14 Marine Ecology Impact Assessment

Assessment of potential impacts to marine ecological values from Project construction and operational phase activities was undertaken in two stages. Stage 1 involved a preliminary risk analysis to identify sensitive ecological receptors that could be impacted by each project activity, the pathways by which potential impact could occur and the type of impact (pulse, press or catastrophic).

Potential impacts were considered in further detail in Stage 2 based on information provided in the Project 30% design report (AECOM, 2019a) that describes the ocean outfall pipeline alignment, diffuser design and anticipated construction methods; and findings from the dispersion modelling report (AECOM, 2019c) that predicts the behaviour and dilution of the treated wastewater plume in the near-field and far field and the predicted water quality impacts (Elgin, 2021).

14.1 Approach

Assessing potential impacts of the Project construction and operational phases to marine ecological receptors and values was undertaken in a qualitative risk analysis which considered the Project design information and data gathered during the preparation of this report, with the following key elements:

1. Upgrade of STP processes to improve wastewater quality
2. Construction and operation of ocean outfall for disposal of treated wastewater
3. Decommission of beach-face outfall
4. Decommissioning dunal ex-filtration ponds
5. Ongoing beneficial re-use of treated wastewater.

Potential sensitive receptors:

- Threatened and protected species – marine mammals and fish listed under FM Act, BC Act and or EPBC Act
- Marine habitats and communities of Merimbula Bay that includes -
    - Soft sediment habitat (Type 3 fish habitat)
    - Soft sediment infauna and epifauna communities
    - Sub-tidal rocky reef communities (Type 2 fish habitat)
    - Fish assemblage
    - Intertidal reef communities
    - Phytoplankton and drift algae
- Estuarine habitats and communities Merimbula Lake and Pambula River estuary.

Environmental Values to be protected:

- Estuarine and marine waters aquaculture
- Recreational and commercial fishing
- Abalone fishery.

The risk analysis was undertaken using a matrix of likelihood and consequence definitions developed for assessing risks associated with identified hazards / impacts to marine ecological receptors and environmental values. The likelihood and consequence definitions and risk ratings tables are included as **Tables 14-1, 14-2**, and **14-3** below**.**

Table 14-1 Marine ecology impact likelihood definitions

LIKELIHOOD LEVEL	Rare 1	Unlikely 2	Possible 3	Likely 4	Almost Certain 5
Likelihood of impacts	Never reported for this situation, but still plausible within the timeframe (< 5%)	Uncommon, but has been known to occur elsewhere. Expected to occur here only in specific circumstances within the timeframe (5-30%)	Some clear evidence exists to suggest this is possible in this situation within the timeframe (30-50%)	Expected to occur in this situation within the timeframe (50-90%)	A very large certainty that this will occur in this situation within the timeframe (>90%)

Table 14-2 Qualitative measures of consequence applicable to the spatial scale of the Project area for marine ecology values

CONSEQUENCE	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Environmental Value	No measureable negative impacts on habitats and/or biotic assemblages are or will be evident against natural variations	Barely measurable negative impacts on habitats and/or biotic assemblages are or will be evident compared to total habitat area or abundance of biota against natural variations.	Measurable and on-going negative impacts on habitats and/or biotic assemblages are or will be evident in one or more locations. Nevertheless, both the level and the percentage of habitats and/or biotic assemblages affected have not or will not influence their overall recovery capacity, and a change in the overall trophic/community structure isn't and will not be evident.	Substantial measureable and on-going negative impacts on habitats and/or biotic assemblages are or will be evident in in one or more locations, and the proportion of habitats and/or biotic assemblages affected will influence the recovery capacity of the habitats and/or biotic assemblages, with some clear shifts in the overall trophic/community structure and function	The level of habitat and/or biotic assemblages negatively affected endangers their long-term survival, and will result in extreme changes to the region's trophic/community structure as well as the function of the remaining habitat and/or biotic assemblages.
Abalone	No measureable negative effect on abalone or abalone habitat will be evident against natural variations	Barely measureable negative effect on abalone or abalone habitat will be evident against natural variations	Measureable negative effect to abalone (i.e. reduced abundance) or abalone habitat localised to some Merimbula Bay reefs. Level of effect may be short-term and does not influence overall capacity of species recovery.	Measureable and on-going negative effect to abalone (i.e. reduced abundance) and abalone habitat on reefs within Merimbula Bay. Level of effect will influence overall capacity of species recovery. Commercial fishery of Merimbula Bay reefs impaired.	Abalone and abalone habitat negatively affected (i.e. reduced abundance) within Merimbula Bay, with limited prospect of species recovery. Commercial fishery of Merimbula Bay reefs no longer viable.

CONSEQUENCE	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Sub-tidal Rocky Reef Assemblage (Invertebrates and Algae)	No measureable effect on subtidal assemblage will be evident against natural variations	Barely measureable negative effect on subtidal assemblages against natural variations	Measureable negative effect (i.e. reduced species diversity and abundance) on subtidal assemblage localised to reefs closest to mixing zone	Measureable and on-going negative effect (i.e. reduced species diversity and abundance) to subtidal assemblages of reefs closest to mixing zone, with potential effect extending futher to one or more other rocky reef locations	Subtidal reef assemblages of Merimbula Bay negatively affected and changes to the broader trophic/community structure of those areas likely.
Intertidal Shore Assemblage	No measureable effect on intertidal assemblage will be evident against natural variations	Barely measureable negative effect on intertidal assemblages against natural variations	Measureable negative effect (i.e. reduced species diversity and abundance) on intertidal assemblage at one or more locations within to Merimbula Bay	Measureable and on-going negative effect (i.e. reduced species diversity and abundance) to intertidal assemblages within Merimbula Bay with potential effect extending to one or more locations beyond Merimbula Bay	Intertidal assemblages of Merimbula Bay negatively affected and changes to the broader trophic/community structure of those areas likely.
Soft Sediment Infauna	No measureable effect on infauna assemblage will be evident against natural variations	Barely measureable negative effect on infauna assemblage (i.e. reduced species diversity and abundance) within the mixing zone would be evident compared to broader Merimbula Bay against natural variations	Measureable negative effect (i.e. reduced species diversity and abundance) on infauna assemblage localised to the mixing zone, and evidence that effect potentially extends outside the mixing zone. A change in the overall trophic/community structure within or outside the mixing zone would not be evident	Measureable and on-going negative effect (i.e. reduced species diversity and abundance) to infauna assemblage outside the mixing zone, including negative effect(s) extending to one or more locations in broader Merimbula Bay. Change in local infauna assemblage causing broader change in trophic/community structure at those locations possible.	Infauna assemblage negatively affected beyond the mixing zone, and changes to the trophic/community structure of those areas likely.
Phytoplankton	No measureable negative or positive effect on phytoplankton assemblage will be evident against natural variations	Barely measureable negative or positive effect on phytoplankton assemblage within the mixing zone would be evident compared to broader Merimbula Bay against natural variations	Measureable negative or positive effect (i.e. reduced or increased species diversity and abundance) on phytoplankton assemblage localised to the mixing zone, and evidence that effect potentially extends outside the mixing zone. A change in the overall trophic/community structure within or outside the mixing zone would not be evident	Measureable and on-going negative or positive effect (i.e. reduced or increased species diversity and abundance) outside the mixing zone, including negative or positive effect(s) extending to one or more locations in broader Merimbula Bay. Change in local phytoplankton assemblage causing broader change in trophic/community structure at those locations possible	Phytoplankton assemblage negatively or positivley affected beyond the mixing zone, and changes to the trophic/community structure of those areas likely

CONSEQUENCE	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Fish Assemblage	No measureable negative effect on fish assemblage will be evident against natural variations	Barely measurable negative effect on fish assemblage (i.e. reduced species diversity and abundance) within the mixing zone would be evident compared to broader sand habitat of Merimbula Bay against natural variations	Measureable negative effect (i.e. reduced species diversity and abundance) on fish assemblage localised to the mixing zone, and evidence that effect potentially extends outside the mixing zone to broader sand habitat areas of Merimbula Bay. A change in the overall trophic/community structure within or outside the mixing zone would not be evident	Measureable and on-going negative effect (i.e. reduced species diversity and abundance) outside the mixing zone, including negative effect(s) extending to one or more locations. Change in fish assemblage causing broader change in trophic/community structure at those locations possible	Fish assemblage negatively affected beyond the mixing zone, such that some species no longer locally present, and changes to the trophic/community structure of those areas likely
Threatened and protected marine species (*FM Act, BC Act, EPBC Act*)	No measureable negative impacts on threatened or protected species are or will be evident against natural variations	Barely measurable negative impacts on threatened or protected species are or will be evident against natural variation. Nevertheless, there are either no substantial negative impacts or only extremely few mortalities within 5-10 years, and there is not and will not be a measurable effect on local population status of protected species or recovery of threatened species	Many individuals of a threatened or protected species are or will be measurably negatively affected. Nevertheless, no on-going impact on local dynamics or overall number of individuals is or will be evident, and the impact has not or will not significantly affect population status of protected species or recovery of already threatened species	Substantial measurable and on-going negative impacts that are or will affect the number of individuals of protected species and recovery of already threatened species	The ongoing level of mortality has or will generate significant additional declines to already threatened or protected species leading to potential local extinction in NSW

Table 14-3 Risk ratings matrix

		Consequence				
		Insignificant 1	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
Likelihood	**Almost Certain 5**	Low 5	Medium 10	High 15	High 20	High 25
	Likely 4	Minimal 4	Low 8	Medium 12	High 16	High 20
	Possible 3	Minimal 3	Low 6	Low 9	Medium 12	High 15
	Unlikely 2	Minimal 2	Minimal 4	Low 6	Low 8	Medium 10
	Rare 1	Minimal 1	Minimal 2	Minimal 3	Minimal 4	Low 5

LEGEND:

High Risk	Unacceptable level of risk. Measures to reduce risk to a lower level required.
Medium Risk	Risk may be considered acceptable. Routine and cost-effective measures required to reduce and/or manage risk.
Low Risk	Tolerable level of risk that can be managed by routine procedures, or, no further measures to manage the risk are required.
Minimal Risk	Acceptable level of risk with no further mitigation measures required.

14.2 Potential Project Impacts to Marine Ecology

14.2.1 Construction phase impacts

Construction phase activities include establishing the proposed ocean outfall pipeline in two sections:

- Section one - STP to a location beyond surf zone: underground trenchless drilling method.
- Section two - Location beyond surf zone to offshore pipeline termination point: laying of pipeline on seabed floor and covering with rock or concrete mattresses.

Construction of pipeline section one is not expected to cause impacts to marine ecological values and has not been assessed. Construction of pipeline section two would involve laying a 450 mm diameter pipeline directly over the seabed and anchoring with either a cover of concrete mattress and/ or rock armour.

Potential impacts to marine ecological receptors and values from the proposed construction activities associated with establishing section two of the pipeline include:

- Introduction or translocation of an invasive marine pest (IMP) via construction vessels and equipment
- Disturbance and loss of Type 3 soft sediment habitat establishing the pipeline and diffuser infrastructure
- Noise impact from construction activities, vessels and equipment
- Vessel or cable strike
- Accidental spill from construction vessels and equipment causing water pollution
- Disturbance of sediments resulting in a turbidity plume

- Reduced opportunities for future marine waters aquaculture

14.2.2 Operational phase impacts

Potential impact to marine ecological receptors and values from the Project operational phase relate primarily to how the discharge of treated wastewater would impact the water quality of Merimbula Bay and the scale of that impact. Assessment of operational phase impacts was based on key findings from the *Water Quality Technical Report* (Elgin, 2021) that identified the following water quality impacts:

- Discharge of nutrients and toxicants above MWQOs to the mixing zone that includes oxides of nitrogen (NOx), ammonia, total phosphorus, orthophosphate, faecal coliforms, enterococci, aluminium, arsenic, copper, iron, lead, selenium and zinc.
- Reduced salinity in the mixing zone due to freshwater discharge that can result in mortality or reduced fitness of stenohaline species.
- Discharge of suspended sediment load, organic particulate material, nutrients and toxicants settling to seabed zone around the diffuser and within the mixing zone.

These impacts were also considered in the context of proposed upgrades to STP treatment processes relevant to the disposal of treated wastewater at the ocean outfall. Upgrades include PAC dosing for enhanced phosphorus removal and UV treatment for improved removal of virus, bacteria and pathogens. Other potential upgrade option includes tertiary filtration if required, that would provide improved removal of aluminium and additional removal of protozoa, viruses, bacteria, TSS and BOD. However, this is noted as a project uncertainty that may not be included. Therefore, the impact assessment is based on no tertiary filtration. It is understood that BVSC also has a long-term strategy to upgrade the reticulated water system that should result in reduction of copper and zinc concentrations in the wastewater stream.

