soil properties of the Greenwell Point soil landscape. Attachment F provides the basin sizing calculations sheet adopted from Landcom (2004).

Table 9: Sediment basin minimum design requirements.

Element	Basin 1/1	Basin 2/1	Basin 2/2	Basin 2/3	Basin 3/1	Basin 3/2	Basin 3/3	Basin 4/1	Basin 5/1
Storage Zone Volume (soil) (m^3)	118	369	283	24	598	75	29	1134	68
Settling Zone Volume (water) (m^3)	2,517	2,198	1,926	217	3,836	774	1,245	5,387	1,377
Basin Total Volume (m^3)	2,635	2,567	2,209	241	4,434	849	1,274	6,521	1,445

Detailed design of the sedimentation basins shall be undertaken in accordance with Landcom (2004) for 'Type F' basins. At a minimum, basins should have a settling zone depth of 600mm, a length/width ratio of 3:1 (Landcom, 2004), and include the following elements:

- Inlet rip-rap protection – to minimise erosion at the basin inlets.
- Internal flow baffles – to ensure even distribution of flow and maximise treatment time prior to discharge.
- Rip-rap outlet structure – to provide controlled discharge into wetland areas and minimise localised erosion and scour.

- Weir and spillway – to be designed to carry the 1 in 10 year ARI event.
- 'Full of Sediment' marker – to denote with sediment storage zone needs to be cleared.

Other sedimentation basin management details are provided in the risk assessment (Attachment C). Sedimentation basin monitoring is outlined in Section 3.4.11.

3.4.3 Earth Diversion Bunds

Earth diversion bunds are used across the site to temporarily divert water from construction areas to sediment detention basins for treatment. Bunds are to include suitably sized outlets to prevent erosion and scour.

Construction of all earth diversion bunds is to be in accordance with Landcom (2004) and in particular Figure SD 5-5.

Locations of bunds are provided in Attachment E.

3.4.4 Sediment Fences

Locations of all sediment fences are provided in Attachment E. They have been placed downstream of construction areas whose runoff is not directed to sediment basins by diversion bunds.

Installation should be in accordance with Figure SD 6-36 of Landcom (2004).

3.4.5 Energy Dissipaters

Energy dissipation structures are required at each of the sediment basin outlets and earth diversion bund outlets to ensure erosion, scour and sedimentation of downslope receiving environments does not occur. Construction shall be in accordance with Landcom (2004) Figure SD 5-8.

Location of each energy dissipater and specifications are provided in Attachment E.

3.4.6 Stabilised Site Entry

A number of stabilised site entrances shall be provided (Attachment E). All construction traffic shall enter and exit through these stabilised entrances which shall include the following:

1. A metal sediment shaker pad located within the site.

2. A minimum 15m long coarse gravel (minimum 75mm aggregate) bed, overlying a geotextile and adjoining the metal sediment shaker. All construction traffic shall exit over the gravel and then over the metal sediment shaker. Construction shall be in accordance with Section 6.3.9 and Figure SD 6-14 of Landcom (2004).

3.4.7 Stockpile Locations

Each stage of construction is to have a nominated stockpile area for:

1. Materials delivered to the site.

2. Spoil from earthworks.

Stockpile requirements are summarised as follows:

- Where required due to the nature of the stockpiled material, stockpile areas are to be lined with an impermeable plastic.

- Stockpiles are to be regularly watered down to prevent movement of sediment and stabilised where possible with quick growing grass.

- Sediment fences are to be installed downslope of stockpile areas to prevent migration of sediments.

- Earth diversion bunds shall be constructed upslope of stockpile areas to divert runoff around the area.

- Stockpiles are not to be located along drainage lines or in areas of concentrated flow.

Suggested stockpile locations are provided in Attachment E. Construction should be in accordance with Figure SD 4-1 of Landcom (2004).

3.4.8 Works South of Culburra Road

In accordance with NSW OEH requirements, all works to the south of Culburra Road (naturally draining south to Lake Wollumboola) shall have runoff diverted towards the north throughout the construction phase. Runoff diversion shall be undertaken using drainage trenches and diversion bunds installed prior to clearing of vegetation and commencement of site works.

3.4.9 Cycleway

A cycleway/pedestrian pathway is proposed within the 7(a) zone to encourage low impact, passive recreational use of the area. As shown in Attachment E, filter fencing shall be installed immediately downslope of the cycleway prior to construction and remain in place until works are complete and the area is stabilised.

Works within this area are to be completed by machinery with a low disturbance footprint and, where required, by hand.

3.4.10 Revegetation

As works are progressively completed across the site, areas with exposed soil shall be revegetated with quick growing grasses. Rapid application and establishment measures should be utilised.

3.4.11 Monitoring

<u>Sedimentation Basins</u>

Monitoring of sedimentation basin waters shall be undertaken in accordance with Attachment C and as follows.

- Weekly visual inspection:
  - Check basin structural integrity.
  - Check weir and outlet for signs of scour/failure.
  - Check basin geotextile liner (where possible) for tears.
  - Check sediment volume.

- In the event of basin overflow:
    - Compare overflow sample to prepared 50 mg/L reference sample for initial screening.
    - Collect water sample from overflow and laboratory analyse for TSS.
    - Samples to not exceed 50 mg/L.

Reference samples are to be prepared using local sediment at 50 mg/L. These reference samples are to be held onsite to allow site staff to assess the quality of overflowing water and allow immediate action in the event of excessive TSS loads. Laboratory samples are to be used to verify site references sample process.

Where adverse impacts are observed additional measures shall be put in place to limit the discharge of sediments from the site to the estuary. Where required, this should include flocculation of basin water.

Secondary Indicator Monitoring

Secondary indicator monitoring, as outlined in Table 7, shall be completed during the construction phase of development. Monitoring of weed extent, scour and erosion, sedimentation, and receptor environments (riparian vegetation, groundcover vegetation, seagrass, mangrove, SEPP 14 wetlands) health shall be monitored every 3 months for the following SEC elements:

- Sedimentation basins.
- Earth diversion bunds.
- Stabilised site access.
- Sediment fences.
- Energy dissipaters.
- Cycleway construction area.
- Revegetation areas.

The construction contractor shall be made aware of any impacts identified during monitoring and remedial works undertaken as required.

4 References

Landcom (2004) *Soils and Construction Handbook.*

NSW DECCW (2010) *New South Wales Natural Resources: Monitoring, Evaluation and Reporting Strategy 2010 - 2015*

NSW DPI (2006) *NSW Oyster Industry Sustainable Aquaculture Strategy* (OISAS).

