Shute Harbour Marina Resort

Receiving Environment Monitoring Program – Water Quality and Sensitive Marine Habitats

Prepared for Shute Harbour Marina Development Pty Ltd

17 January 2018

Cardno
Shaping the Future

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1 Introduction

1.1 Background and Scope

Shute Harbour Marina Development comprises a 395-berth marina, hotel, commercial, managed resort apartments and an indigenous cultural centre with associated infrastructure including breakwaters, seabed excavation and reclamation as well as required services. Environmental assessments prepared on behalf of the Proponent of the Project have been presented in an Environmental Impact Statement, EIS (Cardno 2008) and in a Supplementary Environmental Impacts Statement, SEIS (GBA 2013). On 9 December 2013, the Queensland Coordinator General approved the Shute Harbour Marina Project subject to certain conditions. On 9 January 2014, the Commonwealth also approved the project subject to certain conditions (Appendix 1). Further comments were received from the Commonwealth on 27 October 2017 which have been incorporated into this document (see below)

This Receiving Environment Monitoring Program (REMP) has been developed to detail the water quality monitoring requirements for receiving waters and sensitive marine habitats for the Shute Harbour Marina Resort. The REMP consists of three parts:

1) Baseline monitoring to determine existing environmental conditions;
2) Monitoring to be completed during construction works to ensure that specific water quality indicators are not exceeded by construction activities; and
3) Monitoring to be carried out during operation of the development (i.e. post-construction) to determine whether there are any impacts on the receiving environment associated with activities of the Shute Harbour Marina Resort.

Cardno NSW/ACT Pty Ltd (trading as Cardno Ecology Lab) was engaged by Shute Harbour Marina Pty Ltd to assist with the REMP, which is to be undertaken in two phases:

Phase 1 includes the following scope:

- Review the EIS and the SEIS with regard to water quality, sensitive receptors and the proposed development plan;
- Review the conditions of approval for the project;
- Prepare the REMP in accordance with the conditions of approval;
- Prepare a methodology for baseline water quality testing and monitoring over a 12-month period;
- Identify sampling sites by GPS and mapping;
- Identify times of sampling including seasonal sampling and sampling after extreme events;
- Identify the water quality indicators to be measured;
- Identify sampling equipment to be used for data logging over time, spot sampling and collection of samples for laboratory testing;
- Identify the laboratory and methodology for testing and reporting;
- Indicate proposed methods for data analysis and presentation including information for the Developers website;
- Identify water quality benchmarks and guidelines for comparison purposes;
- Identify Quality Assurance protocols and methods including audit as required;
- Liaise with the Queensland Government Department of Environment and Heritage Protection and obtain approval of the REMP;
- Liaise with the Australian Government Department of the Environment and obtain the Ministers approval of the REMP;
- Prepare a detailed costing for implementation of the REMP in Phase 2.

Phase 2 includes the following scope:

- Implementation of the REMP over 12 months;
- Establish discharge criteria based on the REMP findings;
- Preparation of a report on the findings of the REMP including updates on the Developers website.

A draft of the Phase 1 report was provided to Government in May 2014 and comments on the draft were received in late June 2014. The report was revised to accommodate these comments and re-issued on 5 August 2014. Additional comments were provided by the Department of Environment and Heritage Protection (EPH) on 11 September 2014. Four of seven matters raised by EPH following the first revision were considered to have been adequately addressed by the report. Two of these expressed a view that the document was a proposed approach to development of an REMP rather than a specific REMP – this has been addressed, but with the caveat that the final design of construction and post-construction monitoring will need to be based on the outcome of the baseline phase. The third matter required that hydrocarbons be monitored as part of the baseline, construction and post-construction phases – this also has been addressed in this revised document. Finally, the concern was expressed that the selection of Gunn Island was inappropriate as a reference site. Provision for selecting an alternative site has been incorporated into the REMP.

1.2 Objectives of the REMP

The REMP will be implemented prior to construction determine existing environmental conditions and will be implemented in accordance with conditions stipulated in the Coordinator General's Evaluation Report, the relevant conditions included in the State and Commonwealth development approvals, and in consultation with the Queensland Government Department of Environment and Heritage Protection and the Commonwealth Department of the Environment.

The overall objectives of this REMP are to:

- Establish the existing conditions (i.e. before construction begins) of the receiving environment near the marina development with respect to water quality, through the development and implementation of a baseline monitoring program;
- Develop a monitoring program for implementation during construction and operation activities that can identify changes in the environment and can determine whether these are natural variations or potential impacts from marina development activities.

1.3 Review of the Draft REMP by the Queensland and Commonwealth Governments

In May 2014, a draft REMP was prepared and submitted for review by the Department of Environment and Heritage Protection (EHP), who also coordinated input from the Commonwealth Department of Science, Information Technology, Innovation and the Arts (DSITIA). The 2014 review is provided in Appendix 2. This document incorporates responses to that review, in particular:

- Expanded presentation of draft construction phase monitoring activities;
- Review of water quality objectives with particular reference to monitoring of suspended sediments and associated parameters;
- Justification of sampling locations;
- Additional monitoring of sensitive biological receptors, particularly seagrass communities surrounding the marina site;
- Additional monitoring of sediment quality

On 27 October 2017 the Commonwealth issued review/comments, with the requirement that responses to that document be tabulated at the front of the REMP. This is provided in **Table 1**.

Table 1 Relevant Commonwealth Conditions of Approval with document references (as per comments received 27/10/17)

Conditions of Approval	Comments (Gaps in information, improvements, adequacy of technical/scientific information and assumption/justifications, etc.)	Relevant Section
Condition 4 - To ensure the protection of Matters of National Environmental Significance (MNES), the approval holder must develop and implement a Receiving Environment Monitoring Program (REMP) to identify, describe, monitor and respond to any adverse impacts to: (a) surface water quality; (b) water flows; (c) aquatic flora and fauna; and (d) any receiving waters.	The REMP provides adequate approaches to identify, describe, and monitor any adverse impacts on surface water quality, aquatic flora/fauna and any receiving waters. The following gaps were identified in the REMP: • The management responses for potential adverse impacts on surface water quality, aquatic flora/ fauna and any receiving waters have not been described • Monitoring and management responses for water flows have not been described **Action**. Please provide the information required by Condition 4.	• Each of the 4 conditions (a – d) has been addressed in the REMP, primarily in Section 4 for items a, b & d (water quality, water flows and receiving waters) and in Section 6 for item c (aquatic flora and fauna). • Management responses that may be required are provided in Section 7.2 • Water flow monitoring and management responses have been added to Sections 4 and 7.2
Condition 5 - The REMP must include periodic monitoring for the effects of any release on the receiving environment as a result of contaminant releases to waters from the site.	The REMP proposed to undertake the following: • Baseline - monthly water quality (WQ) monitoring for a year to establish seasonal and non-seasonal temporal variability, • Construction - monthly WQ monitoring to ensure that activities are effective in maintaining acceptable water quality within Shute Bay, and • Operation - 3-monthly WQ monitoring to assess the impact of the development on ongoing water quality outcomes in Shute Bay.	Section 4.5, including Tables 10 – 12.
Condition 6 - The REMP must:		
(a) assess the condition or state of receiving waters spatially within Shute Bay (the REMP area), considering background water quality	The REMP provides an adequate monitoring approach to assess the baseline and water quality	Section 4

Conditions of Approval	Comments (Gaps in information, improvements, adequacy of technical/scientific information and assumption/justifications, etc.)	Relevant Section
characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality);	over time (including seasonal variations) within Shute Bay. This information is provided in	
(b) establish parameters to be monitored including but not limited to turbidity and Total Suspended Solids (TSS), nutrients, metals and metalloids and justify: (i) the parameters chosen, and (ii) assumptions and choices made in preparation of the REMP.	The REMP provides adequate monitoring parameters for water quality and justification of the assumptions and selections. This information is provided in	Sections 4 and 5
(c) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected;	The REMP provides an adequate monitoring approach to identify changes to the identified environmental values that need to be protected (seagrasses, macroalgae and corals within Shute Harbour).	Sections 6, and 7.1.
(d) detail monitoring locations and water quality indicators pertinent to the sensitive receptor types and locations that have been designed to: (i) determine the baseline condition of water quality and sensitive receptors (i.e., corals and seagrass meadows) within the zone of influence to a sufficient resolution to be capable of reliably detecting lethal and sublethal (stress) impacts, (ii) develop or adopt locally-relevant trigger values for key water quality indicators including turbidity, and (iii) provide on-line real-time monitoring capability for key sediment plume- related indicators (including but not limited to turbidity, pH, EC).	The REMP provides detailed monitoring locations and water quality indicators pertinent to the sensitive receptors, including details of baseline determination for water quality and sensitive receptors. It also provides locally-relevant trigger values for key water quality indicators and on-line real-time monitoring for sediment plumes. The following gaps were found: • there is no discussion that links the identified water quality objectives (WQO) (in Table 6) to the identified environmental values (section 6) • there is no explanation as to how the major changes in seagrass distribution would be detected during the operational phase if there	Monitoring locations for sensitive habitats will be refined from mapping undertaken during the Pre-Construction (Baseline) Phase. See Section 6. Section 6: The Baseline sampling will confirm/adjust distribution of sensitive habitats as presented in the EIS documents (2008 & 2013). Currently, no seagrasses are reported to occur within the marina footprint. During Construction sensitive habitats would continue to be monitored to address the potential risk of plumes being transported to those habitats. During Operation adverse changes in water quality would be used as a trigger for reactive monitoring of seagrasses and corals using the same methods as per the Baseline and Construction phases. This approach is considered appropriate given that sensitive habitats