In assessing risks from operational phase impacts, the following water quality and dispersion modelling assumptions were adopted:

- Under most conditions and the majority of time (estimated at 99%), a mixing zone of 25 m is required to achieve necessary dilution to meet MWQOs. Ecological receptors within this mixing zone area is limited to soft sediment habitat and its epifauna and infauna communities. Fish and cetaceans would transit through this mixing zone on an intermittent basis. Potential impacts associated with treated wastewater discharge on marine communities are most likely to be detected within the predicted mixing zone of 25 m. Detection of impacts beyond this zone becomes less likely due to the high levels of dilution achieved over the relatively short distance.
- There would be minor instances where treated wastewater may discharge at higher concentrations, such as during wet weather flows or at licence discharge limits that may also coincide with weak ocean current conditions. Under this modelled worse-case scenario, the mixing zone required to achieve all MWQOs is predicted to occur within 200 m from the diffuser location. Based on weak currents being in the lower 10th percentile and higher concentrations at upper 90th percentile, these combined conditions are predicted a minority, or 1%, of the time. Ecological receptors in this larger mixing zone is also limited to soft sediment habitat and its epifauna and infauna communities.
- The nearest receptors of subtidal and intertidal reef communities, Merimbula Offshore Artificial Reef (OAR), estuarine systems of Merimbula Lake and Pambula River estuary have the following distances from the proposed diffuser location:
    - Hunter Reef ~1400 m to the south-east.
    - Rocky reef shorelines of Haycock Point ~2,000 m to the south south-west.
    - Rocky reef shorelines of Long Point ~2,300 m to the north.
    - Merimbula Offshore Artificial Reef (OAR) ~1,000 m to the north-east;

- Estuary entrances to Merimbula Lake and Pambula River ~2,700 m to 3, 000 m to the southwest, west and northwest.

The above receptors are located beyond the modelled mixing zones, both for discharge under normal conditions expected for the majority of time (25 m), and at a modelled worse-case scenario expected a minority of time (200 m).

- Discharge of treated wastewater to Merimbula Bay has occurred since 1971, including from the existing beach-face outfall since 1974. The replacement of the beach face outfall to ocean outfall results in a change of distance from wastewater discharge point to the above receptors. For example, the distance to receptors of Merimbula Lake and Pambula River estuary increases substantially with the ocean outfall compared to the existing beach face outfall. Conversely, ecological receptors of Hunter Reef, Haycock Point and Long Point and the OAR are closer to the proposed ocean outfall than the beach-face outfall.

14.3 Risk Analysis and Key Issues

The outcomes of the risk analysis are summarised in **Table 14-4** with detailed comments and rationale underlying the risk evaluation provided in **Table 14-5.**

- Risk analysis of potential project impacts found that there would be no high risks to marine ecological receptors or values.
- For construction phase activities, the majority of potential impacts can be effectively managed at low risk levels with the implementation of routine control measures. Exceptions include the physical disturbance and loss of Type 3 soft sediment habitat and impact to the soft sediment infauna and epifauna communities during establishment of the ocean outfall pipeline and diffuser infrastructure, and the potential introduction of a marine pest, both considered a medium risk.
- For operational phase activities, predicted water quality impacts would typically be confined to a 25 m near-field mixing zone most of the time, extending to 200 m under worse-case conditions that may occur a minor proportion of the time. Marine ecological receptors within the mixing zone is limited to Type 3 minimally sensitive soft sediment habitat and the above water column. Potential changes to the soft sediment infauna community from the discharge of treated wastewater to the mixing zone is considered a medium risk while potential changes to the phytoplankton community is considered a minimal risk. The risk to other ecological receptors and values associated with Type 2 rocky reef habitats within Merimbula Bay were considered minimal to low based on their distance to the mixing zone.
- Additionally, a number of impacts were considered not applicable (NA) to one or more ecological receptors or values, and these were not assessed where relevant (**Table 14-4**).

The risk analysis was used to identify key issues associated with the Project. Key issues were determined by consideration of the level of risk, sensitivity of the ecological value (i.e. threatened species, habitat and community type) to threat/s, and scale of the potential impact relative to the overall extent of the ecological value within the broader Merimbula Bay environment.

Key issues identified from the risk analysis include:

- Potential introduction or translocation of marine pest during construction works
- Noise impacts from construction activities, vessels and equipment to marine mammals
- Vessel or cable strike to marine mammals
- Accidental spill of fuel, oil or other harmful substances from construction vessels
- Disturbance and loss of Type 3 soft sediment habitat
- Discharge of treated wastewater at the ocean outfall to Type 3 soft sediment habitat

A discussion of the key issues is provided in **Section 14.4** below

Table 14-4. Summary of project activities, potential hazards and risk level to marine ecological receptors and values (post mitigation)

		MARINE ECOLOGICAL RECEPTORS and VALUES												
Project Activity	**Potential Hazard / Threat**	**Threatened and Migratory Marine Mammals**	**Threatened and Protected Fish**	**Type 3 soft sediment marine habitat**	**Type 2 subtidal rocky reef habitat and communities**	**Abalone and abalone fishery**	**Fish assemblage**	**Soft sediment infauna communities**	**Intertidal reef communities**	**Phytoplankton**	**Drift algae**	**Estuarine communities**	**Aquaculture**	**Recreational and Commercial fishing**
Mobilisation of construction vessels **Establishing Section 2 pipeline covering with rock or concrete mattress**	Noise impact from construction vessels and equipment	Low *	Low *	NA	NA	NA	Minimal	NA	NA	NA	NA	NA	NA	NA
	Vessel or cable strike	Low *	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Accidental spill of fuel, oil or other harmful substances from construction vessels	Low *	Low *	Low *	Low *	Low *	Low *	Low *	NA	NA	NA	NA	NA	NA
	Disturbance and loss of Type 3 soft sediment habitat	Minimal	NA	Medium	NA	NA	Low	Medium	NA	NA	NA	NA	NA	NA
	Reduced opportunities for future marine waters aquaculture	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Low	NA
	Introduction or translocation of marine pest to local waters	NA	NA *	Low*	Low*	Low*	Low*	Low*	NA	NA	NA	NA	NA	Low*
	Disturbance of sediments resulting in a turbidity plume	NA	NA	NA	Minimal	Minimal	NA	NA	NA	NA	NA	NA	NA	NA
Discharge of treated effluent at ocean outfall	Discharge of suspended sediment, particualte organic matter (POM), and toxic contaminants such as metals that exceed MWQOs within mixing zone with potential to bioaccumulate in biota greater than natural background levels	Low	Low	Medium *	Minimal	Minimal	Low	Medium *	Minimal	NA	NA	Minimal	NA	Low
	Discharge of effluent resulting in marine waters with reduced salinity within the mixing zone**	Low	Minimal	Medium *	Minimal	Minimal	Minimal	Medium *	Minimal	NA	NA	Minimal	NA	Minimal
	Discharge of nutrients in treated effluent to mixing zone	Low	Low	Medium *	Minimal	Minimal	Low	Medium *	Minimal	Minimal	Minimal	Minimal	Low	Low

NOTE:

* = Key project issue specific to marine ecological receptor or value

** = The mixing zone is defined as a radius of 25 m from the diffuser 99% of the time and a 200 m radius 1% of the time

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
POTENTIAL CONSTRUCTION PHASE IMPACTS TO THREATENED MARINE SPECIES								
Mobilisation of construction vessels Establishing Section 2 pipeline covering with rock or concrete mattress	Noise impact from construction vessels and equipment	Potential mortality, impairment or behavioural impacts to threatened marine mammals (cetaceans and pinnipeds)	Possible 3	Moderate 3	Low 9	Noise disturbance will be limited to continuous, steady state, vessel noise that is not expected to be outside the range of ambient noise already occurring in Merimbula Bay from recreational, charter and commercial vessels. Based on modelling potential noise disturbance, the permanent threshold shift (PTS) exclusion zone for marine mammals is 170 m (*i.e.* construction activity shutdown in event a marine mammal is present within this zone). The temporary threshold shift (TTS) exclusion zone for marine mammals is 2.3 km (*i.e.* watch zone). Noise disturbance would be short-term, localised and marine mammals within the vicinity of construction activities would avoid or move away from the area as required. The risk of noise levels from proposed construction methods causing permanent or temporary impairment to a threatened marine mammal is considered low.	Recommended control measures to mitigate risk of noise impacts to marine mammals during construction phase based on piliing guidelines (SA Govt 2012) and includes: - Contruction phase works to be undertaken outside of whale migration periods - Adopt recommended saftey zones of 170 m shut-down zone, and 2.3 km watch zone. Construction activities must be stopped as soon as is practical if a cetacean enters or appears within the shutdown zone. - Vessels to have a trained marine mammal observer (MMO) onboard to record observations of when a cetacean or pinniped enters the watch zone - Prior to commencing activities, suggest watch zone be clear of marine mammals for period of at least 10 minutes	Low 6
	Vessel or cable strike	Injury or mortality to marine mammals caused by vessel strike	Possible 3	Moderate 3	Low 9	Construction works would require vessels and materials to mobilise from Twofold Bay to Merimbula Bay. Construction activities broadly include towing the pipeline to site, anchoring vessels, laying pipeline into position, and anchoring pipeline with protective concrete mattress or rock armour. The risk of vessel strike during mobilisation to or works at the study area is most likely to involve slower moving marine mammals such as whales, with seals or dolphins considered at lower risk of vessel strike as they can easily out manoeuvre approaching vessels. Vessel strike has the potential to cause injury and or death depending on vessel size, travel speed and species involved. Cable strike is related to anchor cables that stretch and slacken in the water column. Cables or anchor lines may strike marine fauna, causing slashing injury. Risk of cable strike is considered higher for inquisitive young whales, dolphins and seals, compared to older individuals and potential risk of cable strike increases at night due to reduced visibility.	Control measures to be adopted to reduce risk of vessel or cable strike include: - Contruction phase works to be undertaken outside of whale migration periods - Vessels to adopt safe travel speeds no greater than 10 knots when mobilising to site - Slower speeds adopted in event marine mammal is observed - Vessels maintain 300 m exclusion zone with all whales en-route to and from construction site - trained crew, active management such as daily observations and review of of reported marine mammal activity	Low 6
	Accidental spill of fuel, oil or other harmful substances from construction vessels	Impacts to water quality of Merimbula Bay with harmful substances potentially impacting threatened species	Possible 3	Major 4	Medium 12	Potential water pollution resulting from vessel accidental spill would typically involve light hydrocarbon fuels as opposed to heavy HC fraction with impact most likley confined to surface waters. Risk to threatened fish assessed as minimal with risk to marine mammals initially assessed as medium with risk redcued to low with control measures.	Implement environmental management measures to reduce risk of accidental spills and outlines spill response plan for addressing (i.e. containment and clean-up) a spill event should one occur.	Low 6
	Disturbance and loss of Type 3 soft sediment habitat	Loss of habitat that is critical to the survival of threatened species	Rare 1	Insignificant 1	Minimal 1	No threatened marine species or critical habitat will be affected by the disturbance and loss of Type 3 soft sediment habitat	none	Minimal 1
POTENTIAL OPERATONAL PHASE IMPACTS TO THREATENED MARINE SPECIES								
Discharge of treated wasterwater at ocean outfall	Discharge of suspended sediments, organic particulate material, nutrients and toxic contaminants such as metals to mixing zone impacting threatened species	Potential adverse impact to threatened or protected species via direct exposure to dilute wasterwater in the mixing zone	Possible 3	Minor 2	Low 6	Threatened marine species including cetaceans and pinnipeds may transit the mixing zone and be exposed to highly dilute treated wasterwater. This would occur on an infrequent basis and for short time periods. Exposure levels are not likley to have an adverse impact to any threatened marine species. Migratory marine mammals would be similarly exposed to highly dilute wasterwater discharging from other ocean outfalls along the NSW coastline. The threat likelihood is possible though the consequence of the exposure considered minor. Overall the threat risk is considered low.	none	Low 6