NSW OEH (2013) *'Assessing Estuary Ecosystem Health: Sampling, data analysis and reporting protocols'*

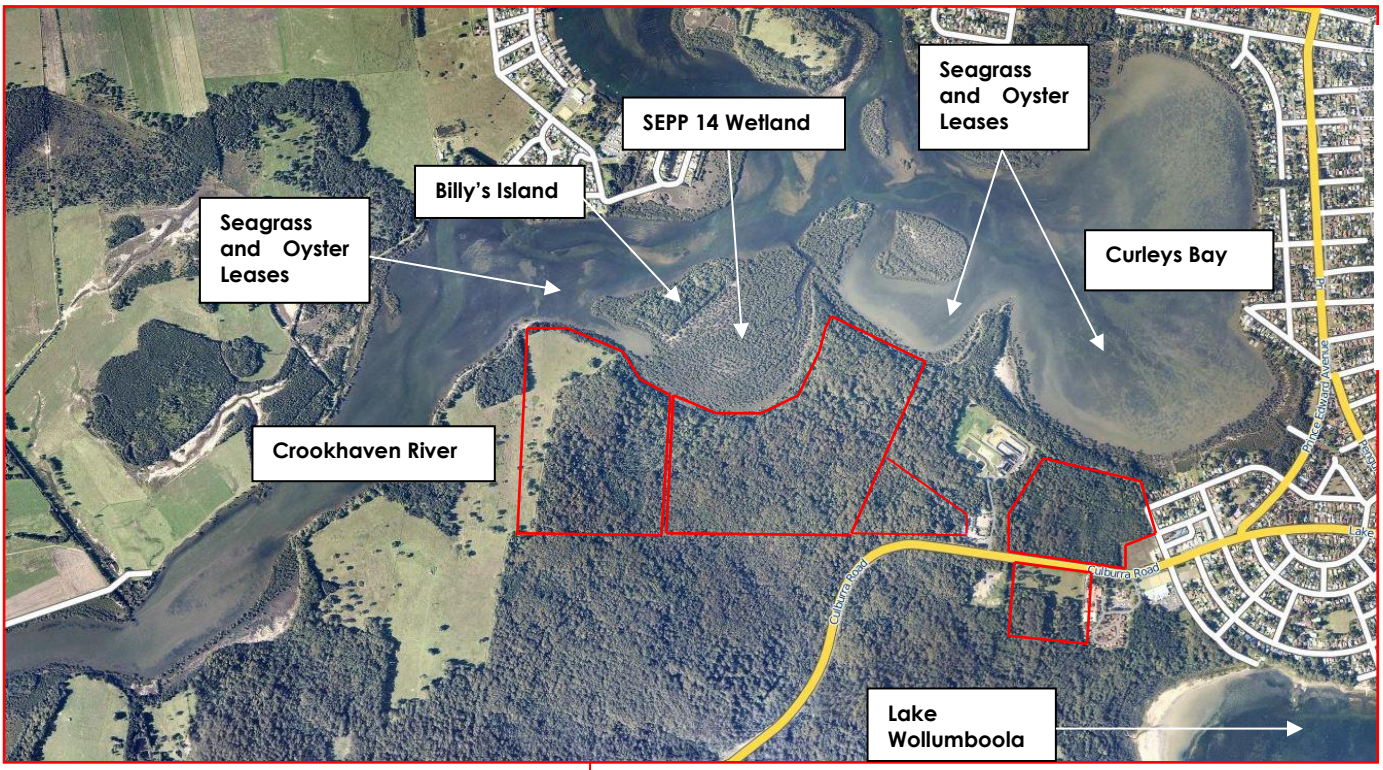
Martens and Associates (July, 2016a) *Water Cycle Management Report* (Ref: P1203365JR01V07)

Martens and Associates (July, 2016b) *Estuarine Management Study* (Ref: P1203365JR02V04)

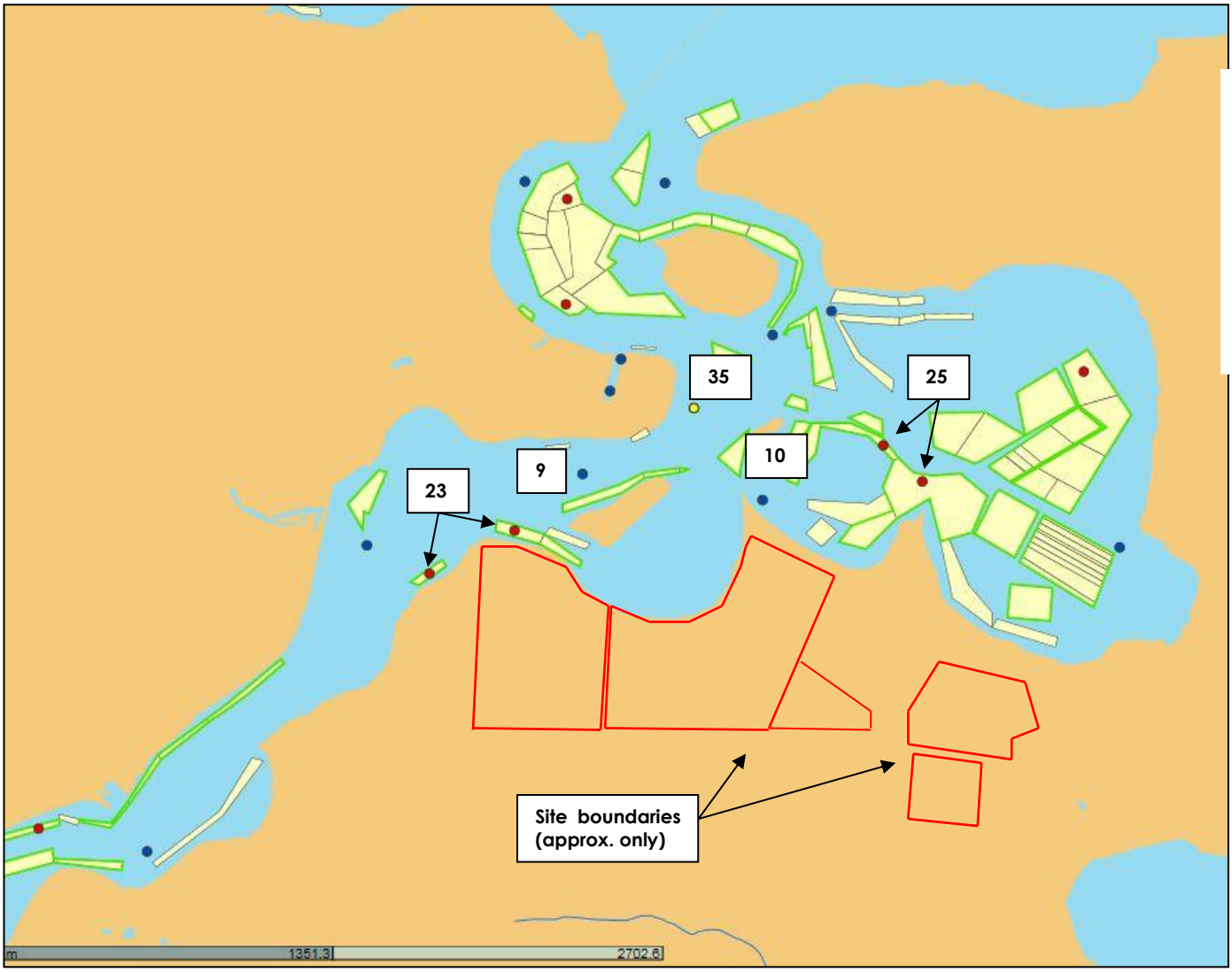
SEPP 62 (2011) *Sustainable Aquaculture.*

SLR (2013) *Culburra West Urban Development Project Culburra Beach: Ecological and Riparian Issues and Assessment Report*.