Conditions of Approval	Comments (Gaps in information, improvements, adequacy of technical/scientific information and assumption/justifications, etc.)	Relevant Section
	is no monitoring for sensitive receptors (table 11) **Action**. Please provide an explanation that links the identified WQO (in Table 6) to the identified environmental values (section 6) and an explanation as to how major changes in seagrass distribution will be detected during the operational phase if there is no monitoring for sensitive receptors (table 11) or propose an alternative approach.	have not been identified within the footprint. An exception to this may be required during maintenance dredging, but this would need to be assessed at the time, based on locations of maintenance dredging and volumes of material. Linking WQOs (e.g. turbidity) to sensitive habitats – see Section 6 and data analysis in Section 7.2
(e) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the Environmental Protection (Water) Policy 2009 (Proserpine River, Whitsunday Island and O'Connell River Basins Environmental Values and Water Quality Objectives) (DEHP 2013);	The REMP describes the frequency and timing for sampling (Tables 9-11), including revised WQO based on the Environmental Protection (Water) Policy 2009. The following gaps were found: • there is no justification for the selected sampling frequency and timing under each of the monitoring phases (tables 9-11) • it is not clear why all the identified water quality parameters (in Table 6) are not to be monitored during the pre-construction **(**baseline monitoring) • it is not clear which water quality parameters will be monitored during the construction and operational phases • it is not clear when the monitoring program will start and finish in relation to each phase • the total monitoring period is not specified • there is very little information on the proposed monitoring during the operational phase • there is no explanation as to how contamination of sediments would be detected during the operational phase if there is no regular sampling regime (table 11). **Action.** Please provide:	Section 4 • Sampling frequency would be continuous for data loggers, and seasonal for laboratory analysis and probe measurements, with provision for event-based surveys. There is provision to adjust these if considered warranted, particularly after the Pre-Construction Phase, when the Baseline has been established.. Frequency is considered to be capable of capturing a range of conditions and hence is considered to be appropriate for the project. Following an initial period of sampling during the operational phase, water quality sampling would be reduced to periods associated with maintenance dredging and to a 5-yearly environmental audit. • Table 6 identifies the water quality timing and indicators presented in the original and supplementary EISs and not what is being proposed in the REMP, which is in Section 2.4 of the REMP.

Conditions of Approval	Comments (Gaps in information, improvements, adequacy of technical/scientific information and assumption/justifications, etc.)	Relevant Section
	• Justification for the selected sampling frequency and timing under each of the monitoring phases (tables 9-11) • Monitoring of all the identified water quality parameters (in Table 6) during the pre-construction (baseline monitoring) or justification if this is not to occur • Details of which water quality parameters wil be monitored during the construction and operational phases • Details of when the monitoring program will start and finish in relation to each phase • Details of the total monitoring period • Full details of the proposed monitoring during the operational phase • A regular sampling regime to detect contamination of sediments or an explanation as to how contamination of sediments will be detected during the operational phase if there is no regular sampling regime (table 11).	• All nominated indicators will be monitored during the REMP, with the exception of pesticides, herbicides and TBT, which would be sampled only during the Baseline, with a decision for ongoing monitoring to be made based on initial analyses (Section 4.6.2 of REMP) • Baseline monitoring will commence at least one year prior to Construction to allow sampling during 4 seasons with provision for 2 event-based sampling events (Table 10). Construction monitoring will continue for the entire period of Construction, with water quality loggers deployed continuously at selected sites, but subject to revision based on the Baseline data. Lab samples and probe will be acquired seasonally except if trigger levels for WQO are exceeded (Table 11). During Operation, full water quality sampling will be phased-out except during maintenance dredging and there will be a 5-yearly audit involving water quality surveys that occurs on an ongoing basis. • Sediments would be sampled as part of the 5-yearly audit (Table 12) at sites S2 & S3 (Figure 1). This is considered adequate at this stage but would be subject to review at the commencement of the Operational Phase.
(f) include monitoring of metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000 and/or the most recent version of Australian Standard 5667.1);	The REMP provides monitoring of metals/metalloids in sediments in accordance with ANZECC and ARMCANZ 2000. This information is provided in section 5.	Section 5.

Conditions of Approval	Comments (Gaps in information, improvements, adequacy of technical/scientific information and assumption/justifications, etc.)	Relevant Section
(g) apply procedures and/or guidelines from ANZECC and ARMCANZ 2000 and other relevant guideline documents;	The REMP uses the procedures and/or guidelines from ANZECC and ARMCANZ 2000 and other relevant guideline documents. This information is used through the document.	The REMP has been revised to also include revised sediment quality guidelines by Simpson *et al.* (2013)
(h) describe sampling and analysis methods and quality assurance and control; and (i) justify all assumptions and choices made in preparation of the REMP.	The REMP provides the sampling methods and quality assurance and control. The following information is not provided: • data analysis methods • not all assumptions and choices have been justified. **Action**. Please provide data analysis methods and justification for all assumptions and choices.	See Revised Section 7
Condition 7 - The REMP must be approved by the Minister in writing prior to its implementation.		
Condition 8 - The REMP must be implemented for a minimum of 12 months prior to commencement of construction and must not cease prior to expiry of this approval.	The approval holder proposes to undertake baseline monitoring for 12 months prior to commencement of construction. This information can be found in section 4.0.	Section 4
Condition 9 - A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared annually and made publicly available on the approval holder's website. All annual reports must remain publicly available for the duration of the approval. The first report must be published prior to the commencement of construction, and all future reports must be published on the anniversary of the commencement of construction. Each report must include, but not be limited to, an	Section 7.2 describes the reporting process, but doesn't provide details of how the requirements of condition 9 will be provided. **Action**. Please provide the information required under condition 9.	Revised Section 7, specifically 7.1.

Conditions of Approval	Comments (Gaps in information, improvements, adequacy of technical/scientific information and assumption/justifications, etc.)	Relevant Section
assessment of measured water quality in the REMP area compared against the water quality objectives outlined and/or established in the REMP at condition 6(c).		
Condition 10 - After at least twelve months of implementation of the REMP, as required under Conditions 4-9, the approval holder must set discharge criteria for relevant parameters, against which future discharges from Shute Harbour Marina to Shute Bay must be monitored. The discharge criteria must: (a) be developed with reference to Queensland Water Quality Guidelines Environmental Protection (Water) Policy 2009 (Proserpine River, Whitsunday Island and O'Connell River Basins Environmental Values and Water Quality Objectives) (DEHP 2013); (b) not be inconsistent with discharge criteria developed or approved under state or local government approvals; and (c) be approved by the Minister in writing prior to commencement of construction.		
Condition 11 - To ensure the protection of MNES, the approval holder must not discharge, irrigate or otherwise release potable water, wastewater, stormwater, harvested water, bilge water or sewage effluent into Shute Bay unless the discharge complies with discharge criteria defined for the site and approved by the Minister as required under Condition 10.	The focus of the REMP is on water quality. In order to meet Condition 11, monitoring and controls regarding flow will be required. **Action.** Please include in the REMP details of monitoring and controls for flow (or advice as to why these are not necessary) so as to provide confidence that the requirements of Condition 11 can be met.	Section 7.2

2 Review of the EIS and SEIS

The potential for a marina development has been recognised for many years, with environmental impacts statements being prepared in 2008 (Original EIS for Shute Bay) and 2013 (Supplementary EIS, SEIS). Water quality data were collected and presented as part of the EIS (Appendix N of the EIS) and these data were referenced within the SEIS. Marine ecology issues were addressed in Appendix P1 of the Original EIS, which also formed the basis for aquatic ecology in the SEIS. Marine ecology studies considered, among other things, the distributions of seagrasses and corals, and the potential occurrence of the blue green alga, *Lyngbya majuscula* (Lyngbya). As far as is known, the most recent maps of the distribution of seagrasses and corals within Shute Harbour were compiled in 2007 for the SEIS.

2.1 Development of Water Quality Objectives

As part of the EIS, Water Quality Objectives (WQOs) appropriate for Shute Bay were developed with reference to the relevant generic guidelines, namely ANZECC/ARMCANZ (2000) and QWQG (2006). WQOs are presented in **Table 2**.

2.2 Available Water Quality Data

Water quality was sampled June and September 2007 as part of the studies for the EIS. On both occasions, eight sites were sampled within Shute Harbour in and around the proposed marina footprint (denoted SW1-SW8) and four sites were sampled in what appears to be tidal creeks (FW1-FW4) (Figure 4 in Appendix N of the 2008 EIS). At each site, measurements of a range of physico-chemical parameters were obtained, presumably using a multi-parameter water quality sonde. Water samples were also collected for laboratory analysis of additional indicators including nutrients, contaminants, metals and biological indicators. It is not specified whether samples were taken at the water surface or at depth. Indicators are listed in **Table 3**.

2.2.1 Findings

The major findings of the water quality assessment for the samples from Shute Harbour (i.e. SW1 - SW8) include the following:

- Results for most indicators met the WQOs including physico-chemical data, nutrients and metals;
- Total Suspended Sediments (TSS) did not meet the WQO for most samples. The likely cause of this exceedance is due to prevailing winds generating waves and causing the resuspension of fine marine sediment present in Shute Bay. The implication of this finding is that TSS and probably turbidity are likely to exceed default WQO due to the local environment, irrespective of the presence of the Shute Harbour Marina;
- Large variability in suspended sediment is expected during wind and wave events due to the prevailing conditions and perhaps to the presence of fine silts in Shute Bay west of the development footprint;
- Values for oil and grease were elevated at one site in September 2007. This was attributed to increased boat traffic during the holiday period at that time;
- Development of local WQOs would need to be refined based on a more comprehensive water quality monitoring program.

2.2.2 Limitations

The data referenced in the EIS and SEIS provide a basic understanding of water quality within Shute Harbour. The data represent two “snapshots” in time and hence do not capture variability at potentially important temporal scales, including the following:

- Temporal variation associated with time of day (especially day/night variation in dissolved oxygen). This type of information can be acquired most efficiently using continuous data loggers.
- Seasonal variations. Data were recorded in early and late winter and hence do not provide a valid measure of seasonal variability, which would require at least two surveys within each season.

- Inter-annual variability, such as long-term shifts in weather patterns (e.g. El Nino/La Nina cycles). This can be addressed partially by the use of reference locations.
- Event based-variability, which may be caused by severe storm events, including cyclones, or prolonged calm periods, which can lead to elevated water temperatures (and consequent coral bleaching). This can be addressed by mobilising rapidly during (if safe) or soon after such events.

In addition to variation through time, the data do not provide a broad spatial coverage of Shute Bay, particularly with reference to the water quality at or near sensitive environmental receptors (mangroves, corals and seagrass meadows – see Appendix P1 in 2008 EIS) that occur outside the marina footprint. Moreover, they do not include data from reference locations.