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
POTENTIAL CONSTRUCTION PHASE IMPACTS TO TYPE 3 SOFT SEDIMENT MARINE HABITATS								
Establishing Section 2 pipeline covering with rock or concrete mattress	Disturbance and loss of Type 3 soft sediment habitat	Loss of sand habitat that may cause negative effect on the faunal assemblages that rely on sand habitat within Merimbula Bay in terms of their diversity and abundance.	Almost certain 5	Minor 2	Medium 10	Loss of sand habitat is an unavoidable impact. Section 2 pipeline construction would involve laying the proposed 450 mm diameter pipeline directly on the seafloor and anchoring with a protective cover of concrete mattress and or rock armour along its 2.7 km length. The construction footprint over the seabed is conservatively estimated at 1.6 m wide by 2,700 m long, or 4,320 m^2. This would result in the direct disturbance and loss of 0.00432 km^2 Type 3 unconsolidated sand habitat, considered minimally sensitive with regard to fish habitat. Based on estimate of 12 km^2 of sand habitat within the study area, this represents a 0.04% loss of Type 3 soft sediment habitat mapped within the study area. The scale of the sand habitat lost to the Project is minor and is unlikely to have a long-term negative effect on the faunal assemblages that rely on sand habitat within Merimbula Bay in terms of their diversity and abundance. The pipeline and diffuser structure may have an overall positive effect on species diversity and abundance creating habitat opportunities for species that require hard substrata.	No control measure is available to mitigate the loss of sand habitat. Construction of the pipeline and diffuser infrastructure would result in loss of Type 3 fish habitat but a gain of Type 2 fish habitat, the latter recognised as being more valuable in terms of fish habitat. Construction of the pipeline is unlikely to have a long-term negative effect on faunal assemblages of sand habitat. The pipeline infrastructure would constitute a change from sandy seabed habitat to hard substrate habitat, effectively resulting in the creation of an artificial reef that may result in a net positive effect on species diversity and abundance in the central region of Merimbula Bay. This may also result in improved recreational fishing opportunities within the	Medium 10
	Accidental spill of fuel, oil or other harmful substances from construction vessels	Impacts to water quality of Merimbula Bay with harmful substances potentially sinking to sandy seabed	Possible 3	Major 4	Medium 12	Potential water pollution resulting from vessel accidental spill would typically involve light hydrocarbon fuels as opposed to heavy HC fraction with impact most likley confined to surface waters. Risk to benthic habitat from accidental spill is assessed as low with control measures.	Implement environmental management measures to reduce risk of accidental spills and outlines spill response plan for addressing (i.e. containment and clean-up) a spill event should one occur.	Low 6
	Introduction or translocation of marine pest to local waters	Potential for colonisation of soft-sediment habitats at the construction site by IMPs that have preference for soft sediment habitat such as European fan worm and New Zealand Screwshell	Possible 3	Major 4	Medium 12	Three IMPs reported from the Port of Eden, 30 km to the south (Pollard et al. 2003) that are not yet reported from Merimbula Bay include the dinoflagellate *Alexandrium catenella*, European fan worm (*Sabella spallanzanii*) and the New Zealand Screwshell (*Maoricolpus roseus*). The latter is known to occur on the continental shelf off Merimbula but is not known to be present within the embayment. Of these IMPs, the European fan worm with its ability to establish in high densities and potentially alter the community composition of soft sediment habitats could pose a risk of introduction.	Implement environmental management measures to reduce risk of IMP in accordance with *National Marine Pest Plan 2018-2023*.	Low 8
POTENTIAL CONSTRUCTION PHASE IMPACTS TO SUBTIDAL REEF INVERTEBRATE AND ALGAL COMMUNITIES								
Mobilisation of construction vessels	Introduction or Translocation of marine pest to local waters	IMPs such as *Caulerpa taxifolia,* northern Pacific seastar and *Undaria pinnatifida* have the potential to alter the community structure of nearby rocky reefs such that community composition may be adversely	Possible 3	Major 4	Medium 12	Neither *Caulerpa taxifolia,* northern Pacific seastar or *Undaria pinnatifida* are yet known from Twofold Bay. Potential threat exists for vessels mobilising to the Project site from other areas to carry IMPs new to the region.	Implement environmental management measures to reduce risk of IMP in accordance with *National Marine Pest Plan 2018-2023*.	Low 8
	Accidental spill of fuel, oil or other harmful substances from construction vessels	Impacts to water quality of Merimbula Bay with harmful substances potentially sinking and smothering rocky reef habitat and communities.	Possible 3	Major 4	Medium 12	Potential water pollution resulting from vessel accidental spill would typically involve light hydrocarbon fuels as opposed to heavy HC fraction with impact most likley confined to surface waters and small in scale. Risk to subtidal rocky reef communities is considered low with control measures.	Implement environmental management measures to reduce risk of accidental spills and outlines spill response plan for addressing (i.e. containment and clean-up) a spill event should one occur.	Low 6
Establishing Section 2 pipeline covering with rock or concrete mattress	Disturbance of sediments resulting in a turbidity plume	Short-term, localised increase in turbidity, potential for smothering of subtidal communities of rocky reef habitat	Unlikely 2	Minor 2	Minimal 4	Construction method may cause localised turbidity plume though of small scale and short-term event. Due to long distance from the construction site to subtidal reef areas, it is considered highly unlikely that a localised turbidity plume at the construction footprint would affect reef areas and deposit enough sediment so as to permanently alter the reef and cause an adverse effect on those communities.	none	Minimal 4
	Accidental spill of fuel, oil or other harmful substances from construction vessels	As above	Unlikely 2	Moderate 3	Low 6	As above	As above - Implement spill response plan	Low 6

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
POTENTIAL OPERATIONAL PHASE IMPACTS TO SUBTIDAL SUBTIDAL REEF INVERTEBRATE AND ALGAL COMMUNITIES								
Discharge of treated wastewater at ocean outfall	Discharge of suspended sediments, organic particulate material, nutrients and toxic contaminants such as metals to mixing zone	Potential change to subtidal rocky reef community structure, including shift in macroalgal community composition and abundance of sessile filter feeders (i.e. altered food resources and habitat structure)	Unlikely 2	Minor 2	Minimal 4	Dispersion modelling shows that the disposal of treated wasterwater containing elevated levels of nutrients and metals to the North-Short diffuser at 30 m depth would meet MWQOs within 5 - 25 m of the diffuser under normal conditions and 200 m under worse-case flow conditions. The nearest subtidal rocky reef community is 1,400 m to south-east at Hunter Reef with rocky reef communities of Long Point and Haycock Point greater than 2,000 m outside the modelled mixing zone. Based on these distances, it is considered highly unlikely that the discharge of treated wasterwater at the North-Short diffuser would have any detectable adverse effect on rocky-reef assemblages.	WQ monitoring undertaken as part of operational compliance.	Minimal 4
POTENTIAL CONSTRUCTION PHASE IMPACTS TO ABALONE								
Mobilisation of construction vessels	Introduction or Translocation of marine pest to local waters	IMPs such as *Caulerpa taxifolia,* northern Pacific seastar have the potential to alter the community structure of nearby rocky reefs such that abalone may be adversely affected	Possible 3	Major 4	Medium 12	Neither *Caulerpa taxifolia* or northern Pacific seastar are yet known from Twofold Bay. Potential threat exists for vessels mobilising to the Project site from other areas to carry IMPs new to the region.	Implement environmental management measures to reduce risk of IMP in accordance with *National Marine Pest Plan 2018-2023*.	Low 8
	Accidental spill of fuel, oil or other harmful substances from construction vessels	Impacts to water quality of Merimbula Bay with harmful substances potentially sinking to crevices and abalone habitat on rocky reefs	Possible 3	Major 4	Medium 12	Construction area is distant from reef areas and unlikely to affect abalone habitat. Fuel spills is likely to be of light hydrocarbon fraction as opposed to heavy HC fraction and small in scale. Risk to subtidal rocky reef communities and abalone is considered low with control measures.	Implement environmental management measures to reduce risk of accidental spills and outlines spill response plan for addressing (i.e. containment and clean-up) a spill event should one occur.	Low 6
Establishing Section 2 pipeline covering with rock or concrete mattress	Disturbance of sediments resulting in a turbidity plume	Short-term, localised increase in turbidity, potential to smothering of rocky reef habitats of abalone	Unlikely 2	Minor 2	Minimal 4	Construction method may cause localised turbidity plume though of small scale and short-term event. Due to long distances from construction site to subtidal reef areas, considered highly unlikely to deposit enough sediment so as to permanently alter the reef and cause adverse effect..	none	Minimal 4
	Accidental spill of fuel, oil or other harmful substances from construction vessels	As above	Possible 3	Moderate 3	Low 9	As above	As above - Implement spill response plan	Low 6
POTENTIAL OPERATIONAL PHASE THREATS TO ABALONE								
Discharge of treated wasterwater at ocean outfall	Discharge of suspended sediments, organic particulate material and toxic contaminants settling onto rocky reefs around adjacent headlands	Changes to community structure of rocky reefs from increased sedimentation such that abalone populations decline	Unlikely 2	Minor 2	Minimal 4	Upgrade project is expected to result in discharge of a higher quality wasterwater that meets marine water quality objectives including low levels of suspended solids at the mixing zone boundary. Distance between the mixing zone and the subtidal rocky reef habitat where abalone populations exist (Long Point and Haycock Point) is greater than 2,000 m, and considerable dilution of suspended sediment is likely to occur over this distance. Should there be settling of fine silt onto the subtidal rocky reefs, it would be minimal and temporary, with the high natural variability in strength of wave action likely re-suspend and remove fine sediments during swells larger than that at the time of deposition. For these reasons, increases in turbidity and sedimentation from construction activities is considered a minimal risk in terms of the potential to impact on the abalone population inhabiting the Merimbula Bay reefs habitat.	none	Minimal 4

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
	Discharge of wasterwater resulting in marine waters with reduced salinity within the mixing zone	Lethal and sub-lethal impacts to abalone	Unlikely 2	Minor 2	Minimal 4	Abalone reefs are greater than 2,000 m outside the modelled mixing zone. Blacklip abalone have been shown to be physiologically tolerant of moderately low salinity (i.e. down to 25 ppt) environments (Edwards, 2003).	none	Minimal 4
Discharge of treated wasterwater at ocean outfall	Discharge of nutrients in treated wasterwater to mixing zone	Stimulus for increased frequency of microalgal blooms that have potential to impact abalone	Possible 3	Moderate 3	Low 9	Phytoplankton blooms naturally occur in Merimbula Bay and regionally, rarely does a bloom occur that may be considered harmful to abalone and the abalone fishery with an incident reported from Twofold Bay in 2016. While the Project may provide stimulus for increased primary productivity within the 25 m mixing zone, it would be localised and small in scale such that potential effects on the overall phytoplankton assemblage (i.e. change in species composition and abundance) would be masked by changes driven by environmental factors operating at broader bioregional, ocean basin scales.	WQ monitoring undertaken as part of operational compliance	Low 9
		Changes to subtidal rocky reef community structure, including shift in macroalgal community composition and abundance of sessile filter feeders (i.e. altered food resources and habitat for abalone)	Possible 3	Moderate 3	Low 9	Nutrient load predicted to meet MWQOs within 25 m mixing zone under normal conditions and 200 m mixing zone under worse-case flow conditions. Abalone reefs are greater than 2,000 m outside the modelled mixing zone. Unlikely that discharge of nutrients in wasterwater will have any detectable effect on rocky-reef assemblages that would cause adverse impact to abalone.	WQ monitoring undertaken as part of operational compliance	Low 9
	Levels of toxic contaminants with potential to bioaccumulate greater than natural background levels	Lethal and sub-lethal impacts to abalone, potential to impact on the local commercial abalone fishery in the form of reduced consumer confidence in the local product	Unlikely 2	Major 4	Low 8	MWQOs for metals would be achieved within 5-25 m of the diffuser location and abalone reefs are unlikely to be affected by dilute treated wasterwater in modelled normal conditions or worse-case flow conditions. e.	WQ monitoring undertaken as part of operational compliance. Tertiary sand filtration will reduce levels of metals in treated wasterwater.	Low 8
POTENTIAL CONSTRUCTION PHASE IMPACTS TO FISH ASSEMBLAGE								
Mobilisation of construction vessels	Noise impact from construction vessels and equipment	Potential mortality, impairment or behavioural impacts to fish with swim bladders involved in hearing	Unlikely 2	Minor 2	Minimal 4	Noise impacts will be limited to continuous, steady state, vessel noise. The temporary threshold shift (TTS) exclusion zone for fish is 120 m AECOM (2020) indicating that fish within this distance of construction activities may be affected. No threatened fish species or habitat critical to species survival would be affected by noise. Noise levels from proposed construction methods are not expected to be outside the range of ambient noise already occurring in Merimbula Bay from recreational, charter and commercial vessels. Noise effects would be short-term, localised and fish within the vicinity of construction activities would avoid or move away from the area as required. The risk of noise disturbance to fish is considered minimal	None relevant to fish	Minimal 4
	Introduction or translocation of marine pest to local waters	IMPs such as European fan worm *has* potential to alter the community composition of soft sediment habitat that could indirectly affect fish assemblage of that habitat.	Possible 3	Major 4	Medium 12	Three IMPs reported from the Port of Eden, 30 km to the south (Pollard et al. 2003) that are not yet reported from Merimbula Bay include the dinoflagellate *Alexandrium catenella*, European fan worm (*Sabella spallanzanii*) and the New Zealand Screwshell (*Maoricolpus roseus*). The latter is known to occur on the continental shelf off Merimbula but is not known to be present within the study area of the embayment. Of these IMPs, the European fan worm with its ability to establish in high densities and potentially alter the community composition of soft sediment habitat could indirectly affect the fish assemblage associated with that habitat through potential change in food resource availability. However, very little work has been done on the impacts of the European fan worm and its effects at an ecosystem level (DPI, 2020).	Implement environmental management measures to reduce risk of IMP in accordance with *National Marine Pest Plan 2018-2023*.	Low 8
	Accidental spill of fuel, oil or other harmful substances from construction vessels	Impacts to water quality of Merimbula Bay with harmful substances potentially impacting fish.	Unlikely 2	Moderate 3	Low 6	Potential water pollution resulting from vessel accidental spill would typically involve light hydrocarbon fuels as opposed to heavy HC fraction with impact most likely confined to surface waters and small in scale. Risk to fish assemblage is considered low.	Implement environmental management measures to reduce risk of accidental spills and outlines spill response plan for addressing (i.e. containment and clean-up) a spill event should one occur.	Low 6