5 Attachment A - Figures



Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	MLK	**Site Locality and Regional Context**	**FIGURE 1**
Approved:	AN		
Date:	16.07.2014		
Scale:	NA		Job No: P1203365



NSW Food Authority Shellfish Quality Assurance Program (SQAP)

NSW SQAP Phytoplankton

NSW SQAP Bacteriological

SampleType

Shellfish

Water incl. bacteriological

NSW SQAP Heavy Metal sites

NSW DPI Fisheries

Oyster Industry Sustainable Aquaculture Strategy

OISAS category

Current leased area in National Park Estate

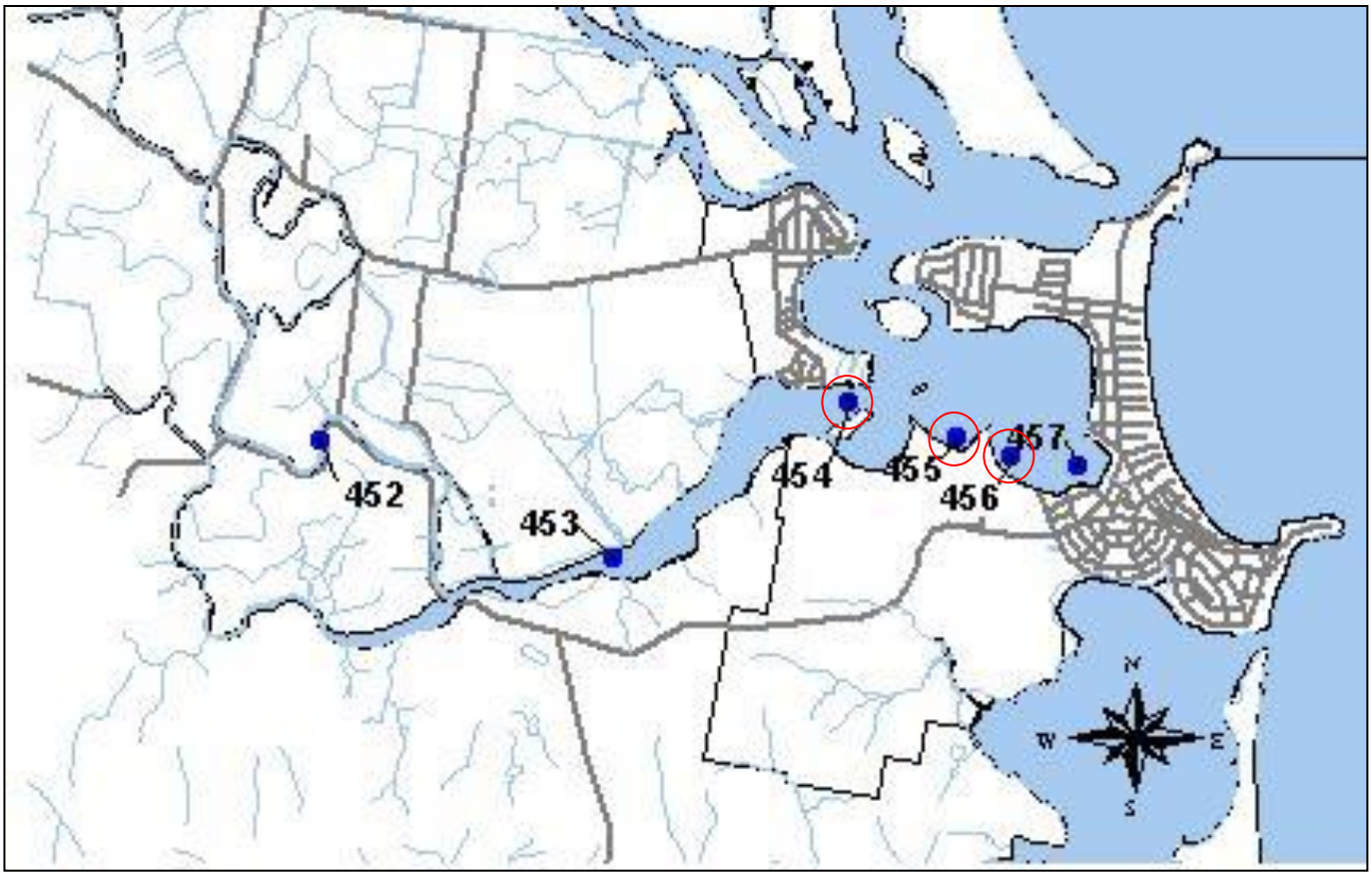
Current oyster Aquaculture leases to be phase out

Priority oyster aquaculture area

Aquaculture Leases

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	MLK	**Crookhaven Water, Shellfish, Phytoplankton Sample Sites**	**FIGURE 2**
Approved:	AN		
Date:	07.07.2014		
Scale:	As above		Job No: P1203365