Table 2 Water Quality Objectives as recommend by the EIS documents (2008, 2013)

Water Quality Parameter	Water Quality Objective
pH	8.0 – 8.4 pH units
Dissolved Oxygen	90 – 100% saturation
Turbidity	< 6 NTU
Total Phosphorous	< 0.02 mg/L
Total Nitrogen	< 0.2 mg/L
Suspended Solids	< 15 mg/L
Chlorophyll-a	< 0.002 mg/L
Ammonia	< 0.008 mg/L
Oxidised Nitrogen	< 0.003 mg/L
Reactive Phosphorous	< 0.006 mg/L
Diuron	< 0.001 mg/L
Secchi Disk Depth	> 1.5 m
Faecal Coliforms	< 150 orgs/100 mL for Primary Contact
Total Aluminium	< 0.2 mg/L
Total Iron	< 0.02 mg/L
Total Organic Carbon	To be derived from baseline monitoring program
Dissolved Organic Carbon	To be derived from baseline monitoring program
Dissolved Inorganic Nitrogen	To be derived from baseline monitoring program
Dissolved Aluminium	To be derived from baseline monitoring program
Dissolved Iron	To be derived from baseline monitoring program

A further issue that requires consideration is the presence of other activities within Shute Harbour, particularly the Ferry Terminal and existing Slipway, to the north of the Marina Footprint. It is understood that potential impacts of these activities have not been assessed. The baseline will help to provide an indication of existing impacts of the Terminal and Slipway. In the longer term, a risk arises if the Terminal and/or Slipway are altered, or practices change, concurrently with construction or operation of the marina. In this situation, it may be difficult to discriminate among impacts that may be due to the Marina, Terminal or Slipway; or to understand cumulative impacts of all three activities.

Table 3 Water quality indicators measured for the EIS

Physico-chemical indicators	Temperature
	Electrical Conductivity
	pH
	Dissolved Oxygen
	Total Suspended Solids
	Turbidity
Nutrients and biological indicators	Nitrogen (ammonia, oxidised, organic, total)
	Phosphorous (reactive, total)
	Organic Carbon (dissolved, total)
	Chlorophyll-a
	Faecal Coliforms
Contaminants	Metals (total and dissolved Al, total and dissolved Fe, Total: As, Be, Ba, Cd, Cr, Co, Cu, Hg, Pb, Mn, Ni, V, Zn)
	Oil and Grease
	Hydrocarbons (Total Petroleum Hydrocarbons)

2.3 Water Quality Monitoring Proposed in the EIS

The EIS documents (2008, 2013) outlined the scope for a water quality monitoring program, developed on the basis of discussions with the then Qld EPA and the GBRMPA. The proposed monitoring program consists of three components:

2.3.1 Pre-Construction (Baseline) Phase Monitoring

This phase was to establish the existing water quality of Shute Bay (the receiving waters) and allow refinement of the WQOs. Monthly monitoring was proposed over a year to allow seasonal variations to be adequately measured. Additionally, water quality was to be monitored during a range of sea state conditions to capture non-seasonal temporal variability.

The background phase included collection of water samples and snapshot probe data as per the EIS, with the addition of a continuous turbidity logger at one site.

In total, nine sites were to be sampled, five sites in Shute Harbour (SH1-SH5) and four sites in unnamed tributaries/tidal creeks (SH7-SH10. The turbidity logger was to be deployed at SH3, to the west of the marina entrance (EIS, Appendix N). Spatially, none of the sites were located within the marina footprint and no reference sites were selected.

2.3.2 Construction Phase Monitoring

This phase was designed to ensure that management of construction activities are effective in maintaining acceptable water quality within Shute Bay. A subset of the WQOs is presented as suggested targets for the construction phase monitoring (**Table 4**). These targets will be refined based on the background phase monitoring. Water quality will be sampled monthly at the same sites as the baseline, but with one additional site (SH6) located within the marina footprint, at the discharge point for water removed from dredge materials. Additionally, spot checks will be undertaken for visible plumes (i.e. evidence of elevated turbidity) within the marina footprint.

2.3.3 Operational Phase Monitoring (Post-Construction)

This phase was to commence following the completion of all construction activities and is to assess the impact of the development on ongoing water quality outcomes in Shute Bay. The monitoring in the

operational phase was to continue for two years from commencement and consist of 3-monthly sampling events.

2.3.4 Water Quality Indicators to be Monitored

The indicators to be sampled during all three phases of monitoring are presented in **Table 5**. Additional indicators were proposed to be monitored during the background and operational phases (**Table 6**). The scale and intensity of the development construction works were deemed insufficiently large to warrant sampling these additional indicators during the construction phase.

2.3.5 Appraisal of EIS Water Quality Assessment

The following items have been identified in reviewing the assessment of water quality issues within the EIS:

- WQOs were based on the guidelines (ANZECC/ARMCANZ 2000 and QWQG 2006). These WQOs are default values to be used in the absence of site-specific values which would normally be derived on the basis of local water quality conditions and the nature of the proposed development. Because they are default values, they tend to be relatively conservative, favouring a precautionary approach to protecting the receiving environment. WQOs for the water quality monitoring program will incorporate the updated Environmental Protection (Water) Policy 2009.
- The monitoring program proposed in the EIS provides a reasonable basis for the development of the REMP scope, but has been refined to conform to the conditions of consent and align more closely with current best practice in environmental monitoring. Improvements to the baseline program include:
    - Sampling at sites at or near sensitive receptors;
    - Inclusion of reference sites (minimum of two) to provide a concurrent measure of indicators in locations considered unlikely to be affected by the marina development;
    - Deployment of four continuous turbidity loggers, with at least one logger including dissolved oxygen, salinity and temperature, in addition to turbidity.

Table 4 Water quality targets suggested in the EIS (2008, 2013) for construction phase monitoring

Water Quality Parameter	Water Quality Indicator
pH	8.0 to 8.4
Suspended Solids	<50 mg/L
Turbidity	<10% increase from background levels During dredging no visible plume beyond 20 metres of the lease extents
Litter/gross pollutants	No anthropogenic material derived from the Project greater than 50 mm in any dimension

Table 5 Water quality indicators sampled during all phases of construction, as recommended in the EIS

In-situ Parameters	Laboratory Parameters
Temperature	Total Nitrogen
Dissolved Oxygen	Total Phosphorous
pH	Suspended Solids
Specific Conductance	Heavy Metals: Cu, Pb
Salinity	Faecal Coliforms

Turbidity	Chlorophyll-a

Table 6 Additional Water Quality Parameters proposed to be monitored during background and operational phase monitoring in the EIS (2008; 2013)

In-situ Parameters	Laboratory Parameters
No additional parameters	Metals: As, Ba, Be, Cd, Cr, Co, Hg, Mn, Ni, V, Zn)
	Total Organic Carbon
	Dissolved Inorganic Nitrogen
	Dissolved Inorganic Phosphorous

3 Development Conditions Relevant to the REMP

The key conditions of consent specified by the Queensland and Commonwealth governments are presented in **Appendix 1**. The Conditions of Consent indicate the following key matters that will be included in the baseline monitoring:

- The sampling design as specified covers a numerous locations and contingencies and gives a basis for designing a program that conforms to current best practice in monitoring water quality. There is scope for developing a cost effective monitoring program within the conditions that focuses on distinguishing impacts that may be related to the marina construction (and operation) from natural events and potentially other human activities in the area. The design will incorporate key issues of spatial and time-based coverage with a high level of Quality Assurance.
- A key issue is the development of appropriate water quality guidelines against which monitoring data will be compared to determine if there is a need to trigger a management response. The methodology used for the baseline study will produce site-specific water quality guidelines. This will be very important for monitoring turbidity (especially during dredging) because natural levels of turbidity and suspended sediments in Shute Harbour were shown in the EIS to exceed the ANZECC (2000) default guidelines. The baseline data collected will enable derivation of site-specific guidelines by sampling in advance of construction and at reference locations. Subject to the outcome of the Baseline Phase, the same reference locations will be sampled during construction activities and compared with locations in close proximity to dredging, dredge plumes and sensitive habitats.
- Real-time telemetry. The conditions require the capacity for real-time telemetry during construction activities. The loggers used for the baseline will be adjusted to provide telemetry during construction and post construction. Toward the end of the baseline period capability will be trialled in preparation for implementation once construction begins.
- Collection, physical and chemical analysis and statistical analysis of sediment samples inside and outside of the footprint of the marina. Sediment characteristics would also be compared with relevant sediment quality guidelines (i.e. ANZECC 2000 and Simpson *et al.* 2013).
- Studies of sensitive marine habitats including seagrasses and corals using mapping, video analysis and sample collection in locations proximate to the marina footprint. Additionally management responses would be established in the event that the noxious blue-green alga (*Lyngbya majuscula*) is identified in Shute Bay.
- Data analysis, reporting and management responses to findings. The conditions specify the need for reporting and availability to stakeholders. Reporting shall include concise progress reports after each sampling event, with a more detailed statistical analysis of data within a final report that will be prepared at the completion of the baseline phase. A database will also be created to be available for comparative purposes over time (i.e. through the construction and operational phases of the project). These are discussed further below.

4 The Water Quality Monitoring Program

4.1 Establishment of Baseline Conditions

As noted above, there is limited information on the existing water quality characteristics of Shute Bay for many of the water quality objectives (**Section 2**). As such, the establishment of baseline water quality conditions adjacent to the Marina Resort development needs to be determined to provide a basis for construction and operation impact assessment.

The objectives of the baseline study are to:

- Gain an understanding of existing water quality conditions in the vicinity of the Marina Resort development site, at reference sites and in the vicinity of existing activities, including the Ferry Terminal and Slipway;
- Establish quantitative baseline conditions and water quality objectives for implementation in the construction and operation monitoring program.

4.2 Water Quality Objectives

The Water Quality Objectives derived during the preparation of the EIS have been revised based on the Environmental Protection (Water) Policy 2009 (EPP Water) with specific reference to the Proserpine River, Whitsunday Island and O'Connell River Basins Environmental Values and Water Quality Objectives (**Table 7**).

The concurrent measurement of TSS by laboratory analysis of grab water samples and the in situ measurement of turbidity, Secchi depth and Photosynthetic Active Radiation (PAR) will be used to develop local relationships among these indicators. These relationships will inform the development of turbidity intensity and duration trigger responses to be used during construction monitoring to ensure protection of sensitive receptors within the expected zone of impact of the development. Potentially, the primary risk to seagrass communities near the development will be the increased attenuation of PAR caused by the dredge plume, thus the proposed use of triggers associated with turbidity levels will be assessed based on the effectiveness of the use of this parameter in predicting PAR attenuation.