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
Establishing Section 2 pipeline covering with rock or concrete mattress	Disturbance and loss of Type 3 soft sediment habitat	Loss of habitat that may result in decrease in fish diversity and abundance	Possible 3	Minor 2	Low 6	Construction of the pipeline will result in the loss of 4,320 m^2 of Type 3 sand habitat, considered minimally sensitive with regard to fish habitat. Overall this represents a 0.04% loss of Type 3 sand habitat mapped within the study area. The scale of the sand habitat lost to the Project is minor and is unlikely to have a negative effect on the fish assemblage that relies on sand habitat within Merimbula Bay in terms of their diversity and abundance.	none	Low 6
	Accidental spill of fuel, oil or other harmful substances from construction vessels	As above	Possible 3	Moderate 3	Low 9	As above	As above - Implement spill response plan	Low 6
POTENTIAL OPERATIONAL PHASE THREATS TO FISH ASSEMBLAGE								
Discharge of treated wasterwater at ocean outfall	Discharge of levels of metals that exceed MWQOs within mixing zone with potential to bioaccumulate in fish greater than natural background levels	Lethal and sub-lethal impacts to fish that transit that mixing zone, potential for metal bioaccumulation to result in reduced confidence in the quality of local fish resources	Possible 3	Minor 2	Low 6	MWQOs for metals would be achieved within 5 - 25 m of the diffuser location under normal conditions and 200 m under worse case conditions. Fish may transit the mixing zone intermittently, and exposure would be infrequent such that lethal or sublethal effects are possible. It is possible that some fish species may be attracted to the mixing zone due to localised increases in food availability and structure provided by the pipeline and diffuser. The fish assemblage associated with sand habitat at the diffuser location and within a 200 m radius buffer is characterised by low diversity and low abundances. While there may be some effect to fish on sand habitats from exposure to metals, the effect may be limited to a few fish species that naturally occur at low abundances within the proposed mixing zone. Thus, the overall scale of the effect would be considered small and impact to fish assemblage of sand habitats across the broader area minor.	WQ monitoring undertaken as part of operational compliance.	Low 6
	Discharge of wasterwater resulting in marine waters with reduced salinity within the mixing zone	Reduced salinity within mixing zone may favour fish that can tolerate a broader range of salinity compared to stenohaline species, those that prefer a narrow range of salinity	Unlikely 2	Minor 2	Minimal 4	None of the fish observed in the study are considered stenohaline species and the zone of reduced salinity would have minimal risk to the fish assemblage.	none	Minimal 4
	Discharge of nutrients in treated wasterwater to mixing zone	Stimulus for increased primary productivity leading to increased food resources and altered fish assemblage i.e. increased abundance of planktivorous fish	Possible 3	Minor 2	Low 6	Discharge of elevated levels of dissolved nutrients to the mixing zone may have an indirect positive effect on fish assemblage, with increased abundance of planktivorous fish such as Mado and baitfish. Overall impact of nutrient discharge on fish assemblage is low.	WQ monitoring undertaken as part of operational compliance	Low 9
POTENTIAL CONSTRUCTION PHASE IMPACTS TO SOFT SEDIMENT INFAUNA AND EPIFAUNA								
Mobilisation of construction vessels Establishing Section 2 pipeline covering with rock or concrete mattress	Disturbance and loss of Type 3 soft sediment habitat	Loss of sand habitat directly below the construction footprint that may have localised negative effect on the infauna and epifauna assemblages	Almost certain 5	Minor 2	Medium 10	Loss of sand habitat is an unavoidable impact. As mentioned above, it is estimated that construction of Section 2 pipeline and diffuser would result in the direct disturbance and loss of 0.00432 km^2 Type 3 unconsolidated sand habitat, considered minimally sensitive with regard to fish habitat. Based on estimate of 12 km^2 of sand habitat within the study area, this represents a 0.04% loss of Type 3 soft sediment habitat mapped within the study area. The scale of the sand habitat lost to the Project is minor and is unlikely to have a long-term negative effect on the faunal assemblages that rely on sand habitat within Merimbula Bay in terms of their diversity and abundance. This includes the sessile epifauna such as the great sea pen (*Sarcoptilus grandis*) and benthic infauna community. Benthic infauna includes polychaete worms, crustacea, molluscs, and other minor groups.	No control measure is available to mitigate the loss of sand habitat and epifauna or benthic infauna commuities within the construction footprint.	Medium 10
	Accidental spill of fuel, oil or other harmful substances from construction vessels	Impacts to water quality of Merimbula Bay with harmful substances potentially sinking to benthos and impacting benthic infauna community	Unlikely 2	Moderate 3	Low 6	Potential water pollution resulting from vessel accidental spill would typically involve light hydrocarbon fuels as opposed to heavy HC fraction with impact most likely confined to surface waters and small in scale. Risk to benthic infauna and epifauna is considered low.	Implement environmental management measures to reduce risk of accidental spills and outlines spill response plan for addressing (i.e. containment and clean-up) a spill event should one occur.	Low 6

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
POTENTIAL OPERATIONAL PHASE IMPACTS TO SOFT SEDIMENT INFAUNA AND EPIFAUNA								
Discharge of treated wasterwater at ocean outfall	Discharge of suspended sediments, particulate organic material (POM), nutrients and toxic contaminants such as metals to mixing zone	Potential change in sediment chemistry within the near field mixing zone resulting in altered community composition of infauna and sessile epifauna assemblages compared to areas outside of the mixing zone	Likely 4	Moderate 3	Medium 12	Dispersion modelling shows that the disposal of treated wasterwater to the North-Short diffuser at 30 m depth would meet MWQOs within 5 - 25 m of the diffuser under normal conditions and 200 m under worse-case flow conditions. The scale of potential impact is directly related to the exposure to the wasterwater plume. Changes to sediment chemistry may occur due to deposition of particulate organic material leading to enrichment of sediments and or depletion of oxygen. As wasterwater quality is characterised by relatively low levels of suspended solids, the pathway by which sediments may become enriched is if nutrient levels stimulate excessive phytoplankton growth that will deliver additional particulate organic matter to the benthos. Should changes to sediment chemistry occur from the Project, these would likely to be limited to the near-field mixing zone of 25 m radius from the diffuser with some level of change to the benthic infauna community possible. It is then expected that the magnitude and likelihood of potential change would decrease with increasing distance from the outfall and the ability to detect change beyond the mixing zone, if some change has occurred, becomes less likely.	STP upgrades to improve treated wasterwater quality. Operational phase monitoring to include: - water quality - infauna and sediment collected from sites within and outside the mixing zone to assess potential impacts from discharge of treated wasterwater.	Medium 12
POTENTIAL CONSTRUCTION PHASE IMPACTS TO INTERTIDAL ROCKY SHORE COMMUNITY								
Mobilisation of construction vessels Establishing Section 2 pipeline covering with rock or concrete mattres	Accidental spill of fuel, oil or other harmful substances from construction vessels	Impacts to water quality of Merimbula Bay with harmful substances potentially impacting intertidal shorelines	Possible 3	Major 4	Medium 12	Potential water pollution resulting from vessel accidental spill would typically involve light hydrocarbon fuels as opposed to heavy HC fraction with impact most likely confined to surface waters that could spread towards intertidal shorelines of Haycock Point and Long Point depending on prevailing weather conditions. Lower shore heights would most likely be affected by a spill event. The negative effects of a potential spill event would likely be short-term, and while loss of some taxa may occur, it is expected that it would not influence the overall recovery capacity of the habitats and communities. Risk to intertidal shorelines is assessed as low with control measures.	Implement environmental management measures to reduce risk of accidental spills and outlines spill response plan for addressing (i.e. containment and clean-up) a spill event should one occur.	Low 6
POTENTIAL OPERATIONAL PHASE IMPACTS TO INTERTIDAL INTERTIDAL ROCKY SHORE COMMUNITY								
Discharge of treated wasterwater at ocean outfall	Discharge of suspended sediments, organic particulate material, nutrients and toxic contaminants such as metals to mixing zone	Potential change to intertidal reef community structure, including shift in macroalgal community composition	Rare 1	Insignificant 1	Minimal 1	Intertidal reef areas of Haycock Point and Long Point are 2,000 m and 2,300 m distal to the diffuser location and would not be affected by the dispersing wasterwater plume. There would be minimal risk to intertidal areas from the construction and or operational phases of the Project.		Minimal 1
POTENTIAL OPERATIONAL PHASE THREATS TO PHYTOPLANKTON								
Discharge of treated wasterwater at ocean outfall	Discharge of nutrients in treated wasterwater to mixing zone	Change in phytoplankton assemblage species composition and abundance that can be distinguished from ambient background conditions	Unlikely 2	Minor 2	Minimal 4	The discharge of nutrients to the mixing zone would provide a localised stimulus for increased primary productivity where it is expected that majority of this nutrient load would be assimilated by phytoplankton within the 25 m mixing zone. However, the overall effect this may have on the phytoplankton assemblage of Merimbula Bay is considered minimal. This finding is based on the nutrient discharge being localised, small in scale compared to episodic nutrient inputs from upwellings and catchment flood events, and an understanding that phytoplankton assemblage dynamics of Merimbula Bay (i.e. change in species composition and abundance) are more likely to be influenced by environmental factors operating at broader bioregional, ocean basin scales.	none	Minimal 4
POTENTIAL OPERATIONAL PHASE THREATS TO DRIFT ALGAE								

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
Discharge of treated wasterwater at ocean outfall	Discharge of nutrients in treated wasterwater to mixing zone	Increased occurrence of drift algae biomass, in scale and frequency, greater than what already occurs on an episodic basis.	Unlikely 2	Minor 2	Minimal 4	The discharge of treated wasterwater to the North-Short diffuser at 30 m depth would include levels of nutrients that exceed MWQOs including oxides of nitrogen (NOx), ammonia, total phosphorus, and orthophosphate. Dispersion modelling shows that under most conditions, nutrient levels would dilute rapidly and meet MWQOs or natural background conditions within a 25 m mixing zone. As the wasterwater would be buoyant and rise upwards in the water column, it is likely that majority of this nutrient load would be assimilated by phytoplankton within the mixing zone with only a minor proportion available to other marine flora in the mixing zone that includes benthic microalgae and may include drift algae on occasion when present within Merimbula Bay.	none	Minimal 4

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
POTENTIAL OPERATIONAL PHASE THREATS TO ESTUARIES								
Discharge of treated wasterwater at ocean outfall	Discharge of suspended sediments, organic particulate material, nutrients and toxic contaminants such as metals to mixing zone impacting estuarine values	Potential for dilute treated wasterwater to enter Merimbula or Pambula Lake	Unlikely 2	Minor 2	Minimal 4	Under existing conditions of treated wasterwater disposal via the beach-face outfall, modelling indicates highly dilute treated wasterwater (at 1,000 - 10,000 times dilution) can enter Merimbula Lake under certain current conditions. Dispersion modelling shows that the disposal of wasterwater to the North-Short diffuser at 30 m depth would meet MWQOs within 5 - 25 m of the diffuser under normal conditions and 200 m under worse case conditions. The treated wasterwater plume would not impact estuaries. The Project represents a reduction in risk level with regards to estuaries compared to existing conditions. Diffuse source pollution in stormwater runoff includes elevated levels of suspended sediment, nutrients and microbiological parameters that exceed estuary WQOs, and poses a greater threat to estuary values than the discharge of treated wasterwater at the proposed outfall.	WQ monitoring undertaken as part of operational compliance including sites at the entrance of both estuaries.	Minimal 4
POTENTIAL CONSTRUCTION PHASE IMPACTS TO AQUACULTURE								
Establishing Section 2 pipeline covering with rock or concrete mattress	Reduced opportunities for future marine waters aquaculture	Reduced area of Merimbula Bay that would be considered for future marine waters aquaculture under the current constraint criteria set out in MWSAS (DPI, 2018)	Likely 4	Minor 2	Low 8	According to the constraint criteria set out in MWSAS (DPI, 2018), marine waters aquaculture operations would not be permissible within 1 km of sewage outfall pipelines or protection zones for submarine cables. Therefore, construction of the North-Short pipeline and outfall diffuser would reduce the area of Merimbula Bay available for future marine waters aquaculture by approximately 50%. It should be noted that this finding is provisional pending further update to the SEPP (Primary Production and Rural Development) 2019 that adopts the recommendations of the MWSAS (DPI, 2018). Threat level is assessed as likely under the current MWSAS (assuming current constraint recommendations are adopted in the SEPP), and consequence level deemed minor based on understanding that there is no current registered interest in developing marine waters aquaculture in Merimbula Bay, and that the central bay region that would be excluded for aquaculture applications due to the establishment of the pipeline, is exposed to all weather conditions and unlikely to be a suitable location for the forms of marine waters aquaculture permitted within Merimbula Bay. There are other nearby locations such as Twofold Bay where marine waters aquaculture operations are likely to be preferred in terms of protection from damaging	none	Low 8
POTENTIAL OPERATIONAL PHASE THREAT TO AQUACULTURE								
Discharge of treated wasterwater at ocean outfall	Discharge of nutrients in treated wasterwater to mixing zone impacting estuarine aquaculture	Potential for increased risk of toxic algal bloom impacting estuarine aquaculture	Unlikely 2	Minor 2	Minimal 4	Ceasing the beach-face outfall and discharging wasterwater instead via the proposed North-Short outfall would improve wasterwater dispersion, with modelling indicating MWQOs would be met within a 25 m mixing zone of the discharge point for the majority of the time. Under worse-case conditions that may occur a small proportion of time (i.e. wet weather flows coinciding with stagnant ocean currents), MWQOs would be met within 200 m of the discharge point. Given the estuary entrances are located 2,700 - 3,000 m away from the proposed North-Short outfall location, there is minimal risk that diluted treated wasterwater will enter the estuaries at concentrations sufficient to trigger an algal bloom above what already occurs on an intermittent basis due to stormwater and catchment inputs. The following are potential benefits to estuarine aquaculture as a result of the Project: • Moving the discharge point from the current beach-face location out into the Bay eliminates the risk of wasterwater being entrained in the surf zone where it has more potential to disperse parallel to the beach and towards the estuary entrances. • Ceasing wasterwater disposal to the dunal ex-filtration ponds would be expected to improve groundwater quality beneath the ponds over time.	WQ monitoring undertaken as part of operational compliance including sites at the entrance of both estuaries.	Minimal 4