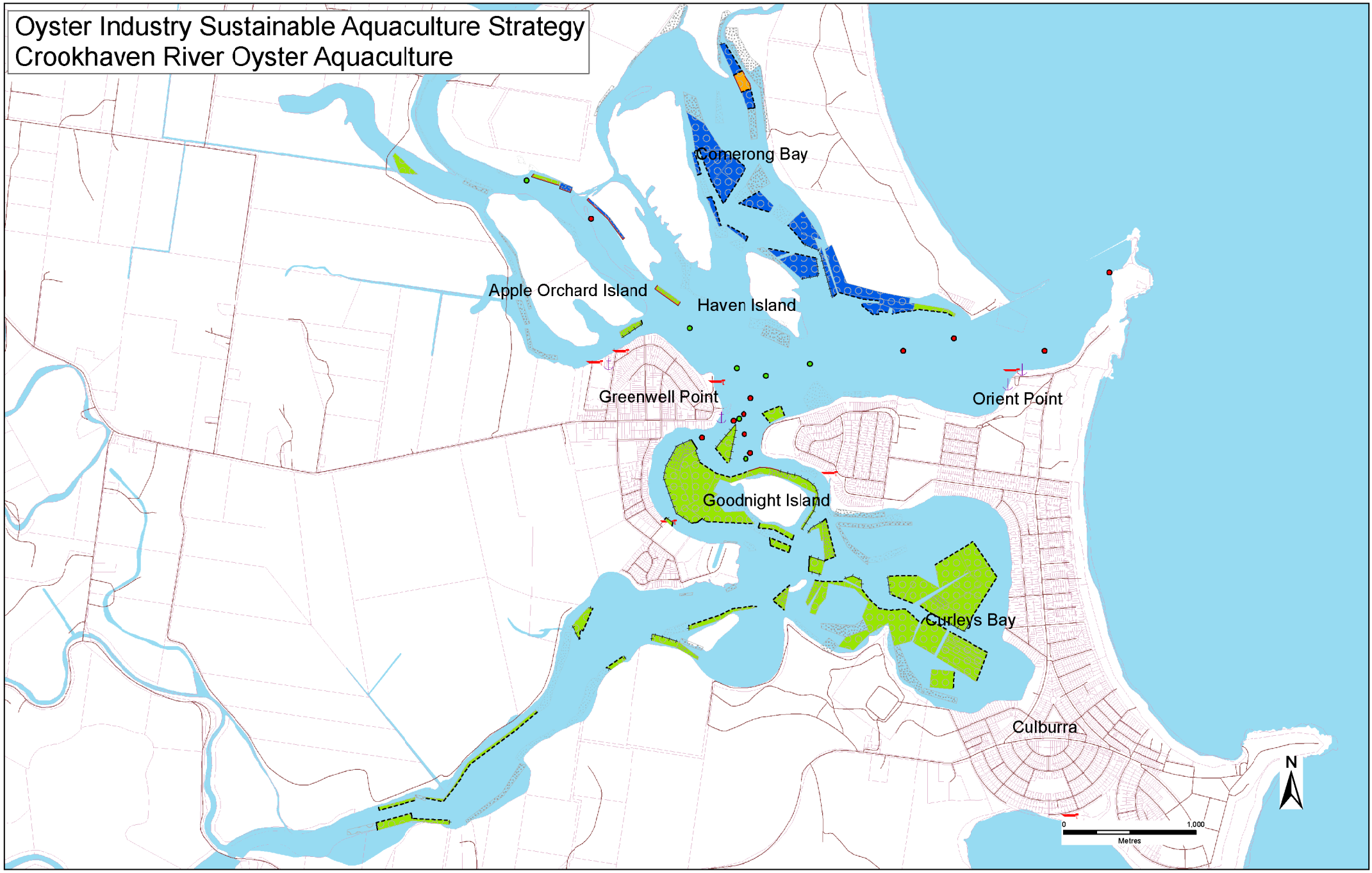
martens



Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	MLK	**Crookhaven River: Shoalhaven City Council Monitoring Locations**	**FIGURE 3**
Approved:	AN		
Date:	07.07.2014		
Scale:	NA		Job No: P1203365

6 Attachment B – OISAS Crookhaven River Oyster Aquaculture

Oyster Industry Sustainable Aquaculture Strategy
Crookhaven River Oyster Aquaculture



Legend

- Priority oyster aquaculture areas
- Current oyster aquaculture leases to be phased out
- Current leased area in National Park Estate
- Leases within Marine Park Boundaries
- Current leasec area within Merimbula Airport Jurisdiction

Minimum Lease Marker post intervals

- 10 metre intervals
- 25 metre intervals
- 50 metre intervals
- Special navigation and marking condition

All other boundaries 100 metre intervals

- Former leases
- Current leases
- Cadastral boundaries (shorelines are indicative only)
- Roads

- Launching ramp
- Marina or boatshed
- Public wharf
- Port marker
- Starboard marker

NSW DEPARTMENT OF PRIMARY INDUSTRIES

August 2006

Source: data from the Department of Lands, NSW DPI, NPWS, and NSW Maritime Authority
Datum: Geocentric Datum of Australia (GDA)
Grid: Mapping Grid of Australia (MGA94)

Prepared by GIS section, Aquaculture Management Branch, Division of Agriculture & Fisheries, NSW DPI.

7 Attachment C – Risk Assessment

Risk Assessment						Management and Contingency	Monitoring Requirements (details provided in WQMP, Martens, 2016)					
Treatment Element	Water Quality Hazard	General Comment	Likelihood	Consequence	Risk	Management Requirement: Contingency Requirement:	Sediment Basin Water Quality (Section 2.6)	Groundwater Quality (Section 2.7)	Estuary Water Quality (Section 2.8)	Shellfish (Section 2.9)	Secondary Indicator (Section 2.10)	SQID (Section 2.11)
Sedimentation Basins (construction phase only)	**Untreated/under-treated water leaves basin**	This could occur through: incorrect sizing of basin, weir or highflow bypass; excessive sediment accumuation; high flow events; poor construction; poor maintenance or poor site management.	3	B	**Medium**	Basin to be sized in accordance with WQMP (MA, 2016) and signed off after construction by MA engineer. Basin to be managed and maintained by contractor in accordance with Landcom (2004). Basin to include 'full of sediment' marker and cleared of sediment as required. Water in basin to be pumped dry every 5 days after rain. Monitoring required. If water sampling results indicate TSS exceeds 50 mg/L flocculation is to be undertaken. Further investigation is to be completed by contractor to ensure basin is operating effectively.	X		X	X	X	
	Structural failure	This could occur through: poor construction; incorrect sizing; extreme weather events.	4	B	**Low**	No management requirements In the unlikely event of failure, the structure shall be re-built and all similar structures inspected to confirm adequacy.						
	Erosion scour at outlet	This could occur through over design flow or poor construction.	3	B	**Medium**	Outlets to be sized and designed in accordance with Landcom (2004) and signed off after construction by MA engineer. Monitoring required. Where observed, scour to be repaired with rip-rap or revegetation. Other similar structures are to be inspected and modified as required.	X				X	
	Vandalism	There is potential for vandalism to result in damage to sedimentation basins .	4	B	**Low**	No management requirements Vandalism to be repaired as required.						
Roadside Bioretention Swales	**Structural failure**	This could occur through: poor construction; incorrect sizing; extreme weather events; vandalism.	4	B	**Low**	No management requirements In the unlikely event of failure, the structure shall be re-built and all similar structures inspected to confirm adequacy.						
	Damage	This could occur through: poor construction; vehicles or vandalism.	3	B	**Medium**	Swales to be signed off after construction by MA hydraulic engineer. Operation to be certified every 5 years. Monitoring required to identify damage and allow rectification. Any damage noted during inspection or reported between inspections shall be reported and repaired as required by suitably qualified professional. Additional access controls to be added where damage by vehicles occurs.						X
	Poor vegetation growth/death	This could occur through: inappropriate plant selection; physical removal or damage; sediment accumulation; poor maintenance.	3	B	**Medium**	Initial planting to be undertaken by suitably qualified professional. Operation to be certified every 5 years. Excess sediment to be cleared as part of routine maintenance. Monitoring required. Any damaged/dead/removed vegetation to be reported and replaced following inspection. Ongoing plant growth issues are to be further investigated by appropriately qualified professional.						X
	Untreated/under-treated water discharging swale or infiltrates into groundwater	This could occur through: incorrect sizing of outlet or highflow bypass; excessive sediment accumuation; filter media deterioration; blocked subsurface drain; high flow events; poor vegetation growth; poor construction.	3	C	**Medium**	Swales to be constructed by suitably qualified professional and signed off by MA engineer. Swale and filter media specifications are to comply with WCMP (Martens, 2016). Operation to be certified every 5 years. Monitoring required. Should SQID or secondary indicator monitoring indicate bioswales are not operating effectively, additional visual inspection supported by water quality sampling is to be undertaken by suitably qualified professional. Remedial action such as filter media replacement, vegetation replacement and sediment removal should be investigated.		X			X	X