Sampling frequency would be continuous for data loggers, and seasonal for laboratory analysis and probe measurements, with provision for event-based surveys. There is provision to adjust these if considered warranted, particularly after the Pre-Construction Phase, when the Baseline has been established.. Frequency is considered to be capable of capturing a range of conditions and hence is considered to be appropriate for the project. Following an initial period of sampling during the operational phase, water quality sampling would be reduced to periods associated with maintenance dredging and to a 5-yearly environmental audit.

- Table 6 identifies the water quality timing and indicators presented in the original and supplementary EISs and not what is being proposed in the REMP, which is in Section 2.4 of the REMP.
- All nominated indicators will be monitored during the REMP, with the exception of pesticides, herbicides and TBT, which would be sampled only during the Baseline, with a decision for ongoing monitoring to be made based on initial analyses (Section 4.6.2 of REMP)
- Baseline monitoring will commence at least one year prior to Construction to allow sampling during 4 seasons with provision for 2 event-based sampling events (Table 10). Construction monitoring will continue for the entire period of Construction, with water quality loggers deployed continuously at selected sites, but subject to revision based on the Baseline data. Lab samples and probe will be acquired seasonally except if trigger levels for WQO are exceeded (Table 11). During Operation, full water quality sampling will be phased-out except during maintenance dredging and there will be a 5-yearly audit involving water quality surveys that occurs on an ongoing basis.
- Sediments would be sampled as part of the 5-yearly audit (Table 12) at sites S2 & S3 (Figure 1). This is considered adequate at this stage but would be subject to review at the commencement of the Operational Phase.

4.3 Baseline Monitoring Methodology

The sampling program of water quality for the REMP baseline is summarised in **Table 9** and **Figure 1**. In addition, an overview schematic of water quality sampling, sediments and sensitive marine habitats is presented in **Table 10**. The sampling plan utilises three approaches: deployed data loggers, water grab samples to be analysed in NATA-accredited laboratories and field data collected using a water quality probe.

Data capture will be based on the following hierarchical model:

- Data loggers will be deployed at four sites (**Figure 1**) to provide continuous monitoring of both the marina footprint and sensitive receptors, with data recorded every 15 minutes;
- Water samples will be collected from just below the water surface at the four logger sites and at three additional sites, two nominated as reference sites, one each to the north and south of the marina footprint; the third will be located within the navigation channel for the Marina and approximately adjacent to the Ferry Terminal. Thus, there will be data derived from chemical analysis of water samples at seven sites (**Figure 1**). One reference location (S6) has been located offshore of Gunn Island. EHP has identified a concern with selection of this site as a reference site. The use of this site will be evaluated at the commencement of monitoring and may be re-allocated elsewhere if found to be inappropriate based on initial review of data;
- Probe data, using an *in situ* water quality probe, will be collected at the water surface and just above the seabed ("surface" and "bottom") at the logger sites and water sampling sites and at three additional sites in and close to the marina footprint, yielding probe data from ten sites (**Figure 1**). Furthermore, if time permits in the field, probe measurements will be taken at 0.5 m intervals through the water column. The equipment to be used has the capacity to be upgraded to provide real-time monitoring capabilities to ensure consistency of measurements between the baseline and construction phases of monitoring.
- Water flows will be monitored at four identified stormwater discharge points (**Figure 1**) in the vicinity of the development site. These locations will be observed during each sampling exercise to determine whether flows are present. If flows are observed (sufficient for water to be flowing from the land into Shute Bay) then in-situ probe measurements and grab water samples for laboratory analysis will be conducted. As it is expected that these discharge points are ephemeral, a minimum of two event-based sampling exercises will be conducted during the baseline monitoring to ensure samples of water flows are collected. Adjustment of sites for monitoring water flow will be incorporated into the REMP as required, including additional sites that will be selected for during and after construction and sites that may receive temporary flows of water (e.g. from dewatering).

Table 7 Water Quality Parameters and Objectives for Water Quality Monitoring Program

Water Quality Parameter	Water Quality Objective
pH	8.1 – 8.4
Dissolved Oxygen	85 – 105 % saturation
Suspended Solids	No recommended objective. To be determined from baseline monitoring of TSS in relation to turbidity, Secchi depth and PAR data
Turbidity	< 10 NTU (long term median)
Secchi Disk Depth	> 1.0 m (long term median)
Photosynthetically Active Radiation (PAR)	No recommended objective. Profiles of PAR to determine light attenuation will inform the development of Turbidity and Secchi Depth objectives.
Total Phosphorous	< 0.02 mg/L
Reactive Phosphorous	< 0.005 mg/L
Total Nitrogen	< 0.16 mg/L

Water Quality Parameter	Water Quality Objective
Oxidised Nitrogen	< 0.01 mg/L
Dissolved Inorganic Nitrogen	< 25 µg/L
Ammonia	< 0.015 mg/L
Chlorophyll-*a*	< 0.002 mg/L
Total Recoverable Hydrocarbons	No recommended objective. To be determined from baseline monitoring, along with Benzene and Naphthalene objectives.
Benzene	< 500 µg/L (99% species protection)
Naphthalene	< 50 µg/L (99% species protection)
Ametryn	< 0.5 µg/L
Atrazine	< 0.6 µg/L
Diuron	< 0.9 µg/L
Hexazinone	< 1.2 µg/L
Tebuthiuron	< 0.02 µg/L
Tributyltin	< 0.006 µg/L (SMD / 95% species protection)
Intestinal enterococci	95th percentile ≤ 40 organisms per 100 mL
Dissolved Metals	WQOs for dissolved metals based on 95% protection level unless otherwise specified
Aluminium	Locally derived objective to be determined
Arsenic	Locally derived objective to be determined
Copper	1.3 µg/L
Cadmium	0.7 µg/L (99% protection level)
Chromium (CrIII/VI)	27.4 / 4.4 µg/L
Cobalt	1.0 µg/L
Iron	Locally derived objective to be determined
Mercury	0.1 µg/L (99% protection level)
Manganese	Locally derived objective to be determined
Nickel	7.0 µg/L (99% protection level)
Lead	4.4 µg/L
Vanadium	100 µg/L
Zinc	15 µg/L

Table 8 Summary of Monitoring Locations (see also Figure 1)

Site	Location	Rationale
1	Within marina development footprint	Reference for post-construction WQ within marina
2	East of marina within access channel	Seagrass impact management during construction, wave resuspension monitoring post construction
3	South of marina	Seagrass impact management during construction. Wave resuspension and scour post construction
4	Near southern shore of Shute Bay	Control
5	East of marina, south of existing ferry terminal	Plume monitoring, ensure not too close to sediment resuspension from ferry propellers

6	Near Gunn Island	Control *(note: subject to further review at commencement of monitoring program, as per Regulator Comments)*
7	Near southern shore of Shute Bay	Control, additional dataset for use with S4
8	West of marina	Proximity to seagrass (to be confirmed) Reference for dewatering monitoring during construction
9	Within marina extents	Additional dataset for use with S1
10	Near Repair Island	Control near coral communities

4.4 Monitoring Sites

Monitoring sites are shown in **Figure 1** and sampling at each site is summarised in **Table 9**. They include sites within and around the marina footprint, at two environmentally sensitive locations (coral and seagrass) and two reference locations. Some of these sites may need to be adjusted or relocated following reconnaissance at the commencement of the Baseline (pre-construction) Monitoring. Any recommended changes to the sampling locations will be described in the first progress report for the Baseline and provided to the Regulators for approval.

4.5 Monitoring Schedule

The full baseline study will involve sampling of water quality on a monthly basis for a minimum of 12 months, in order to provide data on hourly, daily, weekly, monthly and seasonal variability captured using the data loggers. Monthly sampling will coincide with data downloads and servicing of the deployed loggers.

Event-based sampling will be conducted to supplement the logged data and provide a comprehensive assessment of water quality following periods of either increased wave activity or high freshwater inflows to Shute Harbour. The logistics of the event-based sampling will need to be carefully planned, as mobilisation of personnel will need to occur on short timeframes in order for this type of sampling to be effective.

4.6 Selected Indicators

Water quality indicators and sampling designs are summarised in **Table 7** and **Table 9**. Water samples will be collected using suitable field sampling protocols and chain-of-custody documentation will be maintained during delivery to the laboratory for analysis. Field blanks and duplicates will be included in the samples for laboratory analysis in order to provide assurance of both field procedures and the laboratory analysis. The suites of parameters outlined in **Sections 4.6.1 and 4.6.2** will be sampled under a reduced regime, with the frequency of sampling reviewed following results of analysis during the baseline monitoring campaign.

4.6.1 Metals and Metalloids Sampling

Sampling for metals and metalloids will be carried out during the baseline monitoring on a subset of locations and at a reduced quarterly frequency. Sampling for analysis of dissolved metals and metalloids will be undertaken at sites S1, S2 and S7 (**Figure 1**). The concentrations of these contaminants in Shute Bay are likely to be below the default trigger values given the existing sources of contamination in the vicinity of the development area. The reduced sampling frequency will allow assessment of this assumption and the development of locally derived water quality objectives for those metals and metalloids without default values. The initial sampling exercise will include metals and metalloids and results of the first round will inform the need to increase the rate of sampling.

4.6.2 Pesticides, Herbicides and Tributyltin Sampling

Sampling for herbicides and tributyltin will be carried out during baseline monitoring on a subset of locations and at a reduced, quarterly frequency. Sampling for analysis of herbicides and tributyltin will be undertaken at sites S1, S2 and S7. This baseline monitoring will allow assessment of the results from operational monitoring phase and inform an assessment of potential risk of these contaminants from boating activities in the completed development. The initial sampling exercise will include pesticides, herbicides and tributyltin. Results of the first round will inform the need to increase the rate of sampling.

4.7 Field Procedures and Resourcing

All fieldwork will be conducted from a small, outboard-powered vessel, with appropriate registration and safety equipment. A Safe Work Method Statement will be prepared for the project and Toolbox Meetings will be held prior to each day of field sampling. The field team will consist of a minimum of two technicians.