Table 14-5. Risk analysis of project activities and potential impacts to marine ecological values

PROJECT ACTIVITY	POTENTIAL HAZARD / THREAT	POTENTIAL IMPACT	Likelihood	Consequence	Pre-Control RISK LEVEL	Comment	Control Measure to Mitigate Risk	Post-Control RISK LEVEL
Discharge of treated wasterwater at ocean outfall	Discharge of nutrients in treated wasterwater to mixing zone impacting marine waters aquaculture	Potential for increased risk of toxic algal bloom impacting future marine waters aquaculture	Possible 3	Minor 2	Low 6	Phytoplankton blooms occur on a large geographic scale and the seasonal influence of the East Australian Current (EAC) is an important factor controlling phytoplankton dynamics in south-eastern Australia. Occasionally these blooms may include high abundances of a potentially harmful taxa that can pose a threat to marine waters aquaculture as has previously occurred in Twofold Bay. While the Project may provide stimulus for increased primary productivity within the 25 m mixing zone, it would be localised and unlikely to generate a bloom at a scale that would cause adverse impact to marine aquaculture beyond what may already occur under existing environmental factors operating at broader bioregional, ocean basin scales.	WQ monitoring undertaken as part of operational compliance.	Low 6
POTENTIAL OPERATIONAL PHASE THREATS TO RECREATIONAL AND COMMERCIAL FISHING								
Discharge of treated wasterwater at ocean outfall	Discharge of suspended sediments, organic particulate material, nutrients and toxic contaminants such as metals to mixing zone	Potential for adverse impacts to fish assemblage of Merimbula Bay impacting opportunities for recreational and commercial fishing	Unlikely 2	Minor 2	Minimal 4	Potential effects by the Project to fish species important to local recreational and commercial fishing (i.e. Australian salmon, sardine, mullet and snapper) considered the species life history, migratory patterns and the scale of predicted water quality impact to a 25 m mixing zone over sand habitat. Consideration was also given to the proximity of the Project to recreational fishing assets such as Merimbula OAR, approximately ~1000 m away. The Project includes proposed upgrades to the STP that would result in improved wasterwater quality and disposal of treated wasterwater at the proposed outfall would provide improved dispersion of the treated wasterwater compared to the current beach-face outfall which has been in use since 1971. Overall, it is unlikely that the fish assemblage of Merimbula Bay and those occurring at the Merimbula OAR would be adversely affected by the Project. Therefore, the risk to commercial and recreational fishing within Merimbula Bay from the Project is considered minimal, including taking into account the potential risk of bioaccumulation. The Project may result in a net positive effect on fish diversity and abundance in the central region of Merimbula Bay that may also result in improved recreational fishing opportunities within the vicinity of the pipeline.	none	Minimal 4

14.4 Key Issues

14.4.1 Potential introduction or translocation of marine pest during construction works

Introduced marine pest (IMP) species pose a serious threat to biodiversity and marine primary production in NSW (DPI, 2008). They can foul marine infrastructure, alter marine habitats, outcompete or prey on native species and put at risk Australia's fisheries and aquaculture industries. They may be introduced in various ways, including in ballast waters, attached to the hulls of domestic or international ships, or imported deliberately as aquarium or aquaculture species (DPI, 2008).

The *Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales* is listed as a key threatening process (KTP) under the FM Act and is considered with regards to its potential impact to the marine habitats and communities at the study area and broader Merimbula Bay.

The potential risk exists for the introduction or translocation of an IMP to Merimbula Bay from Twofold Bay via construction vessels. The most likely pathway for introduction of an IMP to Merimbula Bay would be via transport of organisms or their eggs or cysts attached to hulls of construction vessels, equipment or in ballast water of vessels.

Three IMPs reported from the Port of Eden, Twofold Bay, 30 km to the south (Pollard *et al*. 2003) that are not yet reported from Merimbula Bay include the dinoflagellate *Alexandrium catenella*, European fan worm (*Sabella spallanzanii*) and the New Zealand Screwshell (*Maoricolpus roseus*).

- *Alexandrium catenella* can exist as resting cysts within soft sediments. As the project would not be disturbing or moving sediments at the Port of Eden, the likelihood that this dinoflagellate would be translocated to Merimbula Bay is low. Whilst *Alexandrium catenella* was not reported in phytoplankton monitoring undertaken as part of this marine ecology assessment, it has been previously reported in low abundance from Merimbula Lake between 2012-2013 (refer **Section 9 – Phytoplankton**).
- For the European fan worm to be introduced to Merimbula Bay, it would first need to be transported as larval phase in ballast waters, and those ballast waters then to be released at Merimbula Bay. In the southern hemisphere, spawning of *S. spallanzanii* has been reported to occur during autumn to winter period, and coincides with falling water temperatures (11-14 ^{o}C, Port Phillip Bay in Currie *et al.* 2000). Based on this, it can be assumed that the highest risk period for translocating *S. spallanzani* larvae in ballast water from Port of Eden to Merimbula Bay would typically be the winter to early spring period of July to September when local waters are typically coolest.
- The New Zealand screwshell is already known to occur in deeper waters of the continental shelf off Merimbula but is not present within the study area of the embayment. If conditions at Merimbula Bay were suitable for the species, then it would likely already be present. The risk of translocating this species via vessels and equipment is considered low.
- Another two IMPs reported from Twofold Bay include the Pacific oyster and European green shore crab (*Carcinus maenus*). Both species are already known to occur within the estuarine habitats of Merimbula and Pambula Lakes.

Other IMPs not yet detected in Twofold Bay but that are considered possible high risk to coastal waters of the Twofold Shelf Bioregion more broadly include the Yellowfin goby, Japanese goby, Northern Pacific seastar, *Caulerpa taxifolia* and Japanese kelp (*Undaria pinnatifida*). These IMPs could also pose a threat to habitats and species at Merimbula Bay. Overall, the potential risk of introducing an IMP during construction phase activities is considered a medium risk that can be reduced to a low risk by implementing routine control measures in accordance with the *National Marine Pest Plan 2018-2020* and outlined in **Section 15 – Environmental Management**.

14.4.2 Noise impacts from construction vessels and equipment to marine mammals

Noise disturbance from the Project include vessel and equipment noise during construction activities. These include vessel movements, establishing the pipeline and diffuser infrastructure on the seabed, and anchoring the pipeline with protective concrete mattress or rock armour. Noise from these activities is classified as non-impulsive, steady-state continuous noise as opposed to impulsive noise such as from activities involving pile driving, explosions, and airgun shots.

Marine fauna that are most likely to be affected by construction noise are marine mammals that include whales, dolphins and seals. Exposure to anthropogenic underwater noise can interfere with key life functions of marine mammals (*i.e.* foraging, mating, nursing, resting, migrating) by impairing hearing sensitivity, masking acoustic signals, eliciting behavioural responses, or in extreme cases (if the receptor is close enough to the noise source for long enough) possible physiological stress and / or injury.

A number of listed threatened and protected marine mammals have a high likelihood of occurrence at the study area and are known to be sensitive to noise. These include southern right whales, humpback whales, orcas, bottlenose dolphins and seals. An assessment of underwater noise by AECOM (refer **Chapter 21 Noise (Underwater)** of the EIS) identified zones within which noise impacts to marine mammals may be expected to occur. The zone of potential hearing injury, where there is potential risk of permanent physiological impact to low frequency cetaceans (i.e. humpback whale and southern right whale) is modelled to potentially occur within a 170 m radius from the source noise. Temporary hearing injury (referred to as TTS) for low frequency cetaceans may occur within a radius of 2.3 km from the noise source. For high frequency cetaceans (i.e. orca and dolphins) there is a potential risk of TTS occurring within an 85 m radius of source noise and for seals the potential risk of TTS may occur within 70 m radius of source noise. The zone of potential responsiveness (i.e. where any of the above marine mammals may show a behavioural response, such as avoidance) is considered to be within a 16 km radius of the noise source.

The risk of noise impacts to whales can be reduced by timing construction works outside of whale migration periods, where practicable and introducing safety zones (**Section 15 – Environmental Management**). Of the marine mammals that may occur within the Project area, there is high likelihood for the humpback whale to occur during its southerly migration between late August and early November, with dolphins and seals occurring in Merimbula Bay all year round. At a local level, the approximate 30 m depth contour of Merimbula Bay appears to be the western edge of the southerly migratory pathway for humpback whale. Individuals, mothers and calves were observed following this depth contour commencing offshore from Long Point south to Hunter Reef then south-east to Haycock Point.

The southern right whale is rarely seen in Merimbula Bay with the most recent sighting in 2016 and generally considered rare in NSW (Smith, 2001). Similarly, the orca is rarely seen in nearshore coastal waters, preferring to forage along the edge of the continental shelf with the last regional sighting in Twofold Bay in 2015.

The risk of noise impacts can be further reduced to low by implementing control measures such as safety zones (shut-down zones and watch zones) based on hearing threshold limits for those marine fauna likely to occur in the Project area. A shut-down zone of 170 m radius from the noise source would be implemented during June and November (humpback and southern right whale migration periods) and would result in works being shut-down (when safe to do so) if a whale is seen within this zone. A watch zone of 2.3 km radius, from the noise source, would also be implemented during June and November and result in marine fauna observers continuously monitoring for whale activity within this zone.

Noise modelling results indicate that permanent hearing (PTS) threshold levels for dolphins and seals would not be exceeded during Project construction activities, therefore no shut down zone is required. A 500 m watch zone would be implemented for dolphin and seals during noise generating activities.

Marine fauna observers (MFOs) would be present during all underwater noise generating activities and would record all marine fauna observed during shifts.

Dolphins and seals are exposed to regular boating traffic in Merimbula Bay for recreational, commercial and

charter fishing purposes and are therefore regularly exposed to noise levels similar to those that are anticipated to be generated by the Project. They are therefore considered a lower risk of exposure to underwater noise generated from the Project. Dolphins may also be disturbed by construction vessels resulting in altered foraging behaviour (*i.e.* preference to move away to another area). Any potential change in their foraging and migratory behaviour is expected to be short-term. Control measures would be implemented to effectively mitigate the risk of these impacts, such as a safety zone of 500 m, vessel speed limits and MFOs.

Birds and fish are generally considered to be less likely affected by construction noise and would avoid or move away from the area as required. However, it is now understood that fish with swim bladders are sensitive to noise disturbance although the physiological effects from noise are not yet well understood (Hawkins and Popper, 2017; Popper and Hawkins, 2019). As the works would be conducted over soft sediment habitat characterised by a fish assemblage of lower diversity and abundance compared to rocky reef habitats (**Section 6 – Fish Assemblage**) and that does not contain habitat critical to the survival of a threatened or protected fish species, the risk of noise impacts to fish is considered minimal.

Noise levels from the proposed construction activities are expected to be similar to the range of ambient steady state noise that already occurs in Merimbula Bay from recreational, charter and commercial vessels. Noise effects would be short-term, localised and it is considered that marine mammals and fish within the vicinity of construction activities would avoid or move away from the area as required. However, due to the sensitivity of marine mammals as listed threatened or protected species, the potential risk of non-impulsive underwater noise is considered a key issue that can be effectively managed at low level with adoption of routine mitigation measures during construction (**Section 15 – Environmental Management**).