Risk Assessment						Management and Contingency	Monitoring Requirements (details provided in WQMP, Martens, 2016)					
Treatment Element	Water Quality Hazard	General Comment	Likelihood	Consequence	Risk	Management Requirement: Contingency Requirement:	Sediment Basin Water Quality (Section 2.6)	Groundwater Quality (Section 2.7)	Estuary Water Quality (Section 2.8)	Shellfish (Section 2.9)	Secondary Indicator (Section 2.10)	SQID (Section 2.11)
SFEP Treatment Train	**Damage**	This could occur through: incorrect installation; vehicles or vandalism.	3	B	**Medium**	SFEP system to be appropriately installed by appropriately qualified professional and signed off by MA engineer. Operation to be certified in accordance with manufacturers specifications. Monitoring required to identify damage and allow rectification. Any damage noted during inspection or reported between inspections shall be reported and repaired as required by suitably qualified professional. Additional access controls to be added where damage by vehicles occurs.						X
	System failure	This could occur through:poor maintenance; incorrect sizing; incorrect installation; part failure.	3	C	**Medium**	SFEP system to be sized and installed by appropriately qualified professional and signed off by MA engineer. Operation to be certified in accordance with manufacturers specifications. Maintenance to be completed in line with manufactuers requirements. Monitoring required. Emergency maintenance/replacement of system components to take place as required by suitably qualified professional. Ongoing failure is to be further investigated and monitoring/maintenance reviewed as required.						X
	Untreated/under-treated water discharging system	This could occur through: incorrect sizing; sediment/debris/gross pollutant accumuation; poor maintenance; blockages; high flow events; incorrect installation.	3	C	**Medium**	SFEP system to be sized and installed by appropriately qualified professional and signed off by MA engineer. Operation to be certified in accordance with manufacturers specifications. Maintenance to be completed in line with manufactuers requirements. Monitoring required. Should SQID or secondary indicator monitoring indicate SFEP devices are not operating effectively, additional visual inspection supported by water quality sampling is to be undertaken by suitably qualified professional. Remedial action (part replacement, maintenance, repair, system redesign) investigated and undertaken as required.					X	X
Bioretention Basins/Constructed Wetlands	**Structural failure**	This could occur through: poor construction; incorrect sizing; extreme weather events; vandalism.	4	B	**Low**	No management requirements In the unlikely event of failure, the structure shall be re-built and all similar structures inspected to confirm adequacy.						
	Damage	This could occur through vehicles or vandalism.	3	B	**Medium**	Basins/wetland be signed off after construction by MA engineer. Operation to be certified every 5 years. Access to basin/wetland to be restricted. Monitoring required to identify damage and allow rectification. Any damage noted during inspection or reported between inspections shall be reported and repaired as required by suitably qualified professional. Additional access controls to be added where damage by vehicles occurs.						X
	Poor vegetation growth/death	This could occur through inappropriate plant selection, physical removal or damage, sediment accumulation; poor maintenance.	3	B	**Medium**	Initial planting to be undertaken by suitably qualified professional. Operation to be certified every 5 years. Sediment to be cleared from base of wetland/basin annually to maintain basin invert. Monitoring required. Any damaged/dead/removed vegetation to be reported and replaced following inspection. Ongoing plant growth issues are to be further investigated by appropriately qualified professional.						X
	Untreated/under-treated water discharging basin/wetland or infiltrates into groundwater	This could occur through: incorrect sizing of outlet or highflow bypass; excessive sediment accumuation; blocked subsurface drain; high flow events; poor vegetation growth; poor construction.	3	C	**Medium**	Basin/wetland to be constructed by suitably qualified professional and signed off by MA engineer. Basin/wetland and filter media specifications are to comply with WCMP (Martens, 2016). Operation to be certified every 5 years. Sediment to be cleared from base of wetland/basin annually to maintain basin invert. Monitoring required. Should SQID or secondary indicator monitoring indicate basin/wetland is not operating effectively, additional visual inspection supported by water quality sampling is to be undertaken by suitably qualified professional. Should estuarine and shellfish monitoring results be non-compliant with wider monitoring strategies undertaken by Council and NSW Food Authority, functioning of basin to be further investigated. If groundwater quality differs from pre development levels by +/- 10% or more for 2 sampling events further investigation required.		X	X	X	X	X
	Erosion scour at outlet	This could occur through over design flow or poor construction.	3	B	**Medium**	Outlets to be sized and designed in accordance with Landcom (2004) and signed off after construction by MA engineer. Monitoring required. Where observed, scour to be repaired with rip-rap or revegetation. Other similar structures are to be inspected and modified as required.					X	X
	Illegal dumping	Illegal dumping of pollutants (e.g. chemicals, fuel, asbestos, rubbish) into basin/wetland	4	D	**High**	Access is to be restricted. Signage to be included around wetland/basin detailing penalty for illegal dumping. Monitoring required. Any illegal dumping reported/detected should be remediated as soon as possible. If contamination presents a risk to human health or more than a short term, localised environmental impact, relevant authorities should be notified (e.g. SCC, NSW OEH, NSW FA, Fisheries).						X

Risk Assessment						Management and Contingency	Monitoring Requirements (details provided in WQMP, Martens, 2016)					
Treatment Element	**Water Quality Hazard**	**General Comment**	**Likelihood**	**Consequence**	**Risk**	**Management Requirement:** **Contingency Requirement:**	**Sediment Basin Water Quality (Section 2.6)**	**Groundwater Quality (Section 2.7)**	**Estuary Water Quality (Section 2.8)**	**Shellfish (Section 2.9)**	**Secondary Indicator (Section 2.10)**	**SQID (Section 2.11)**
Infiltration Systems	**Structural failure**	This could occur through: poor construction; incorrect sizing; extreme weather events; vandalism.	4	B	**Low**	No management requirements In the unlikely event of failure, the structure shall be re-built and all similar structures inspected to confirm adequacy.						
	Damage	This could occur through vehicles or vandalism.	3	B	**Medium**	Infiltration system to be constructed by appropriately qualified professional and signed off by MA engineer. Operation to be certified every 5 years. Access to be restricted. Monitoring required to identify damage and allow rectification. Any damage noted during inspection or reported between inspections shall be repaired as required by suitably qualified professional.						X
	Poor vegetation growth/death	This could occur through inappropriate plant selection, physical removal or damage, sediment accumulation; poor maintenance.	3	B	**Medium**	Initial planting to be undertaken by suitably qualified professional. Operation to be certified every 5 years. Sediment to be cleared from base of wetland/basin annually to maintain basin invert. Monitoring required. Any damaged/dead/removed vegetation to be reported and replaced following inspection. Ongoing plant growth issues are to be further investigated by appropriately qualified professional.						X
	Untreated/under-treated water discharging system or infiltrates into groundwater	This could occur through: incorrect sizing of outlet or highflow bypass; excessive sediment accumuation; filter media deterioration; blocked subsurface drain; high flow events; poor vegetation growth; poor construction.	3	C	**Medium**	System to be constructed by suitably qualified professional and signed off by MA engineer. System and filter media specifications are to comply with WCMP (Martens, 2016). Operation to be certified every 5 years. Monitoring required. Should SQID or secondary indicator monitoring indicate infiltration systems are not operating effectively, additional visual inspection supported by water quality sampling is to be undertaken by suitably qualified professional. Should estuarine and shellfish monitoring results be non-compliant with wider monitoring strategies undertaken by Council and NSW Food Authority, functioning of basin/wetland to be further investigated. If groundwater quality differs from pre development levels by +/- 10% or more for 2 sampling events further investigation required.		X	X	X	X	X
	Erosion scour at outlet	This could occur through over design flow or poor construction.	3	B	**Medium**	Outlets to be sized and designed in accordance with Landcom (2004) and signed off after construction by MA engineer. Monitoring required. Where observed, scour to be repaired with rip-rap or revegetation. Other similar structures are to be inspected and modified as required.					X	X
	Illegal dumping	Illegal dumping of pollutants (e.g. chemicals, fuel, asbestos, rubbish) into basin/wetland	4	D	**High**	Access is to be restricted. Signage to be included around foreshore area detailing penalty for illegal dumping. Monitoring required. Any illegal dumping reported/detected should be remediated as soon as possible. If contamination presents a risk to human health or more than a short term, localised environmental impact, relevant authorities should be notified (e.g. SCC, NSW OEH, NSW FA, Fisheries).						X