At each sampling site, the position of the site will be confirmed and recorded using a hand-held GPS (accuracy typically ± 5 m). Time of sampling, wind/weather conditions and the data scribe will be noted. The probe will be deployed twice at each site (i.e. two replicates) with data recorded at the surface and bottom and/or through the water column (time-dependent); water samples will then be collected for just below the water surface, labelled and stored; and finally the data logger will be retrieved, downloaded, serviced and returned to the water. A spare logger will be on hand to replace any lost or any malfunctioning logger at the time. Specifications for recommended multi-parameter water quality sondes are presented in **Appendix 3**.

QA/QC will be undertaken using documentation to show that all procedures have been followed correctly. QA/QC procedures will be integrated into the field log sheets, to ensure that all information relevant to the fieldwork is documented in a concise and meaningful manner.

Field procedures will be managed by CoC documentation, where data may not be transferred for further processing unless sign off demonstrates that they have undergone the necessary QA/QC checks.

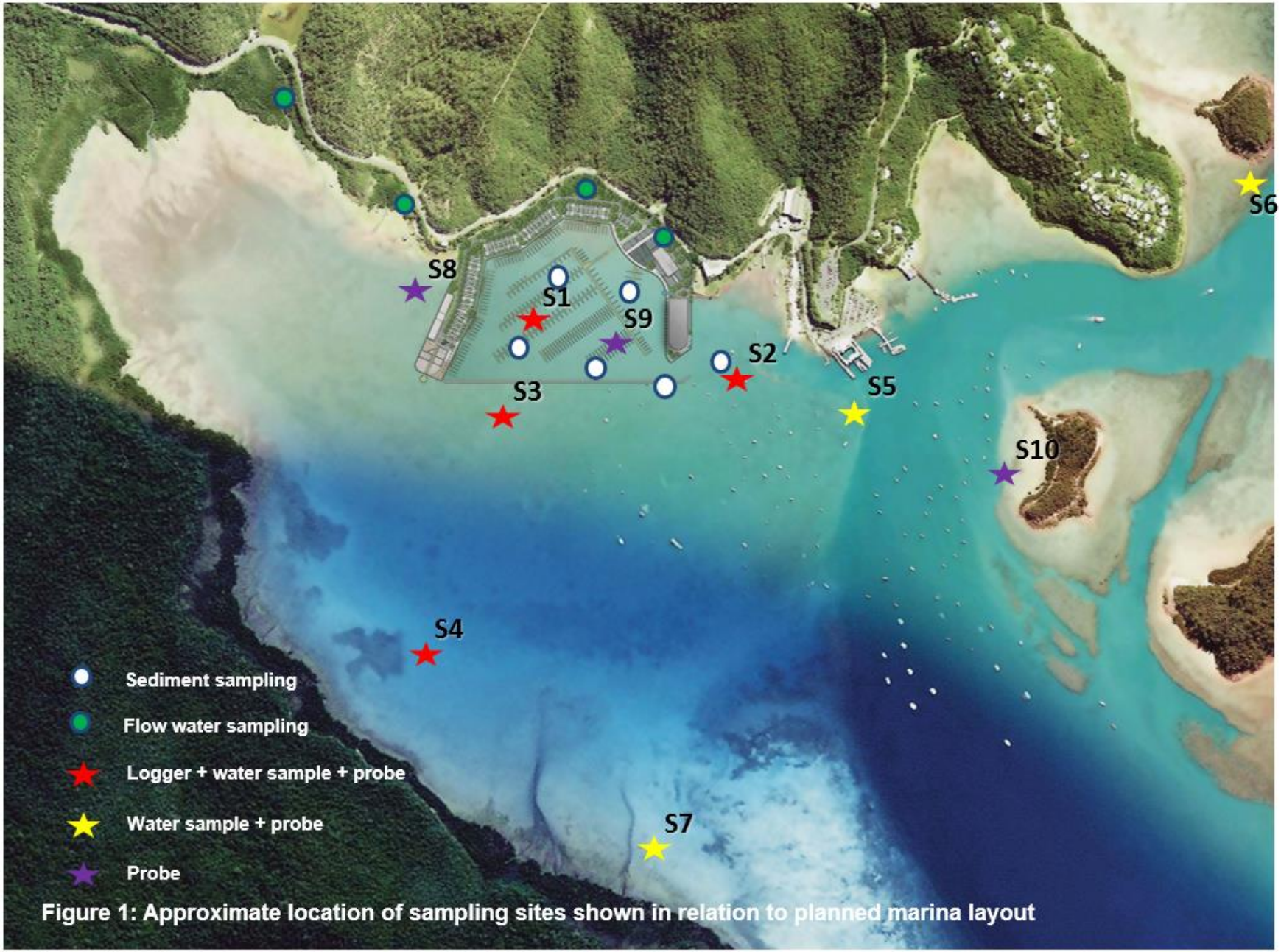

Figure 1: Approximate location of sampling sites shown in relation to planned marina layout

Table 9 Summary of baseline sampling methodology for water quality

Sample Locations (see Figure 1)	Ten monitoring locations for *in-situ* measurements; Seven of those locations for water grab sampling in addition to *in-situ* measurements; Four of those locations for additional deployment of continuous multi-parameter water quality loggers in addition to water grab sampling in and *in-situ* measurements: Three locations in Shute Harbour surrounding the development extents One location near sensitive receptors Four flow monitoring locations to be sampled for *in-situ* and laboratory analysis suites when flow is present.	
Scheduling	Monthly sampling for twelve months for all locations Continuous *in-situ* logging for twelve months at four locations	
Indicators	***In-situ* Logged and probe samples**	**Laboratory Analysis**
	Temperature (°C)	Nitrogen Suite (TN, NH_3+NH_4^+, NOx)
	Dissolved Oxygen (mg/L & % saturation)	Phosphorous Suite (TP, FRP)
	pH	Total Suspended Solids
	Electrical Conductivity (mS/cm)	Intestinal Enterococci
	Salinity (derived) (ppt)	Chlorophyll-a
	Turbidity (NTU)	Heavy Metals Suite (Cu, Pb, Ba, Be, Cd, Cr, Co, Mn, Ni, V, Zn, Hg)
	Secchi Disk Depth (not for flow monitoring)	Toxicants (see Table 7)
	Gross pollutants	Oil and Grease
	PAR vertical profile (not for flow monitoring)	Total Hydrocarbons (TRH), BTEXN
		Biological Oxygen Demand (BOD) – flow monitoring only
Methods	Samples for laboratory analysis – to be collected near-surface using pre-washed bottles to provide samples co-located with the logger data. *In-situ* measurements to be recorded using multi-parameter sonde at surface and bottom, and at 0.5 m intervals through the water column when time permits PAR profiles to be taken at each location Loggers to be deployed approximately 1 m below a surface marker buoy	
Reporting	Brief progress report following each monthly survey; major report with data analysis, recommended local WQOs and confirmation of on-going sampling design for construction and operational phases	

Table 10 Baseline (Pre-construction) Program. ● indicates 2 replicate samples taken at one station within a site

●● indicates 2 replicates taken at each of 2 stations within a site. The final selection of sites for photoquadrats and seed bank collections to be based on the outcome of habitat mapping (see Section 6).

Sites	Water Quality: Logger	Water Quality: Lab samples	Water Quality: Probe	Sediment Quality	Mapping: Sensitive habitats	Photo Quadrats: Sensitive habitats	Seagrass Seed bank
S1	●	●	●	●	Video Transects across Shute Bay – to include but not limited to transects sampled for EIS		
S2	●	●	●	●●		●	●
S3	●	●	●	●			
S4	●	●	●			●	●
S5		●	●			●	●
S6		●	●			●	●
S7		●	●			●	●
S8			●			●	●
S9			●	●●		●	●
S10			●				
Flow locations		●	●				
Frequency							
Season 1	Continuous manual downloads	●	●			●	●
Season 2		●	●			●	
Season 3		●	●			●	
Season 4		●	●	●		●	●

Table 11 Draft of During-Construction Program (subject to the results of the pre-construction (baseline) program)

● indicates 2 replicate samples taken at one station within a site; ●● indicates 2 replicates taken at each of 2 stations within a site.

Sites	Water Quality: Logger	Water Quality: Lab samples	Water Quality: Probe	Sediment Quality	Mapping:	Photo Quadrats: Sensitive habitats	Seagrass Seed bank
S1					Video Transects across Shute Bay		
S2	●	●	●	●●		●	
S3	●	●	●	●●			
S4	●	●	●			●	
S5		●	●			●	
S6		●	●			●	
S7		●	●			●	
S8	●	●	●			●	
S9			●				
S10			●				
Dredge tail water		●	●				
Frequency							
Seasonal and reactive	Continuous telemetered downloads	Once per season except if trigger levels exceeded Dredge tail water based on dredge volume progress	Once per season except if trigger levels exceeded	Annual	Seasonal	Seasonal	Only in response to major change in seagrass distribution

Table 12 Draft Post-Construction (Operational Phase) Program (subject to outcome of earlier stages).

● indicates 2 replicate samples taken at one station within a site, ●● indicates 2 replicates at each of 2 stations within a site.

Sites	Water Quality: Logger (*in situ*)	Water Quality: Lab samples	Water Quality: Probe (*in situ*)	Sediment Quality	Habitat Mapping:	Photo Quadrats: Sensitive habitats	Seagrass Seed bank
S1	●	●	●				
S2	●	●	●	●●			
S3	●	●	●	●●			
S4	●	●	●				
S5		●	●				
S6		●	●				
S7		●	●				
S8			●				
S9			●				
S10			●				
Flow locations		●	●				
Frequency							
Seasonal and reactive	Continuous telemetered monitoring for 6 months following commissioning, then during maintenance dredging one week before, through the dredging program and one week after	Seasonal for 6 months following commissioning, then one week before, during and one week after maintenance dredging	Seasonal for 6 months following commissioning, then one week before, during and one week after maintenance dredging	Five yearly audit	Five yearly audit	Five yearly audit	Only in response to major changes in seagrass distribution

4.8 Draft of Construction Phase & Post-Construction Phase Water Quality Monitoring

4.8.1 Construction Phase Monitoring

Construction phase monitoring will involve continuation of the baseline monitoring logger deployments, with the addition of real time telemetry to provide implementation of trigger responses to be developed based on results of the baseline monitoring. The scope of construction phase monitoring is summarised in **Table 11**. The provisional parameters and trigger values are presented in **Table 13**.