14.4.3 Vessel or cable strike to marine mammals

Construction works would require vessels and materials to mobilise from Twofold Bay to Merimbula Bay. Construction activities broadly may include towing the pipeline to site, anchoring vessels, laying pipeline into position, and anchoring pipeline with protective concrete mattress or rock armour.

Vessel strike to marine fauna is a world-wide problem (Marsh et al., 2003) and there is a clear relationship between the number of vessels within a given area and the incidence of vessel strike. The risk of vessel strike during mobilisation to or during works at the study area is most likely to involve slower moving marine mammals such as whales, with seals or dolphins considered at lower risk of vessel strike as they can easily out manoeuvre approaching vessels. Vessel strike has the potential to cause injury and or death depending on vessel size, travel speed and species involved.

Cable strike is related to anchor cables that stretch and slacken in the water column. Cables or anchor lines may strike marine fauna, causing slashing injury. Risk of cable strike is considered higher for inquisitive young whales, dolphins and seals, compared to older individuals and potential risk of cable strike increases at night due to reduced visibility.

The potential risk of vessel or cable strike is related to the number of individuals in the area, which is also related to the species seasonal migration period. The risk of vessel or cable strike is considered low with the risk further reduced by adopting routine control measures during construction phase activities (**Section 15 – Environmental Management**).

14.4.4 Accidental spill of fuel, oil or other harmful substances from construction vessels

There is the potential for hazardous substances (*ie.* fuels, oils and other construction vessel related fluids) to accidently enter the water through spills or leaks from construction vessels and/or equipment. Water pollution resulting from vessel accidental spill would typically impact the water surface initially and depending on the scale of the spill and prevailing weather conditions, could potentially spread towards intertidal shorelines Long Point, Haycock Point or beach zone. In the event of large spill event that could not be contained and managed, there may be changes in chemical composition over subsequent days such that various product components would become mixed into the water column and/or may potentially sink and impact the benthos that could

include sandy seabed or rocky reef habitat.

The risk of accidental spill is initially assessed as a medium risk to marine fauna that occur or forage near surface waters such as marine mammals and birds with fish and subtidal communities considered at low risk of impact. The potential risk can be reduced by implementing a range of routine control measures to protect water quality during the construction phase that would be outlined in a Construction Environmental Management Plan (CEMP). Measures would typically include procedures for storage and use of fuel, oil and hydraulic fluids and a spill response plan (**Section 15 – Environmental Management**).

14.4.5 Disturbance and loss of Type 3 soft sediment habitat

Pipeline construction comprises laying the proposed 450 mm diameter pipeline directly on the seafloor (from the HDD riser location) and anchoring with a protective cover of concrete mattress and or rock armour along its 2.7 km length. The construction footprint over the seabed is conservatively estimated at 1.6 m wide by 2,700 m long, or 4,320 m^2. This would result in the direct disturbance and loss of 0.00432 km^2 Type 3 soft sediment habitat, considered minimally sensitive with regard to fish habitat. Based on estimate of 12 km^2 of soft sediment habitat within the study area, this represents a 0.04% loss of Type 3 soft sediment habitat mapped within the study area.

Establishing the pipeline infrastructure would result in the smothering of soft sediment infauna and epifauna that occur directly below the pipeline footprint. The impact on infauna is expected to be minimal as infauna are highly mobile and can move to adjacent habitat. Epifauna such as the sessile great sea pen (*Sarcoptilus grandis)* or mobile comb sand star (*Astopecten vappa*) present along the pipeline alignment could be lost due to direct physical damage during the placemnt of rock armour over the pipeline. Few individuals of the great sea pen were noted during surveys, conservatively estimated at one per 10,000 m^2, and the potential loss of a few individuals is not expected to have an adverse effect on the local population. Similarly, the comb sand star is distributed throughout Merimbula Bay and while a few individuals may be lost during construction of the pipeline, that loss would not have an adverse effect on the local population.

No control measure is available to mitigate the loss of soft sediment habitat and infauna or epifauna directly below the construction footprint. The scale of the soft sediment habitat lost to the Project would be minor and is unlikely to have a long-term negative effect on the faunal assemblages that rely on soft sediment habitat within Merimbula Bay in terms of their diversity and abundance.

Conversely, establishment of the pipeline infrastructure with concrete mattress and or rock armour protection along its length constitutes a change from soft sediment habitat to hard substrate habitat, effectively resulting in the creation of an artificial reef. Any available hard substrate placed in the marine environment provides habitat opportunity in the short-term for a wide range of colonising sessile invertebrates such as ascidians, bryozoans, sponges, barnacles, oysters and mussels. The pipeline and diffuser are also likely to be colonised by various macroalgae. In effect, by laying the pipeline on the seabed rather than trenching and burial, the Project is creating an artificial reef that over the long-term would become colonised by sessile invertebrates and algae and be considered Type 2 fish habitat.

Over the long-term, or for some periods, the pipeline may become buried by sand. Intermittent sand burial and sand scour of hard substrates is a naturally occurring process in the marine environment that can contribute to increased species diversity due to the intermediate disturbance that provides both early and late successional species an opportunity to establish. Therefore, the Project may result in a net positive effect on species diversity and abundance in the central region of Merimbula Bay.

Construction of the pipeline and diffuser infrastructure would result in loss of Type 3 fish habitat but a gain of Type 2 fish habitat, the latter recognised as being more valuable in terms of fish habitat. This may also result in improved recreational fishing opportunities within the vicinity of the pipeline providing an overall beneficial outcome.

14.4.6 Discharge of treated wastewater at the ocean outfall to Type 3 soft sediment habitat

The discharge of treated wastewater at the ocean outfall poses a medium risk to Type 3 soft sediment habitat

and the infauna community occurring within the predicted mixing zone. The risk of impact to all other receptors and values was assessed as minimal to low based on the rapid dilution of wastewater and distance to the mixing zone as discussed in the relevant report sections (**Section 3 Subtidal reef invertebrate and algal community, Section 4 Abalone, Section 5 Fish assemblage, Section 8 Intertidal rocky shore communities, Section 9 Phytoplankton, Section 10 Drift algae, Section 11 Estuarine communities, and Section 12 Aquaculture**).

The potential impact to Type 3 soft sediment habitat is a change in sediment chemistry that could arise from the deposition of particulate organic material (POM) and contaminants absorbed to particles discharged in treated wastewater. Accumulation of deposited POM can cause localised enrichment of sediments and or depletion of oxygen within those sediments. The benthic infauna community of Type 3 soft sediment habitats are known to be sensitive to such changes and the potential effects of enrichment associated with wastewater discharges has been widely studied both in Australia (Otway, 1995; Scanes and Philip, 1995) and overseas (Warwick, 1993; Gray and Elliot, 2009; Puente and Diaz, 2015). Typical effects include altered community structure (i.e. change is species richness and abundance), and changes in the proportions of opportunistic-sensitive species or trophic groups.

The soft sediment infauna community is comprised typically of variable proportions of three main taxon groups – polychaete worms, crustacea, and molluscs, as well as other minor groups (nemerteans, sipunculids, cnidarians, echinoderms and fish). Among these, particular polychaete worm taxa have been identified as useful bio-indicators of organic enrichment as they tend to be tolerant of hypoxic conditions and proliferate under organically enriched conditions. One such example, commonly used as an bio-indicator of eutrophic systems, is the polychaete genus *Capitella* (Pearson and Rosenberg, 1978; Macleod and Forbes, 2004; Edgar et al., 2005; Weisberg et al., 2008). Other polychaete families that are considered indicators of pollution include Spionidae, Orbiniidae, Cirratulidae, Neridae, Nephtyidae, Dorvilleidae, Goniadidae, Hesionidae, Lumbrineridae and Phyllodocidae (Pearson and Rosenberg, 1978). Among studies somewhat relevant to Merimbula Bay are the studies associated with monitoring the environmental impact of wastewater discharge from the Sydney deep water outfalls (Otway, 1995; Scanes and Philip, 1995; Leadbitter, 1996; Philip and Pritchard, 1996). Long-term effects on the soft sediment infauna community noted at two of Sydney deep-water outfall sites were increased abundance of crustaceans Anthurid and Paranthurid isopods, with an overall decrease in polychaete worm diversity noted at one site (Otway, 1995; Scanes and Philip, 1995).

While impacts to infauna communities from wastewater discharges are well documented, the scale of the potential impact is related to the hydrodynamic environment, volume and quality of wastewater being discharged, with higher energy environments such as deep water oceanic settings at lower risk of POM accumulation near the outfall. For the three Sydney deep water outfalls, the daily discharge volume ranges between 126 and 498 ML per day (from Table 1 in Puente and Diaz, 2015), that is many magnitudes greater than the current daily average dry weather (ADW) discharge volume at Merimbula of 1.4 ML per day. Furthermore, future average daily disposal volumes are forecast to decrease to 1.1 ML from the current 1.4 ML (**Section 1.3**). As described in **Section 1.4**, treated wastewater at Merimbula is characterised by typically low total suspended sediment load (median TSS = 5 mg/L), with intermittent higher suspended loads discharged during wet weather flows. Historical exceedance of the TSS discharge limit (30 mg/L) occurred six times over 10-year period and is attributed to microalgae growth within the wastewater storage pond prior to discharge. The discharge of freshwater microalgae in wastewater represents a potential food-source for filter-feeding invertebrates and zooplankton and may provide some benefit in the marine environment. Furthermore, TSS of ambient ocean waters can often be higher than that contained in wastewater discharge, particularly during upwelling events and catchment flood flow discharges. Overall, existing wastewater quality is very clear and the risk of POM accumulation to sediments within the mixing zone over the long-term is considered low to medium noting that upgrades to the STP will result in further improvements in wastewater quality.

Another pathway by which sediments may become enriched is if the discharge of dissolved nutrients to the water column stimulates excessive phytoplankton growth that could then deliver additional POM to the benthos. The threat of dissolved nutrient load discharged to the mixing zone and its potential effect on the

phytoplankton community and risk of increased occurrence of algal blooms was assessed in **Section 9 – Phytoplankton**. It was concluded that the discharge of nutrients to the mixing zone would provide a localised stimulus for increased primary productivity where it is expected that the majority of this nutrient load would be assimilated by phytoplankton within the 25 m mixing zone. However, the overall effect this may have on the phytoplankton assemblage of Merimbula Bay would be minimal. This finding is based on the nutrient discharge being localised, small in scale compared to episodic nutrient inputs from upwellings and catchment flood events, and an understanding that phytoplankton assemblage dynamics of Merimbula Bay (i.e. change in species composition and abundance) are more likely to be influenced by environmental factors operating at broader bioregional, ocean basin scales.

Should changes to sediment chemistry occur from the Project, these would likely to be limited to the near-field mixing zone of 25 m radius from the diffuser with some level of change to the soft sediment infauna community possible. It is then expected that the magnitude and likelihood of potential change would decrease with increasing distance from the outfall and the ability to detect change beyond the mixing zone, if some change has occurred, becomes less likely.

Control measures to mitigate risk of potential impact to the soft sediment infauna community include proposed STP upgrades of PAC dosing for enhanced phosphorous removal and UV disinfection to remove microbial contaminants. If required, a mitigation measure to reduce the risk of metals in the treated wastewater would be the addition of tertiary filtration. Dispersion modelling shows that MWQOs for metals would be achieved within 5 to 25 m from the diffuser and risk of metals to the mixing zone and water quality is already considered low. Tertiary filtration if required, would improve removal of metals and other contaminants from the wastewater stream. However, with dissolved nutrients requiring the highest dilution and effectively defining the extent of the mixing zone, further metal removal would not change the mixing zone extent and would be expected to only marginally decrease an already low risk. Therefore, including tertiary filtration would be unlikely to be justified from a metal removal perspective.

It is recommended that soft sediment infauna monitoring at sites within and outside the mixing zone form a key element of operational phase environmental monitoring. Combined with water quality monitoring, an appropriately designed infauna and sediment quality monitoring program would provide a useful approach for validating assumptions of dispersion modelling, the extent of the mixing zone and predicted impacts on water quality and sediment quality from the Project.

14.5 Cumulative impact

Cumulative impact considers the potential interactions among the various Project impacts and the integrity and resilience of the marine communities of Merimbula Bay. As the majority of the potential impacts to marine ecological receptors and values were assessed as minimal to low, the risk of cumulative impact from interactions between those impacts is unlikely to change the conclusions of this assessment.

Cumulative impact also considers the interaction between the potential Project impacts and other environmental stressors already acting upon the marine habitats and communities of Merimbula Bay. The marine habitats and communities of Merimbula Bay have evolved with and are adapted to the coastal processes acting on the local environment that includes tidal flows, ocean currents, and local climatic conditions. Together these processes directly influence ambient water quality and environmental conditions that change on a seasonal basis. The integrity and resilience of the marine communities within Merimbula Bay are directly related to potential changes in coastal processes acting at the local level. It is considered unlikely that the Project, in its construction or operation, would result in any detectable impact on coastal processes within Merimbula Bay (refer to **Chapter 10 Coastal Processes** of the EIS). Therefore, it is also unlikely that the Project would have a detrimental effect on the integrity or resilience of the marine communities.