8 Attachment D – Water Quality Monitoring Plan

KEY

- 7(a) ZONE BOUNDARY
- GW1 GROUNDWATER MONITORING LOCATION
- WQ1 WATER QUALITY MONITORING LOCATION
- SF1 SHELLFISH MONITORING LOCATION
- PP1 PHOTO POINT LOCATION
- SQID 1 SQID MONITORING LOCATION
- PROPOSED PARKLAND WETLAND LOCATION
- PROPOSED INFILTRATION SYSTEM
- PROPOSED BIORETENTION BASIN LOCATION
- APPROX SEPP14 WETLAND EXTENT
- PROPOSED CYCLEWAY

N W E S

CROOKHAVEN ESTUARY

BILLYS ISLAND

WQ4 WQ2 WQ1 WQ3 SF1

PP 11 GW1 SQID 3 PP 10 PP 9 PP 4 SQID 5 PP 5 GW5 PP 6 SQID 4 PP 7 GW2 PP 8 SQID 1 SQID 6 PP 3 PP 2 GW6 PP 1 GW3 GW7 PP 14 PP 12 PP 13 SQID 2 GW4 GW8 PP 15

(PDR 6) 61 DP 755971 (PDR 81) 81 DP 755971 7 DP 1065111 DP 1065111 DP 1065111 DP 1065111 DP 227179 4 DP 631825 6 DP 825697 12 DP 788445 7 DP 825697

PM 73996 FD PM 62367 FD

CULBURRA ROAD

PAGE BAR SCALE

0 80 160 240 320 400

UNITS – METRES

SCALE – 1:4000 @ A1 1:8000 @ A3

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CLIENT/ PROJECT: THE HALLORAN TRUST

TITLE: WATER QUALITY MONITORING PLAN
MIXED USE SUBDIVISION – WEST CULBURRA, NSW

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in mm unless otherwise specified.

PROJECT MANAGER: ANDREW NORRIS

DRAWING NUMBER: P1203365JD01V10

DESIGNED:	DATUM:	SHEET
MLK	mAHD	SK210
DRAWN: KT	HORIZONTAL RATIO: 1:4000 @ A1 1:8000 @ A3	
REVIEWED: AN	VERTICAL RATIO: 1:4000 @ A1 1:8000 @ A3	PAPER SIZE: A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	FINAL	3.11.2016	AN

9 Attachment E - Sediment and Erosion Control Plan

KEY

- RIDGE DIVIDING CROOKHAVEN AND LAKE WOLLUMBOULA CATCHMENT
- 7(a) ZONE BOUNDARY
- STAGE BOUNDARY
- — F — F — FILTER FENCE
- — D — D — EARTH DIVERSION BUND
- SEDIMENT BASIN (FOOTPRINT APPROXIMATE)
- STABILISED SITE ACCESS
- ENERGY DISSIPATER
- STOCKPILE AND MATERIALS DELIVERY POINT

CROOKHAVEN ESTUARY

Element	Basin 1/1	Basin 2/1	Basin 2/2	Basin 2/3	Basin 3/1	Basin 3/2	Basin 3/3	Basin 4/1	Basin 5/1
Storage Zone Volume (soil) (m³)	118	369	283	24	598	75	29	1134	68
Settling Zone Volume (water) (m³)	2,517	2,198	1,926	217	3,836	774	1,245	5,387	1,377
Basin Total Volume (m³)	2,635	2,567	2,209	241	4,434	849	1,274	6,521	1,445

N
W E
S

BILLYS ISLAND

CURLEYS BAY

BASIN 4/1
BASIN 2/1
BASIN 5/1
BASIN 1/1
BASIN 2/2
BASIN 3/1
BASIN 3/2
BASIN 3/3
BASIN 2/3

CULBURRA ROAD

STAGE 4
STAGE 3
STAGE 2
STAGE 5
STAGE 1
STAGE 1

(PDR 61) 61 DP 755971
(PDR 81) 81 DP 755971
DP 1065111
DP 1065111
DP 1065111
DP 22779
4 DP 631825
6 DP 825697
12 DP 788445
7 DP 825697

PM 73997 PM 73996 PM 62367 PM 62368

OVERFLOW FROM BASIN 3/3 TO BE DIVERTED TO NORTH

OVERFLOW FROM BASIN 2/3 TO BE DIVERTED TO NORTH

PAGE BAR SCALE
0 80 160 240 320 400
UNITS – METRES
SCALE – 1:4000 @ A1 1:8000 @ A3

NOTE: APPROXIMATE MANGROVE EXTENT BASED ON 2011 AERIAL PHOTO

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CLIENT/ PROJECT
THE HALLORAN TRUST

TITLE
SEDIMENT AND EROSION CONTROL PLAN
MIXED USE SUBDIVISION – WEST CULBURRA, NSW

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in mm unless otherwise specified.

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DRAWING NUMBER: P1203365JD01V10