In addition to the Baseline sampling, field monitoring of the extent of the dredge plume will be conducted to verify modelled plume extent, and to assess the potential impacts of plumes on sensitive receptors. This monitoring will involve a towed multi-parameter water quality profiler with GPS logged tracks to provide logging of the horizontal extents of the dredge plume, and vertical profiles at regular intervals. Grab water samples for analysis of TSS will support the interpretation of the field measurements. The plume monitoring will be conducted during the commencement of dredge activities, and at intervals during the dredge works based on the findings of the initial monitoring. Any exceedances identified will require dredge operations to be suspended until the trigger level or background (control) conditions are achieved.

As recommended by the acid sulphate soils and sediment quality investigation for the EIS (Ullman & Nolan 2005), TBT contamination of sediments require that dredge spoil be contained prior to tail water release subject to verification testing. This requirement applies specifically to the upper portion of sediment and will require dredge activities to be planned to ensure that this testing can be conducted. In addition to the TBT monitoring, for all dredge spoil TSS will be monitored prior to release of tail water discharge. Tail water discharge will be monitored at a frequency determined by the volume of material dredged and the size of storage bunds. Dredge tail water releases will be held until verification testing results are available. Should verification testing results breach target levels, additional treatment and/or alternate disposal of tail waters will be required, such as reduction in dredge rates, extension of retention time prior to release, or other management action if contamination is deemed likely to cause environmental harm.

Table 13 Construction Phase Water Quality Targets

Water Quality Parameter	Water Quality Target	Notes
pH	8.0 to 8.4	Based on deployed loggers at limit of expected dredge plume in vicinity of sensitive receptors
Suspended Solids	<50 mg/L	During dredge monitoring sampling in vicinity of sensitive receptors
Turbidity	<10% increase from background levels During dredging no visible plume beyond 20 metres of the lease boundary	Based on deployed loggers at limit of expected dredge plume in vicinity of sensitive receptors
Litter/gross pollutants	No anthropogenic material greater than 50 mm in any dimension	During dredge monitoring at extents of plume
Tributyltin	<0.006 µg/L	Dredge spoil dewatering verification testing Additional parameters as required based on results of sediment quality sampling

Sampling and profiler measurements as per the baseline monitoring will continue during construction, with any change to the analysis suite from the baseline monitoring to be determined with consideration of the baseline results. Any exceedances of WQO's identified at impact sites without concurrent exceedances at control locations will require a suspension or reduction in dredging activities until appropriate management actions appropriate for the parameter are implemented.

4.8.2 Post-Construction (Operational) Monitoring

Operational monitoring will be conducted for six months following completion of construction as per the baseline monitoring methodology and subsequently carried out in association alongside maintenance dredging operations as required, The monitoring associated with maintenance dredging will commence one week prior to commencement of dredging operations and conclude one week following the completion of those works.

Locations for Post-Construction flow monitoring from site will be determined based on final development plans to ensure that site water discharges are adequately monitored, especially in regards to stormwater outflows. To ensure that stormwater flows are monitored adequately, two of the post-construction monitoring exercises will be performed following rainfall events to ensure flows from the development site are sampled. In addition, potential impacts arising from site activities (such as fuel or chemical contamination from the marina) will be captured by water monitoring within the marina extents during routine sampling.

4.8.3 Telemetered Data

Telemetry will not be implemented as a part of the baseline monitoring. The outcome of the baseline data will be used to refine the monitoring for the construction stage to enable implementation of telemetry during construction and, post-construction, including during maintenance dredging. The instrumentation selected for the baseline monitoring will integrate into a real-time telemetered system for the construction stage. The multi-parameter water quality sonde (YSI 6600-V2) will be supported by appropriate telemetry hardware, the Nexsens SDL500 data logger. This unit will provide radio, cellular or satellite data transmission, with potential web access to transmitted data. For this application, radio or cellular data are considered to be the most appropriate and cost effective transmission method.

The SDL500 logger will integrate into a surface buoy and allows cable connection to the water quality sonde, which will be deployed below the buoy as per the baseline monitoring mooring arrangement. The transmission antenna is protected within the surface buoy, with transmitted data received using the Nexsens iChart software package which allows data presentation on a PC housed in a site office.

4.9 Quality Assurance

Monthly servicing of the deployed loggers will be implemented to ensure consistent operation of the equipment. Calibration of all sensors will be done during the monthly servicing and comprehensive records will be maintained for all sensor calibration and maintenance. Data will be downloaded from the loggers during each servicing to allow ongoing monitoring of instrument performance, especially regarding the impact of marine biofouling on data quality.

Water samples will be collected in sample bottles prepared by the analytical laboratory and appropriate for each indicator. Upon collection, water samples will be stored on ice until dispatch to the analytical laboratory. All samples will be delivered within required holding times and accompanied by appropriate chain-of-custody documentation. Analyses will be undertaken at detection limits below the WQOs as prescribed following the Baseline.

Laboratory analysis will be carried out by the NATA accredited ALS Environmental Laboratory in Mackay.

5 Sediment Monitoring Program – All Phases of Construction

5.1 Rationale

Sediment testing was carried out in 2004 to assess both acid sulphate soils and sediment contamination with findings reported in Appendix I2 of the EIS (Ullman and Nolan, 2005). These findings indicated negligible risk of acid sulphate soils due to the net neutralising characteristics of the sediment in the dredge area. Some sediment contamination was identified, specifically tributyltin (TBT) normalised for organic carbon in the north and east of the development area. This contamination is likely due to the impact of boat mooring in the area.

Due to the length of time since sediment testing was conducted and the ongoing potential for contamination in the area particularly due to boating activities, further testing of sediments in the top portion of the bed will be carried out to assess the possible deposition of further contaminants since the previous testing. **Table 10 - Table 12** identify sampling sites and frequency of sampling for each of the three phases of construction.

5.2 Methodology

During the last of the baseline water quality surveys, duplicate sediment samples will be collected from six locations within and close to the development footprint, as shown in **Figure 1**. A grab sampler will be used to collect the sample from the upper portion of the sediment, representing the most recently deposited sediment layer. Samples will be handled using appropriate field procedures and sent for laboratory analysis for the following parameters.

- Heavy Metals: As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn;
- Total Petroleum Hydrocarbons/BTEX;
- Polyaromatic Hydrocarbons;
- Tributyltin;
- Total Organic Carbon.

These indicators reflect potential sources of contamination near the development. Results of this sampling will be assessed using ISQG sediment thresholds presented in ANZECC (2000) and as revised by Simpson *et al.* (2013). Results will inform the development of construction phase dredge spoil dewatering verification testing, as described in **Section 4.8.1**.

6 Monitoring Sensitive Habitats – All Phases of Construction

Sensitive habitats could potentially be a risk due to direct loss of habitat, but this would be avoided by the positioning of the marina footprint and navigation channel (EIS documents, 2008 and 2013). Indirect impacts are most likely to be related to changes in water clarity, causing increased light attenuation to the bay floor. Thus monitoring of sensitive habitats will be linked to turbidity, suspended sediment and PAR.

Sensitive habitats will be monitored within three tiers of investigation, with greatest emphasis on seagrasses, and with the ability to implement reactive monitoring if water quality objectives are exceeded during Construction and Operation. All methods will be standardised to provide consistency and enable continuity for monitoring before, during and after construction (**Table 10 – Table 12**). Notwithstanding this, some sites may need to be moved (or removed) from the marina footprint during construction. The selection of sites (see below) will ensure that some sites are placed within the zone of influence associated with construction. The following three tiers of monitoring will be implemented:

Tier 1 will consist of habitat mapping using towed video transects to map the distribution of seagrasses, macroalgae and corals within Shute Bay. As recommended in **Appendix 2**, a subset of transects sampled for the EIS studies (2008) will also be sampled as part of the REMP.

As part of the habitat mapping and during all site visits, observers will look for and report any incidence of lyngbya within the study area. The presence of lyngbya would trigger a more detailed mapping of that blue green alga and compare its distribution with water quality data (e.g. nutrient concentrations).

Tier 2 will utilise photoquadrats taken by drop camera or video (if the quality of video stills is adequate) to obtain data on the percent cover of seagrasses and presence of corals and macroalgae (e.g. using coral point count methodologies). The primary emphasis will be seagrasses and sites will be confirmed following the first mapping survey. Notionally, six to eight sites will be selected within Shute Bay and another four sites will be selected outside the bay as reference sites.

Tier 3 will investigate the seed bank for seagrasses at the sites selected in Tier 1. This will provide information on the persistence of seagrasses at each site and may indicate the potential for recovery from disturbance by natural processes or from an effect of the marina. Replicate samples of sediment will be obtained using a small grab or push corer operated from a small boat.

The above methods have been developed so that they do not require the use of divers to sample sensitive habitats. Use of diving has been avoided in this study because of HSE issues potentially arising due to the poor water clarity likely to arise in Shute Harbour and potential for encounters with dangerous marine animals, including crocodiles, stonefish and marine stingers. This approach will be reviewed if necessary during the Pre-Construction Phase.

Locations for sensitive habitats will be refined from mapping undertaken during the Pre-Construction (Baseline) Phase.

The Baseline sampling will confirm/adjust distribution of sensitive habitats as presented in the EIS documents (2008 & 2013). Currently, no seagrasses are reported to occur within the marina footprint. During Construction sensitive habitats would continue to be monitored to address the potential risk of plumes being transported to those habitats. During Operation adverse changes in water quality would be used as a trigger for reactive monitoring of seagrasses and corals using the same methods as per the Baseline and Construction phases. This approach is considered appropriate given that sensitive habitats have not been identified within the footprint. An exception to this may be required during maintenance dredging, but this would need to be assessed at the time, based on locations of maintenance dredging and volumes of material.

Linking WQOs (e.g. turbidity) to sensitive habitats – see data analysis in Section 7.2

- Sampling frequency would be continuous for data loggers, and seasonal for laboratory analysis and probe measurements, with provision for event-based surveys. There is provision to adjust these if considered warranted, particularly after the Pre-Construction Phase, when the Baseline has been established. Frequency is considered to be capable of capturing a range of conditions and hence is considered to be appropriate for the project. Following an initial period of sampling during the

operational phase, water quality sampling would be reduced to periods associated with maintenance dredging and to a 5-yearly environmental audit.