The primary threat to the integrity and resilience of marine communities in Merimbula Bay and the broader Twofold Shelf Bioregion is climate change and its predicted impacts on the marine environment. South-east Australia is considered a global hot spot for ocean warming, occurring at around four times the global average

(~0.7°C Century^{-1}), due to increased strength, southward penetration and separation point of the EAC (Hobday et al. 2006, Ridgway 2007, Cetina-Heredia *et al.,* 2014). Predicted impacts to the NSW marine environment include:

- altered ocean currents and nutrients
- climate and sea temperature rise
- ocean acidification
- altered storm and cyclone activity
- sea level rise as well as associated indirect changes to species interactions.

For the marine environment, habitat related impacts are predicted to include changes to abundance of macroalgae, changes in distribution of sub-tidal and intertidal assemblages, and changes in phytoplankton activity. Changes to marine habitats and productivity regimes would have flow-on effects for other trophic levels including fish assemblages and top order predators that include seabirds, cetaceans (whales and dolphins) and pinnipeds (seals).

Potential cumulative impacts from marine climate change operating at broad ocean basin scales to coastal processes poses a greater risk to marine habitats and communities in Merimbula Bay than the proposed Project.

15 Environmental Management

A Construction Environmental Management Plan (CEMP) would be prepared for the Project that would include control measures to mitigate risks associated with key project issues that are provided below.

15.1 Proposed mitigation for introduction or translocation of invasive marine pest

The risk of translocating an IMP during construction phase activities is considered a medium risk. It is expected that construction vessels would adopt standard environmental management practices and controls that meet the broad objectives of the *National Marine Pest Plan 2018-2023* to mitigate the risk.

Minimum control measures include:

- All contractors must undertake a vessel risk assessment prior to mobilising the vessel to site. This would include an inspection of all vessels and equipment considered uncertain or at high risk for introduction of invasive marine pest (IMP). Any vessel or equipment mobilising to site from outside of Australia would automatically be considered high risk and an IMP inspection required.
- Construction vessel antifouling must be maintained to avoid the attachement and potential translocation of IMPs from Twofold Bay.
- No sediments from Twofold Bay are to be disturbed or carried by construction vessels en-route to Merimbula Bay.
- Ballast water management procedures to be adopted by all construction vessels and barges in accordance with the *Australian Ballast Water Management Requirements* (DAWE, 2020).

15.2 Proposed mitigation for underwater noise disturbance impacts

A Construction Noise and Vibration Management Plan (CNVMP) would be prepared for the Project as part of the CEMP. The Plan would include underwater noise and vibration mitigation measures, including implementing safety zones.

The CNVMP should include general feasible and reasonable work practices as identified in ‘Section 6 Work practices’ of the *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change (DECC), 2009).

The CNVMP would include the following measures as a minimum:

- undertake works during standard construction hours where practicable;
- works undertaken between June to November during the whale migration period (southern right and humpback whale southern migrations) would be avoided where possible, or otherwise minimised; if work is required within this period adopt a safety shut-down zone of 170 m and a safety watch zone of 2.3 km where work activity would either be temporarily halted or varied in event that a LF cetacean occurs within these zones;
- works undertaken outside of June to November period would implement a safety watch zone of 500 m where marine mammals (dolphins and seals) will be observed and recorded, no shut down zone is required;
- vessels are to have a trained marine fauna observer (MFO) onboard during all underwater noise generation activities, to record observations of when a cetacean or pinniped enters the 2.3 km safety watch zone. All marine fauna sightings are to be recorded;
- prior to commencing noise disturbance activities, the watch zone is to be clear of marine mammals for a period of at least 10 minutes;
- all injured marine mammals should be immediately reported to ORRCA (02 94153333) and National

Parks and Wildlife Service Merimbula office (02 64955000); and implement vessel speed limits to reduce vessel noise.

15.3 Proposed mitigation for accidential spills

Routine control measures to protect water quality during construction phase would be outlined in a Construction Environmental Management Plan (CEMP). The CEMP would outline the following minimum control measures to mitigate the risk of accidental spill of hazardous substances from construction vessels and equipment:

- All contractor vessels to demonstrate a spill response plan that includes procedures, roles and responsibilities. The plan should include contact details of authorities that are to be notified in the event of a spill including NSW EPA.
- Spill response plan to be included as part of general site works induction
- All contractor vessels to carry spill response kits
- Secure and safe storage of all fuels, oils and fluids for construction equipment

15.4 Proposed mitigation for vessel impacts to marine mammals

The project CEMP would also include provisions for mitigating risk of vessel strike and vessel noise to whales when mobilising to site.

Control measures to be adopted to reduce risk of vessel or cable strike include:

- Construction phase works to be undertaken outside of peak whale migration periods (June to November) where practicable
- Vessels to adopt safe travel speeds no greater than 10 knots when mobilising to site
- Vessels maintain a 300 m exclusion zone with all whales en-route to and from construction site
- Slower speeds adopted in event a whale is observed within 100 m of the vessel
- Vessels are to have a trained marine fauna observer (MFO) onboard to record observations of marine fauna when transiting in vessls

15.6 Environmental Monitoring

As part of operational licence requirements, it is expected that water qualiy monitoring of marine and estuarine waters would need to be undertaken as a key performance indicator of environmental compliance. The monitoring program would have the objective of assessing marine water quality at sites inside and outside the treated wastewater mixing zone against MWQO trigger values to ensure sensitive receptors and environmental values are protected.

Details for a proposed water quality monitoring program are included in the *Water Quality Technical Report* (Elgin, 2021). It is anticipated the data from the water quality monitoring program would be used in an initial screening process of results against MWQO trigger values for protection of nearby receptors and environmental values. In the event trigger values were exceeded in frequency and/or magnitude, contingency actions would typically include:

- Confirming result(s) with follow up sampling.
- Checking treated wastewater quality at the STP for any significant changes.
- Assessing regional factors such as fluvial/rainfall event outflows from Merimbula and Pambula estuaries and marine upwelling.
- More detailed Tier 2 risk assessment of potentially impacted receptor and/or values such as, benthic infauna, recreational beach users, aquaculture, fish or shellfish.

A marine ecological monitoring program may also be undertaken with a similar risk-based approach. Components for a marine ecological monitoring program would be based on risk of impact as indicated by water quality monitoring and may include:

- Soft sediment infauna monitoring to validate assumptions of dispersion modelling, the extent of the mixing zone and predicted impacts on water quality.
- In event that sediment metal concentrations within the mixing zone increase over time, the potential risk exists for bioaccumulation pathway from infauna to fish. This would trigger additional sampling of fish for bioaccumulative contaminants to assess whether the pathway for bioaccumulation is complete.
- Monitoring the pipeline and diffuser infrastructure to validate predictions regarding enhancement of local biodiversity through creation of Type 2 habitat.
- A strategy for operational phase monitoring of abalone populations in the form of a two-data-source approach to be able to quickly detect potential changes to Merimbula Bay abalone populations, and accurately and reliably assess whether any changes detected could reasonably be attributable to treated wastewater discharge though the risk is assessed as minimal to low.
    - Source 1 would involve analysis of fishery-dependent CPUE data
    - Source 2 would involve analysis of fishery-independent data in the form of diver field surveys of abalone abundance and population size structure.

  Such a two-pronged approach would mitigate the risk of erroneous conclusions based on observed trends in changes in abalone population health and structure interpreted from just a single source of data lacking independence (i.e. CPUE) (Rotherham *et al.* 2011). Alternatively, a two-stage approach could be implemented, for which Source 2 data (field surveys) would only be required if triggered by Stage 1 (i.e. if the results of CPUE analysis indicated a potential problem with the fisheries at Haycock Point and/or Long Point, or if the CPUE data were assessed to be inadequate).

16 References

Abalone Council (2016). *Assessment of abalone stocks in NSW*. Submission to the TAC setting process for 2017, Abalone Council of NSW, October 2016.

ABARES (2020). Australian fisheries and aquaculture statistics 2016. Australian Bureau of Agricultural and Resource Economics and Sciences.

AECOM (2019a). 30% Concept Design Report - Merimbula STP and Deep Ocean Outfall. Prepared for Bega Valley Shire Council, 6 December 2019.

AECOM (2019c). Merimbula Ocean Outfall – Dispersion Modelling Report. Prepared for Bega Valley Shire Council, 20 December 2019.

AECOM (2017a). Report 'Design Criteria – Merimbula STP and Deep Ocean Outfall Concept Design and Environmental Assessment' (Draft). 31 October 2017.

AECOM (2017b). Merimbula STP Upgrade and Deep Ocean Outfall, Transmittal Advice No. E01. 12 December 2017.

AECOM (2013). Desktop Ecological Assessment of the Potential Impacts on Merimbula Lake from Dunal Exfiltration of Effluent. Prepared for Bega Valley Shire Council, March 2013.

AECOM (2020). Underwater Noise assessment, 9 September 2020.

Ajani P, Hallegraeff G, Allen D, Coughlan A, Richardson AJ, Armand L, et al. (2016). Establishing baselines: a review of eighty years of phytoplankton diversity and biomass in southeastern Australia. *Oceanography and Marine Biology - An Annual Review*.

Ajani PA, Allen AP, Ingleton T, Armand L. (2014a). A decadal decline in relative abundance and a shift in microphytoplankton composition at a long-term coastal station off southeast Australia. *Limnology and Oceanography*. 59(2): 519-31.

Ajani P, Allen AP, Ingleton T, Armand L. (2014b). Erratum: A decadal decline in relative abundance and a shift in phytoplankton composition at a long-term coastal station off southeast Australia. *Limnology and Oceanography*. 59(6): 2240-2.

Ajani P, Brett S, Krogh M, Scanes P, Webster G, Armand L. (2013c) The risk of harmful algal blooms (HABs) in the oyster-growing estuaries of New South Wales, Australia. *Environmental Monitoring and Assessment*.185(6): 5295-316.

Ajani P, Lee R, Pritchard T, Krogh M. (2001). Phytoplankton dynamics at a long-term coastal station off Sydney, Australia. *Journal of Coastal Research*. 34: 60-73.

Ajani, P., Roberts, D.E., Smith, A. and Krogh, M. (1999). The effect of sewage on two bioindicators at Port Stephens, NSW Australia. *Ecotoxicology*, 8: 253-267.

ALA (2020). Atlas of Living Australia, URL: https://www.ala.org.au/

ALCW (2020). Atlas of Life in Coastal Wilderness Sightings Records, https://atlasoflife.org.au/

AMA (2016). Infauna Survey – Offshore Disposal Location. Specialist study undertaken for the Eden Harbour-Breakwater Wharf Extension. Australasian Marine Associates, 7 September 2016.

Andrew, N.L. and Underwood, A.J. (1989). Patterns of abundance in the sea urchin *Centrostephanus rodgersii* on the central coast of New South Wales. *Journal of Experimental Marine Biology and Ecology* 131, 61-80.

Andrew, N.L., Worthington, D.G., Brett, P.A., Bentley, N., Chick, R.C., and Blount, C. (1998). Interactions between the abalone fishery and sea urchins in New South Wales. FRDC Project No. 93/102.

Andrew, N.L. and O'Neill, A.L. (2000). Large-scale patterns in habitat structure on subtidal rocky reefs in New

South Wales. *Marine and Freshwater Research*, **51**: 255-263.

Andrew, N.L. and Underwood, A.J. (1992). Associations and abundance of sea urchins and abalone on shallow subtidal reefs in Southern New South Wales. *Aust. J. Marine and Freshwater Research*, **43:** 1547-59.

ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. 2000.

ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. 2018.

Bebbington, G.N., Mackay, N.J., Chvojka, R., Williams, R.J., Dunn, A., Auty, E.H. (1977). Heavy metals, selenium and arsenic in nine species of Australian commercial fish. Aust. J. Mar. Freshwater Res., 1977, 28, 277-86.

Bega Valley Shire Council (2017). Policy 4.07 – Water and Sewerage Services. November 2017.

Bega Valley Shire Council (2009). Procedure 4.06.3 – Liquid Trade Waste. September 2009.

Bega Valley Shire Council (2017). BVSC influent and effluent data for the site in spreadsheet file entitled 'Merimbula STP influent and effluent quality data_kb02112017.xls.' 2017.

Bellgrove, A., Clayton, M.N., and Quinn, G.P. (1997). Effects of secondarily treated sewage effluent on intertidal macroalgal recruitment processes. *Marine Freshwater Research*, 48, pp. 137-146.

Bennett, I., Pope, E.C. (1953). *Intertidal zonation of the exposed rocky shores of Victoria, together with a rearrangement of the biogeographical provinces of temperate Australian shores*. Marine and Freshwater Research 4: 105-159.