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DRAWN: KT
REVIEWED: AN
DATUM: mAHD
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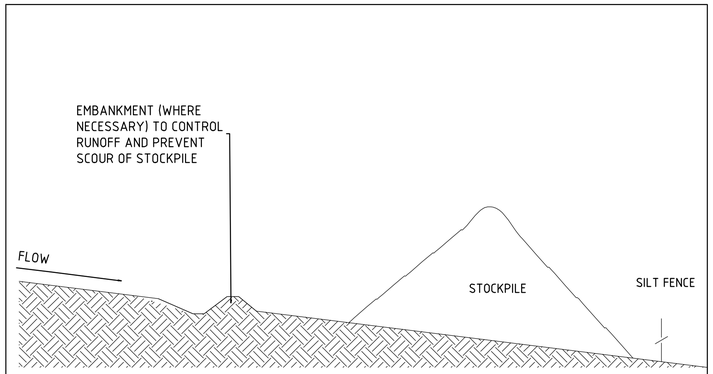
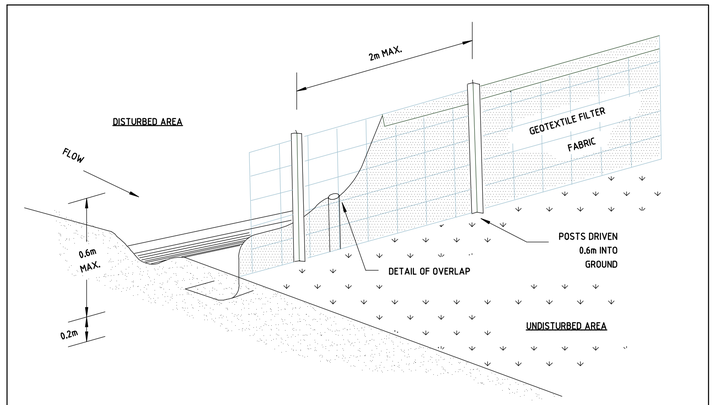
VERTICAL RATIO: 1:4000 @ A1 1:8000 @ A3
SHEET SK207
PAPER SIZE: A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	FINAL	3.11.2016	AN



SITE STOCKPILES

NOT TO SCALE



SEDIMENT CONTROL FENCE

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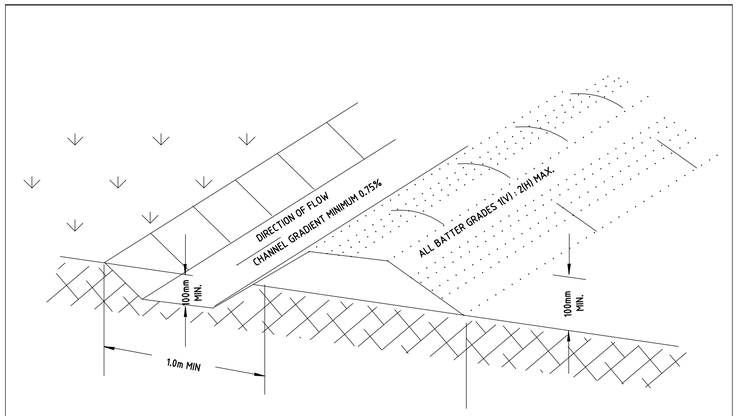
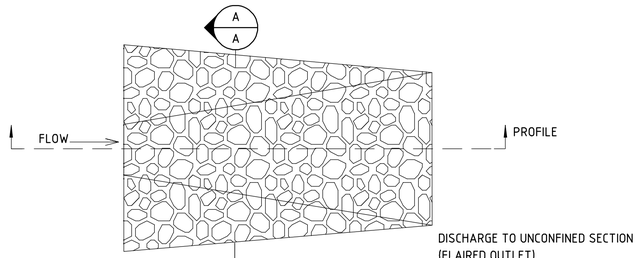
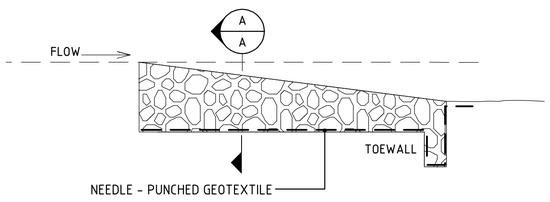


EARTH CHANNEL

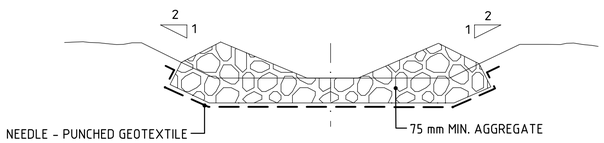
NOT TO SCALE



PLAN VIEW



ELEVATION

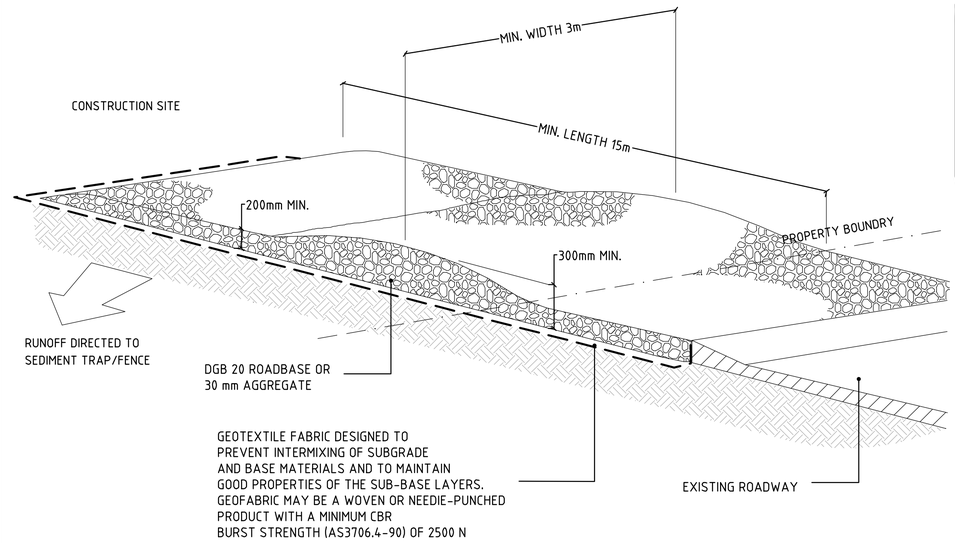


CROSS SECTION AA

CONSTRUCTION NOTES

1. COMPACT THE SUBGRADE FILL TO THE DENSITY OF THE SURROUNDING UNDISTURBED MATERIAL.
2. PREPARE A SMOOTH, EVEN FOUNDATION FOR THE STRUCTURE THAT WILL ENSURE THAT THE NEEDLE-PUNCHED GEOTEXTLLE DOES NOT SUSTAIN SERIOUS DAMAGE WHEN COVERED WITH ROCK.
3. SHOULD ANY MINOR DAMAGE TO THE GEOTEXTILE OCCUR, REPAIR IT BEFORE SPREADING ANY AGGREGATE. FOR REPAIRS, PATCH ONE PIECE OF FABRIC OVER THE DAMAGE, MAKING SURE THAT ALL JOINTS AND PATCHES OVERLAP MORE THAN 300 mm.
4. LAY ROCK FOLLOWING THE DRAWING, ACCORDING TO TABLE 5.2 OF LANDCOM (2004) AND WITH A MINIMUM DIAMETER OF 75 mm.
5. ENSURE THAT ANY CONCRETE OR RIPRAP USED FOR THE ENERGY DISSIPATER OR THE OUTLET PROTECTION CONFORMS TO THE GRADING LIMITS SPECIFIED ON THE SWMP.