- Table 6 identifies the water quality timing and indicators presented in the original and supplementary EISs and not what is being proposed in the REMP, which is in Section 2.4 of the REMP.
- All nominated indicators will be monitored during the REMP, with the exception of pesticides, herbicides and TBT, which would be sampled only during the Baseline, with a decision for ongoing monitoring to be made based on initial analyses (Section 4.6.2 of REMP)
- Baseline monitoring will commence at least one year prior to Construction to allow sampling during 4 seasons with provision for 2 event-based sampling events (Table 10). Construction monitoring will continue for the entire period of Construction, with water quality loggers deployed continuously at selected sites, but subject to revision based on the Baseline data. Lab samples and probe will be acquired seasonally except if trigger levels for WQO are exceeded (Table 11). During Operation, full water quality sampling will be phased-out except during maintenance dredging and there will be a 5-yearly audit involving water quality surveys that occurs on an ongoing basis.

Sediments would be sampled as part of the 5-yearly audit (Table 12) at sites S2 & S3 (Figure 1). This is considered adequate at this stage but would be subject to review at the commencement of the Operational Phase.

7 Data Analysis, Reporting and Management Responses

7.1 Data Analysis and Reporting

A brief progress report will be prepared upon completion of each survey during each of the three project phases and following future maintenance dredging. The progress reports will present dates/times of sampling, methods and tasks, issues or problems associated with the survey, and a brief overview of findings or any recommended changes to the program. An annual report will also be prepared and made publicly available on the approval holder's website.

The annual report will include:

- Non-technical Executive Summary
- Introduction (background information, objectives and scope or works of the phase)
- Methodology – field, laboratory and data analysis
- Results – including:
  - data summaries
  - results of statistical analyses of spatial and temporal trends and interpretation of those results, and
  - derivation of WQOs, which will be based on exceedance of median values and 95% confidence limits (as per ANZECC/ARMCANZ 2000)
- Discussion and Recommendations for ongoing monitoring. This will include, as part of the Pre-Construction Phase, a proposed methodology for telemetered, real time data during Construction.

The final report for the Pre-Commencement Phase will be published and posted prior to the commencement of Construction. Subsequent annual reports will be published on the anniversary of the commencement of construction.

Water Quality data will be analysed in two ways. First, data will be compared against WQOs, in terms of range of values, average concentration and 95% confidence limits (CL). The CL are important in showing variability in the data and the likelihood of exceedance of a WQO. Data will be tabulated and displayed graphically for each sampling site and time of sampling. Second, data will be used to test for statistical changes in indicators among sites and times of sampling. This would be done using statistical tests such as Analysis of Variance (ANOVA) or Permutational Analysis Variance (PERMANOVA), subject to the final sampling designs and various assumptions associated with these tests. Additionally, multivariate analyses

will be considered (PERMANOVA and Principal Coordinates Analysis) to characterise water associated (based on all water quality indicators – chemical and/or physical) with different sites/times; and regression analysis will be considered to assess the presence of gradients in water quality indicators with distance from specified activities (e.g. dredging, tail water outflow, creeks).

Sediment data will be analysed in a similar way to that described above for water quality, with concentrations of potential contaminants (range, mean and CL) compared against Low and High trigger values (ANZECC 2000; Simpson *et al.* 2013) and inferential statistics used to compare concentrations among sites and times.

Data acquired for sensitive habitats will be examined in the following ways. Video transects will be used to map the distributions of seagrasses and corals within Shute Bay. Scaled maps would depict presence and occurrence of seagrass or coral taxa and their proximity to the marina footprint, dredging activities, tail water discharge, etc. Mapping also would be used to estimate the area of sensitive habitats in Shute Bay at each time of sampling. Video stills or drop camera photographs would be processed using the Coral Point Count (CPCe) application to estimate percent cover of seagrass, coral or macroalgae (or other seabed features of interest). These would be analysed statistically to determine variability in percent cover or taxon richness over time and among sites. Similarly, measures of the seagrass seedbank would be used to identify changes in abundance of taxa and seeds through time and among sites. Finally, metrics associated with sensitive habitats will be compared against key water quality indicators, such as turbidity and suspended sediments, to determine the likelihood that activities associated with the marina could be impacting upon them.

7.2 Options for Management Response

A detailed protocol for management responses will be provided in the final report for the Pre-Construction Phase based on the finding of the baseline studies, specifically, project-specific WQO sediment quality data and locations and environmental condition of sensitive habitats. To ensure the protection of MNES, the approval holder will not discharge, irrigate or otherwise release potable water, wastewater, stormwater, harvested water, bilge water or sewage effluent into Shute Bay unless the discharge complies with discharge criteria defined for the site and approved by the Minister as required under Condition 10. Thus, any such discharges will be subject to monitoring and assessment of water quality and discharges modified based of compliance or non-compliance with the WQOs.

The following options for management response are considered in relation to each phase of the project.

7.2.1 Options Based on Pre-Construction Findings

No impacts associated with the marina will occur during the Pre-Construction (Baseline) Phase. Management responses will arise from the data collected during this phase and will include refining the monitoring as follows:

- Confirming WQOs to be applied throughout the project
- Defining sediment characteristics and potentially identifying hotspots that may need to be need to be considered for the dredging program
- Confirming the locations of sensitive habitats which may also require consideration during construction and operational phases.

Potential responses to the baseline data will be described during progress reports and consolidated into the final report for the Pre-Construction Phase.

7.2.2 Options Based on Construction Impacts

Management responses will need to be considered for both the construction and operational phases in two ways. First in terms of unforeseen effects, that could be either effects that were not predicted in the EIS documentation (2008, 2013) or that cause an impact greater than was predicted in the EIS documentation. Second, effects caused by accident, such as a fuel spillage.

The Baseline monitoring data and concurrent monitoring of all sampling sites, including reference sites, will be used as a measure of change that could be inferred as an impact due to the project. The WQO and Sediment Guidelines will be used to assess the environmental importance of change. Changes in sensitive

habitats will also be compared with baseline and reference data, but there is no set guideline to judge change against.

In the event that a change due to the project is inferred, options available for management response include the following:

- Intensify monitoring for short term and minor impacts (e.g. small increase in concentration of a contaminant, or turbidity, or a small reduction in dissolved oxygen)
- Determine what has caused the impact and modify activities (e.g. dredging, dredge water discharge) to remove it. Applicable for a moderate impact
- Determine what has caused the impact and immediately cease that activity until it can be redesigned to ensure no repeat of that impact. This would be applicable for a major impact (e.g. direct loss of sensitive habitat or fish kill).

The Baseline Data will be used to provide a context for determining what constitutes “minor”, “moderate” or “major” impacts.

The potential for accidental impacts such as oil spills, sewage overflows, failure of containment bunds, etc. should be anticipated and responses plan developed during the Baseline Phase. Such plans should include assignment of roles to staff or contractors, acquisition and maintenance of a clean-up kits, containment booms, work vessels, etc., and emergency contact numbers. The Baseline Data should provide a basis for measuring impacts from spills, although selection of additional sampling sites and intensified sampling.

If damage to sensitive habitats occurs as a result of activities associated with the marina, habitat restoration should be considered, such as transplanting of seagrasses or corals to affected areas.

7.2.3 Options Based on Operational Impacts

Operational impacts have the potential to occur in a similar way to those described for the Construction Phase, that is, in terms of unforeseen effects and accidents. Impacts occurring during this phase may build up over time, causing chronic rather than acute effects. Impacts also may occur due to maintenance dredging although these are likely to be of a lesser magnitude than the capital required during construction.

Management responses for impacts occurring during operation are similar to those described above, such as modification of activities, but will be refined during the Construction Phase.

8 Management Systems

A project of this nature will require establishment of a range of systems in order to manage the project with a high degree of quality, integrity, safety and continuity so that the data that are collected can have benefit well beyond the three phases of monitoring defined under the conditions of consent. The sections below list key factors that must be included in the operations of the REMP, including data management, reporting, access, field equipment, staff training and qualifications and safety.

8.1 Data Management System

An Oceanographic Information Management System (OIMS) or similar database platform should be implemented to manage the data acquired during all phases of the monitoring. OIMS has been adapted from the publically available framework Integrated Marine Observing System (IMOS), which was originally established by eMarine Information Infrastructure, based at the University of Tasmania. This data management structure will manage the coordination of information relating to all fieldwork and instrument deployment being carried out as part of the Water Quality and Subtidal Sedimentation Scope. It will also result in the generation of NetCDF files for all logged data obtained on a monthly basis.

OIMS is made up of two major elements: a database run through a Microsoft Access/SQL database (OIMS database) and a processing toolbox (OIMS toolbox) that utilises Matlab®. Field trip metadata will be stored within the OIMS database in conjunction with the data file. The metadata will be read into the toolbox for further processing into the NetCDF files. The OIMS processing system is built on a system of routines written as Matlab® scripts and contained in the freely available IMOS toolbox.

OIMS allows standardised QA/QC routines to be automatically performed on all field, logged and laboratory data, with additional processes to standardise the completion of manual data QA/QC assessments.

8.2 Access Issues and Constraints

Access issues are essential to ensure that the work is undertaken in the most efficient manner feasible. Additionally, staff will come into contact with members of the public both on the shore and the water. Staff must be trained in interacting with the public in a polite and courteous manner. Potential areas that will need to be considered include accessing boat ramps and other places with appropriate boat ramp “etiquette”. Particular consideration may be necessary under circumstances including:

- Access during construction;
- High tide sampling.

8.3 Field Equipment Required

A field kit will need to be compiled by each field team, including, for example:

- Small boat and safety equipment;
- Toolkit(s) and first aid kit(s);
- Ruler, quadrats
- Water and sediment grab samplers;
- Towed video/Camera equipment
- Slates/waterproof paper/pencils
- GPS unit and backup, spare batteries, etc.

8.4 Staff Training and Qualifications

Staff undertaking the monitoring program described above would need, as a minimum, the following qualifications, experience and skills:

- Undergraduate degree in a relevant discipline (Biological/Ecological/Environmental Science/oceanography/coastal processes);

- Training and practical experience in the principles of sampling design and techniques;
- Scheduling and time management experience skills;
- If scuba diving is required, recognised commercial dive qualification (AS 2815 or equivalent);
- Training and practical experience in the use of a variety of field equipment (i.e. small boats, GPS units);
- Training and practical experience in procedures for recording field data;
- Training and practical experience in implementing QC procedures for field and data, including data checking and storage;
- Database management skills and experience;
- GIS mapping skills and experience;
- Training and practical experience in analysis of biological/ecological data; and
- Report writing skills.

Overall, it is considered that approximately three years practical experience will be expected, in addition to qualifications and training as listed above would be required for staff undertaking the monitoring program under the supervision of a senior environmental scientist.

8.5 Summary of OHS&R and Considerations

Staff undertaking the outlined monitoring program will be required to have experience in the following OHS&R tasks:

- Preparation of Safe Work Methods Statements (SWMS);
- Training in relevant OHS&R procedures, including on-site induction (if required – e.g. during the construction phase) and emergency procedures;
- Evidence of competency in boat operation (i.e. small boat license);
- Competency in swimming;
- First aid training to senior level;
- Appropriate vaccinations;
- Understanding and use of appropriate personal protection equipment (protective clothing, hat, sunscreen, etc.); and
- Planning and implementation of safe work methods for diving, if required.

All staff will be required to read and sign and attend pre-start team meetings for every field day. Pre-start meetings will utilise a toolbox form that details work for that day and identifies safety issues.

9 References

ANZECC/ ARMCANZ (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Canberra.

Cardno (2008) Shute Harbour Marina Resort, Environmental Impact Statement. Cardno (Qld) Pty Ltd. Queensland

DERM (2009). Queensland Water Quality Guidelines. Version 3. Department of Environment and Resource Management. Queensland Government. Queensland.

DSDIP (2013) Shute Harbour Marina project: Coordinator-General's evaluation report on the environmental impact statement. Department of State Development, Infrastructure and Planning. Queensland Government. Queensland.

GBA (2013) Shute Harbour Marina Resort, Supplementary Environmental Impact Statement. GBA Projects. South Australia.

Simpson, S. L., Batley, G. E. and Chariton, A. A. (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO Land and Water Science Report 08/07, May 2013. Prepared for the Department of Sustainability, Environment, Water, Population and Communities.

Ullman and Nolan (2005), Shute Harbour Marina – Report on Acid Sulphate Soils and Sediment Contamination Investigation, Ullman & Nolan Technical Services Pty Ltd, Queensland

Appendix 1: Relevant Conditions

QLD Department of Environment and Heritage Protection

Receiving Environment Monitoring Program

The Department of Environment and Heritage Protection has jurisdiction for the following conditions:

Condition 17.

A Receiving Environment Monitoring Program (REMP) must be developed and implemented to monitor, identify, describe and respond to any adverse impacts to:

(a) surface water quality

(b) water flows

(c) aquatic flora and fauna, and

(d) any receiving waters.

Condition 18.

The REMP must include periodic monitoring for the effects of any release on the receiving environment as a result of contaminant releases to waters from the site.

Condition 19.

(a) The REMP must:

(i) assess the condition or state of receiving waters spatially within Shute Bay (the REMP area), considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality)

(ii) establish parameters to be monitored including but not limited to turbidity and Total Suspended Solids (TSS), nutrients, metals and metalloids and justify:

(A) the parameters chosen, and

(B) assumptions and choices made in preparation of the REMP.

(iii) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected

(iv) detail monitoring locations and water quality indicators pertinent to the sensitive receptor types and locations that have been designed to:

(A) determine the baseline condition of water quality and sensitive receptors (i.e., corals and seagrass meadows) within the zone of influence to a sufficient resolution to be capable of reliably detecting lethal and sublethal (stress) impacts

(B) develop or adopt locally-relevant trigger values for key water quality indicators including turbidity, and

(C) provide on-line real-time monitoring capability for key sediment plume-related indicators (including but not limited to turbidity, pH, EC).

(v) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the Environmental Protection (Water) Policy 2009 (Proserpine River, Whitsunday Island and O'Connell River Basins Environmental Values and Water Quality Objectives) (DEHP 2013)

(vi) include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 200027 and/or the most recent version of Australian Standard 5667.1)

(vii) apply procedures and/or guidelines from ANZECC and ARMCANZ 2000 and other relevant guideline documents

(viii) describe sampling and analysis methods and quality assurance and control, and

(ix) justify all assumptions and choices made in preparation of the REMP.

Condition 20.

The REMP must be implemented for a minimum of 12 months prior to commencement of construction activity and not cease until construction is completed.

Condition 21.

A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared and made publicly available on the proponent's website annually, within one month of its completion and remain for the duration of the action. The first report must be published prior to the commencement of construction. This report must include an assessment of background reference water quality in the REMP area compared against the water quality objectives established in the REMP.

9.1.1 Marine Water Quality

The Department of Environment and Heritage Protection has jurisdiction for the following conditions:

Condition 37.

(a) After at least twelve months of implementation of the REMP, as required under Conditions 17-21, the proponent must set discharge criteria for relevant parameters, against which future discharges from Shute Harbour Marina to Shute Bay must be monitored. The discharge criteria must be:

(i) developed with reference to Queensland Water Quality Guidelines Environmental Protection (Water) Policy 2009 (Proserpine River, Whitsunday Island and O'Connell River Basins Environmental Values and Water Quality Objectives) (DEHP 2013), and

(ii) approved by the administering authority/Department of Environment and Heritage Protection prior to commencement of construction.

Condition 38.

The proponent must not discharge, irrigate or otherwise release potable water, wastewater, stormwater, harvested water, bilge water or sewage effluent into Shute Bay unless the discharge complies with discharge criteria defined for the site and approved by the administering authority/Department of Environment and Heritage Protection.

Condition 39.

Acid sulphate soils or potential acid sulphate soils encountered during construction must be managed in accordance with the Queensland Government's Instructions for the Treatment and Management of Acid Sulphate Soils (2001).

Condition 40.

Structural components of the Shute Harbour Marina in contact with marine waters are to be non-biodegradable and are not to be treated with toxic compounds (including but not limited to copper chrome arsenic) or anti fouling agents such as Tributyltin (TBT).

Condition 41.

An Erosion and Sediment Control Plan (ESCP) must be developed by an appropriately qualified person and implemented for all stages of the Shute Harbour Marina to minimise to the greatest extent possible erosion and the release of sediment to receiving waters and contamination of stormwater. The ESCP must be developed in accordance with Best Practice Erosion & Sediment Control (IECA 2008).

Condition 42.

The proponent must ensure that maintenance and cleaning of any vessels, vehicles, plant or equipment within Shute Harbour Marina is not carried out in areas from which contaminants can be released into any receiving waters.

Commonwealth Department of the Environment

Relevant conditions under the **Commonwealth Approval** include the following:

Condition 4

To ensure the protection of Matters of National Environmental Significance (MNES), the approval holder must develop and implement a Receiving Environment Monitoring Program (REMP) to identify, describe, monitor and respond to any adverse impacts to:

(a) surface water quality;

(b) water flows;

(c) aquatic flora and fauna; and

(d) any receiving waters.

Condition 5

The REMP must include periodic monitoring for the effects of any release on the receiving environment as a result of contaminant releases to waters from the site.

Condition 6

The REMP must:

(a) assess the condition or state of receiving waters spatially within Shute Bay (the REMP area), considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality);

(b) establish parameters to be monitored including but not limited to turbidity and Total Suspended Solids (TSS), nutrients, metals and metalloids and justify:

(i) the parameters chosen, and

(ii) assumptions and choices made in preparation of the REMP.

(c) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected;

(d) detail monitoring locations and water quality indicators pertinent to the sensitive receptor types and locations that have been designed to:

(i) determine the baseline condition of water quality and sensitive receptors (i.e., corals and seagrass meadows) within the zone of influence to a sufficient resolution to be capable of reliably detecting lethal and sublethal (stress) impacts,

(ii) develop or adopt locally-relevant trigger values for key water quality indicators including turbidity, and

(iii) provide on-line real-time monitoring capability for key sediment plume- related indicators (including but not limited to turbidity, pH, EC).

(e) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the Environmental Protection (Water) Policy 2009 (Proserpine River, Whitsunday Island and O'Connell River Basins Environmental Values and Water Quality Objectives) (DEHP 2013);

(f) include monitoring of metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000 and/or the most recent version of Australian Standard 5667.1);

(g) apply procedures and/or guidelines from ANZECC and ARMCANZ 2000 and other relevant guideline documents;

(h) describe sampling and analysis methods and quality assurance and control; and

(i) justify all assumptions and choices made in preparation of the REMP.

Condition 7

The REMP must be approved by the Minister in writing prior to its implementation.

Condition 8

The REMP must be implemented for a minimum of 12 months prior to commencement of construction and must not cease prior to expiry of this approval.

Condition 9

A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared annually and made publicly available on the approval holder's website. All annual reports must remain publicly available for the duration of the approval. The first report must be published prior to the commencement of construction, and all future reports must be published on the anniversary of the commencement of construction. Each report must include, but not be limited to, an assessment of measured water quality in the REMP area compared against the water quality objectives outlined and/or established in the REMP at condition 6(c).

Condition 10

After at least twelve months of implementation of the REMP, as required under Conditions 4-9, the approval holder must set discharge criteria for relevant parameters, against which future discharges from Shute Harbour Marina to Shute Bay must be monitored. The discharge criteria must:

(a) be developed with reference to Queensland Water Quality Guidelines Environmental Protection (Water) Policy 2009 (Proserpine River, Whitsunday Island and O'Connell River Basins Environmental Values and Water Quality Objectives) (DEHP 2013);

(b) not be inconsistent with discharge criteria developed or approved under state or local government approvals; and

(c) be approved by the Minister in writing prior to commencement of construction.

Condition 11

To ensure the protection of MNES, the approval holder must not discharge, irrigate or otherwise release potable water, wastewater, stormwater, harvested water, bilge water or sewage effluent into Shute Bay unless the discharge complies with discharge criteria defined for the site and approved by the Minister as required under Condition 10.

Appendix 2: Department of Environment and Heritage Protection: Advice on proposed REMP for Shute Harbour Marina, June 2014.

Appendix 3: Probe and Logger Descriptions and Specifications