ENERGY DISSIPATER SD 5-8

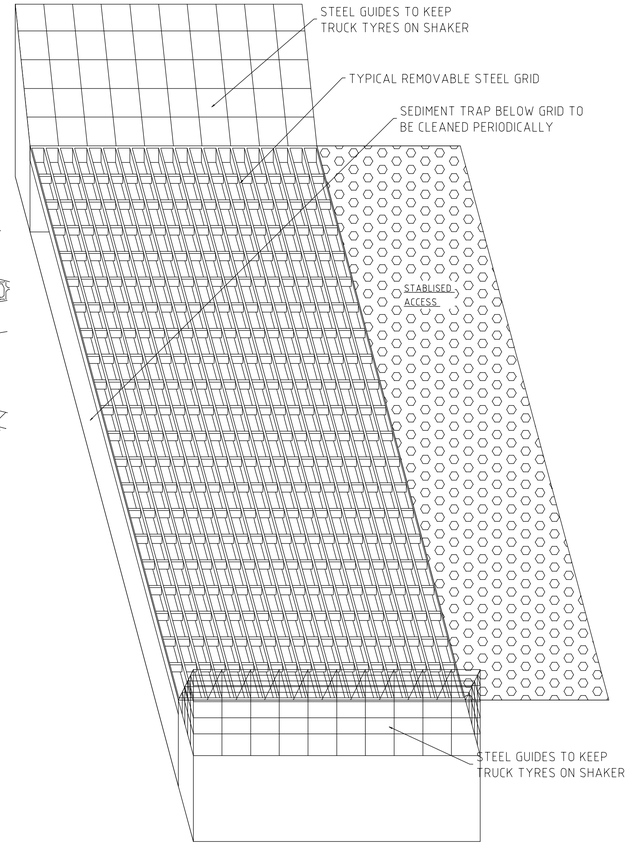


CONSTRUCTION NOTES

1. STRIP THE TOPSOIL, LEVEL THE SITE AND COMPACT THE SUBGRADE.
2. COVER THE AREA WITH NEEDLE-PUNCHED GEOTEXTILE.
3. CONSTRUCT A 200-mm THICK PAD OVER THE GEOTEXTILE USING ROAD BASE OR 30-mm AGGREGATE.
4. ENSURE THE STRUCTURE IS ATLEAST 15 METRES LONG OR TO BUILDING ALIGNMENT AND AT LEAST 3 METRES WIDE.
5. WHERE A SEDIMENT FENCE JOINS ONTO THE STABILISED ACCESS, CONSTRUCT A HUMP IN THE STABILISED ACCESS TO DIVERT WATER TO THE SEDIMENT FENCE

STABILISED SITE ACCESS SD 6-14

NOT TO SCALE



TYPICAL SEDIMENT SHAKER

NOT TO SCALE

martens
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MARTENS & ASSOCIATES PTY LTD
Sustainable Solutions
Environmental - Geotechnical - Civil
Hydraulic - Wastewater Engineers

CLIENT/ PROJECT: THE HALLORAN TRUST

TITLE: SEDIMENT AND EROSION CONTROL SPECIFICATIONS
MIXED USE SUBDIVISION - WEST CULBURRA, NSW

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in mm unless otherwise specified.

PROJECT MANAGER: ANDREW NORRIS

DRAWING NUMBER: P1203365JD01V10

DESIGNED:	DATUM:	SHEET
MLK	mAHD	SK208
DRAWN: KT	HORIZONTAL RATIO: 1:4000 @ A1, 1:8000 @ A3	
REVIEWED: AN	VERTICAL RATIO: 1:4000 @ A1, 1:8000 @ A3	PAPER SIZE: A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	FINAL	3.11.2016	AN

10 Attachment F – Sediment Detention Basin Sizing

1. Erosion Hazard and Sediment Basins

Site Name: NA

Site Location: West Culburra Mixed Use Subdivision

Precinct/Stage: NA

Other Details: Updated based on Staging Plan

Site area	Sub-catchment or Name of Structure						Notes
	B 1/1	B2/1	B2/2	B 2/3	B 3/1	B 3/2	
Total catchment area (ha)	10.31	9.004	7.888	0.887	15.71	3.17	Existing/Pre Dev Catchments
Disturbed catchment area (ha)	4.57	9.004	7.888	0.887	15.71	3.17	Post Dev/Operational Catchments

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	F	F	F	F	F	F	From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)	45	45	45	45	45	45	Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)	19	19	19	19	19	19	
% clay (fraction finer than 0.002 mm)	25	25	25	25	25	25	
Dispersion percentage	27.0	27.0	27.0	27.0	27.0	27.0	E.g. enter 10 for dispersion of 10%
% of whole soil dispersible	9.315	9.315	9.315	9.315	9.315	9.315	See Section 6.3.3(e). Auto-calculated
Soil Texture Group	F	F	F	F	F	F	Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5	5	5	5	See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	85	85	85	85	85	85	
x-day, y-percentile rainfall event (mm)	42.1	42.1	42.1	42.1	42.1	42.1	
Rainfall R-factor (if known)	3300	3300	3300	3300	3300	3300	Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)							

RUSLE Factors

Rainfall erosivity (*R*-factor)	3300	3300	3300	3300	3300	3300	Auto-filled from above
Soil erodibility (*K*-factor)	0.042	0.042	0.042	0.042	0.042	0.042	RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	250	280	267	173	300	255	
Slope gradient (%)	3	4	3.7	3.5	3.7	2.8	
Length/gradient (*LS*-factor)	1.12	1.78	1.55	1.15	1.65	1.02	
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2	2	2	2	Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.58	0.58	0.58	0.58	0.58	0.58	See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	201	320	279	208	297	185	
Soil Loss Class	2	3	3	2	3	2	See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	155	246	215	160	228	142	Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	118	369	283	24	598	75	See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	2517	2198	1926	217	3836	774	See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	2635	2567	2209	241	4434	849	

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).

1. Erosion Hazard and Sediment Basins

Site Name: NA

Site Location: West Culburra Mixed Use Subdivision

Precinct/Stage: NA

Other Details: Updated based on Staging Plan

Site area	Sub-catchment or Name of Structure						Notes
	B 3/3	B4/1	B5/1				
Total catchment area (ha)	5.1	22.06	5.64				Existing/Pre Dev Catchments
Disturbed catchment area (ha)	5.1	22.06	5.05				Post Dev/Operational Catchments

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	F	F	F				From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)	45	45	45				Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)	19	19	19				
% clay (fraction finer than 0.002 mm)	25	25	25				
Dispersion percentage	27.0	27.0	27.0				E.g. enter 10 for dispersion of 10%
% of whole soil dispersible	9.315	9.315	9.315				See Section 6.3.3(e). Auto-calculated
Soil Texture Group	F	F	F				Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5				See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	85	85	85				
x-day, y-percentile rainfall event (mm)	42.1	42.1	42.1				
Rainfall R-factor (if known)	3300	3300	3300				Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)							

RUSLE Factors

Rainfall erosivity (*R*-factor)	3300	3300	3300				Auto-filled from above
Soil erodibility (*K*-factor)	0.042	0.042	0.042				
Slope length (m)	200	240	200				
Slope gradient (%)	1	5	2				RUSLE LS factor calculated for a high rill/interrill ratio.
Length/gradient (*LS*-factor)	0.24	2.23	0.58				
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2				Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.58	0.58	0.58				See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	44	401	105				
Soil Loss Class	1	4	1				See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	34	309	81				Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	29	1134	68				See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	1245	5387	1377				See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	1274	6521	1445				

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).