Birch and Apostolatos (2013). Use of sedimentary metals to predict metal concentrations in black mussel (Mytilus galloprovincialis) tissue and risk to human health (Sydney estuary, Australia). Env. Sci. and Pol. Research, 20-8, August 2013.

Breen, D.A., Avery, R.P. and Otway, N.M. (2005). Broadscale biodiversity assessment of the Batemans Shelf and Twofold Shelf marine bioregion. Final Report for the NSW Marine Parks Authority 2005.

BMT-WBM (2017). NSW marine estate threat risk assessment report.

Brown, V.B., Davies, S.A. and Synnot, R.N. (1990). Long-term monitoring of the effects of treated sewage effluent on the intertidal macroalgae community near Cape Schanck, Victoria, Australia. *Botanica Marina* **33**, 85-98.

Burridge, T.R., Portellia, T., and Ashton, P. (1996). Effect of sewage effluents on germination of three marine brown algal macrophytes. *Marine Freshwater Research*, 47, pp. 1009-1014.

Carbery, M., O'Connor, W., Thavamani, P. (2018). Trophic transfer of microplastics and mixed contaminants in the marine food web and implications for human health. Environment International, 2018.

Cardno (2012). Pambula River Estuary Processes study, Prepared for Bega Valley Shire Council, Final Report - 27 April 2012.

Cardno (2012). Southern Bluefin Tuna Species Impact Statement. Report prepared for NSW DPI, 2012.

CEE (2000). Marine Biological Impacts Study Part I. Existing Discharges, Report No. CHEIS R09, in Coffs Harbour Sewerage Strategy Environmental Impact Statement Report, Coffs Harbour City Council 2000.

Cetina-Heredia, P., Roughan, M., van Sebille, E., Coleman, M.A. (2014). Long-term trends in the East Australian Current separation latitude and eddy driven transport. J. Geophys. Res. Oceans, 119, 4351-4366.

Clarke, K.R. and Warwick, R.M. (2001). A further biodiversity index applicable to species lists: variation in taxonomic distinctness. Mar. Ecol. Prog. Ser. 216: 265-278

COA (2015). South-east Marine Region Profile – A description of the ecosystems, conservation values and uses of the South-east Marine Region. Commonwealth of Australia, 2015.

Cole, M., Lindeque, P., Halsband, C., Galloway, T.S. (2011). Microplastics as contaminants in the marine environment: A review. Mar. Pol. Bulletin, 62 (2011) 2588-2597.

Corbeil, S., and Berthe, F.C.J. (2009). Disease and Mollusc Quality. In: Shumway, S.E., and Rodrick, G.E. (Eds.) Shellfish Safety and Quality. Woodhead Publishing, UK.

Coutin, P. C., Cashmore, S., and Sivakumuran, K. P. (2003). Assessment of the snapper fishery in Victoria. Fisheries Research and Development Corporation Final Report 97/127.

Creese, R.G., Glasby, T.M., West, G. and Gallen, C. (2009). *Mapping the habitats of NSW estuaries.* Report to the Hunter Central Rivers Catchment Management Authority, September 2009. Available online at URL: http://www.dpi.nsw.gov.au/data/assets/pdf_file/0004/306625/AE_2009_Output-1575_Creese-et-al_Habitat-Mapping-Final-Report-113_REPORT.pdf

Currie, D.R., McArthur, M.A., and Cohen, B.F. (2000). Reproduction and distribution of the invasive European fanworm Sabella spallanzanii (Polychaeta: Sabellidae) in Port Phillip Bay, Victoria, Australia. *Mar. Biol.* 136, 645–56.

Dafforn, K.A., Kelaher, B.P., Simpson, S.L., Coleman, M.A., Hutchings, P.A., Clark, G.F., Knott, N.A., Doblin, M.A., Johnston, E.L. (2013). Polychaete richness and abundance enhanced in anthropogenically modified estuaries despite high concentrations of toxic contaminants. *PLoS One* 8: e77018.

Dalton, S. (2005). State of Knowledge of the NSW Sapphire Coast Marine Environment. Envirofund Project.

Dakin WJ, Colefax A. (1933). The marine plankton of the coastal waters of New South Wales. 1. The chief planktonic forms and their seasonal distribution. Proceedings of Linnean Society of New South Wales. 58: 186-222.

Dakin WJ, Colefax A. (1940). The plankton of the Australian coastal waters of New South Wales. Part 1. University of Sydney, Department of Zoology Monograph 1:303-14.

Dauvin, J. and Ruellet, T. (2006). Polychaete/Amphipod Ratio Revisited. *Marine Pollution Bulletin* 55 (1-6), 215-224.

DAWE (2020). National Conservation Values Atlas – Biologically Important Areas, Australian Government Department of Agriculture Water and Environment, accessed June 2020.

DAWE (2020). Infection with *Perkinsus olseni*. In: Aquatic animal diseases significant to Australia: identification field guide, 5th edition. Australian Government Department of Agriculture, Water and the Environment, Canberra.

DAWR (2018). Marine Pest Plan 2018–2023: the National Strategic Plan for Marine Pest Biosecurity. Department of Agriculture and Water Resources, Canberra.

Day, J.H. and Hutchings, P. (1984). Descriptive notes on the flora and fauna of Merimbula, Pambula and Back Lakes, New South Wales. Aust. Zool. 21(3): 269-289.

Dean, H. (2008). The use of polychaetes (Annelida) as indicator species of marine pollution: a review. *Revista de Biologia Tropical* 56, 11-38.

DECC (2006). NSW Water Quality and River Flow Objectives, Towamba and Genoa River. 2006.

DECC (2005). Marine Water Quality Objectives for NSW Ocean Waters – South Coast. October 2005.

DECCW (2010). Seabed habitat mapping of the continental shelf of NSW. DECCW report 2010/1057, December 2010.

DECCW (2011). State of the catchments 2010 Estuaries and Coastal Lakes – Southern Rivers region. Available online at URL: http://www.environment.nsw.gov.au/resources/soc/southernrivers/10603SRestuarine.pdf

DPI (2013). *Policy and Guidelines for Fish Habitat Conservation and Management*

DPI (2008). NSW Invasive Species Plan 2008 - 2015. NSW, Department of Primary Industries, August 2008.

DPI (2012). Black Rockcod (*Epinephelus daemelii*) Recovery Plan, 2nd Edition.

DPI (2014). Southern Bluefin Tuna (*Thunnus maccoyii*) Primefact 1382, December 2014, First Edition.

DPI (2015). Black Rockcod (*Epinephelus daemelii*) Primefact 189, June 2015, 2nd Edition

DPI (2016). DPI Fisheries submission to the DP&E Secretary's Environmental Assessment Requirements (SEARs), letter dated 30/5/2016.

DPI (2017). Commercial fisheries catch data 2009 to 2017 for Pambula area, provided to Elgin Associates per email request dated 23 July 2017.

DPI (2018a). Southern fish trawl fishery closures, DPI website URL: https://www.dpi.nsw.gov.au/fishing/closures/commercial/southern-fish-trawl-fishery-closures/water-closed-to-ocean-trawl-for-the-southern-fish-trawl-fishery

DPI (2018b). Merimbula Offshore Artificial Reef, DPI website URL: https://www.dpi.nsw.gov.au/fishing/recreational/resources/artificial-reef/merimbula-offshore-artificial-reef

DPI (2020). Priority Action Statement – Actions for Southern Bluefin Tuna, website accessed June 2020

DPI (2020a). Disease issues in wild fish and wild shellfish. Information webpage at: https://www.dpi.nsw.gov.au/fishing/aquatic-biosecurity/recreational-waterway-users/wildfish-shellfish

DPI (2020b). Marine Pests - *Caulerpa taxifolia*. Information webpage at: https://www.dpi.nsw.gov.au/fishing/aquatic-biosecurity/pests-diseases/marine-pests/found-in-nsw/caulerpa-taxifolia

DPI (2020c). Marine Pests - Black-striped mussel. Information webpage at: https://www.dpi.nsw.gov.au/fishing/aquatic-biosecurity/pests-diseases/marine-pests/found-in-australia/black-striped-mussel

DPI (2020d). NSW Blue Mussel spat translocation protocol (Twofold Bay to Jervis Bay). V2, 6 May 2020. OUT18/11739.

DPI (2020e). Sea Urchin and Turban Shell Restricted Fishery. Information webpage at: https://www.dpi.nsw.gov.au/fishing/commercial/fisheries/sea-urchin-and-turban-shell-restricted

DoE (2014). Recovery Plan for the Grey Nurse Shark (*Carcharias Taurus*), Commonwealth Dept. of Sustainability, Environment, Water, Population and Communities, 2013.

Doney S.C. (2006). Oceanography - Plankton in a warmer world. *Nature*. 444(7120): 695-6.

Dorsal (2020). Shark Reporting URL: https://www.dorsalwatch.com/report/

Doubleday, Z., Mayfield, S., Gorfine, H., and Worthington, D. (2011). Abalone, blacklip and greenlip *Haliotis rubra* and *H. Laevigata*, individual species assessment. In: Pecl, G.T., Doubleday, Z., Ward, T., Clarke, S., Day, J., Dixon, C., Frusher, S., Gibbs, P., Hobday, A., Hutchinson, N., Jennings, S., Jones, K., Li, X., Spooner, D. and Stoklosa, R. Risk Assessment of Impacts of Climate Change for Key Marine Species in South Eastern Australia. Fisheries Research and Development Corporation, Project 2009/070.

DSEWPaC (2013). Draft issues paper for the Grey Nurse Shark (*Carcharias Taurus*), Commonwealth Dept. of Sustainability, Environment, Water, Population and Communities, 2013.

DSEWPaC (2013). Recovery Plan for the White Shark (*Carcharodon carcharias*).

DSEWPaC (2013). Issues Paper for the White Shark (*Carcharodon carcharias*).

DSEWPaC (2012). Conservation Management Plan for the Southern Right Whale.

Edgar, G.J., Macleod, C.K., Mawbey, R.B., Shields, D. (2005). Broad-scale effects of marine salmonid aquaculture on macrobenthos and the sediment environment in southeastern Tasmania. Journal of Experimental Marine Biology and Ecology 327: 70-90.

Edwards, S. (2003). Assessment of the physiological effect of altered salinity on greenlip (*Haliotis laevigata*) and blacklip (*Haliotis rubra*) abalone using respirometry. *Aquaculture Research*, 34 (14): 1361-65.

Elgin (2013a). Merimbula Bay Algal Bloom Study. Report prepared for Bega Valley Shire Council, 9 January 2013.

Elgin (2013b). Ecological Assessment of the Potential Impacts on Merimbula Lake from dunal exfiltration of effluent - Supplementary Report. Prepared for Bega Valley Shire Council, 5 March 2013.

Elgin (2014a). Merimbula Lake – Estuary Health Monitoring Report Series No.5, Report prepared for BVSC, 21 February 2014.

Elgin (2014b). Pambula Lake – Estuary Health Monitoring Report Series No.10, Report prepared for BVSC, 5 February 2014.

Elgin (2017). Progress Report 12 of 12 (Data collected in April 2017) – Merimbula Background Ocean Water Quality Monitoring, dated 14 May 2017. Includes compiled WQ dataset 2014-2017 and Baseline Sediment Quality

Elgin (2021). Water Quality Technical Report – Merimbula STP upgrade and ocean outfall EIS. Prepared for AECOM, February 2021.

Environment Australia (2017). Directory of Important Wetlands in Australia. URL: http://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands

Fabris, G. Turoczy, N.J. and Stagnitto, F. (2006). Trace metal concentrations in edible tiisue of snapper, flathead, lobster, and abalone from coastal waters of Victoria, Australia. *Ecotoxicology and Environmental Safety*, 63: 286-292.

Fairweather, P.G. (1990). Sewage and the biota on seashores: assessment of impact in relation to natural variability. Environmental Monitoring and Assessment 14, 197-210.

Falkowski, P.G., Barber, R.T., Smetacek, V. (1998). Biogeochemical controls and feedbacks on ocean primary production. *Science*. 281(5374): 200-6.

Falkowski, P.G., Katz, M.E., Knoll, A.H., Quigg, A., Raven, J.A., Schofield, O., et al. (2004). The evolution of modern eukaryotic phytoplankton. *Science*. 305(5682): 354-60.

Falkowski, P.G., Oliver, M.J. (2007). Mix and match: how climate selects phytoplankton. *Nature Reviews Microbiology*. 5(10): 813-9.

Fetterplace, L.C., Davis, A. R., Neilson, J.M., Taylor, M.D., Knott, N.A. (2016). Active acoustic tracking suggests that soft sediment fishes can show site attachment: a preliminary assessment of the movement patterns of the blue-spotted flathead (Platycephalus caeruleopunctatus). Anim Biotelemetry (2016) 4:15.

Field CB, Behrenfeld MJ, Randerson JT, Falkowski P. (1998). Primary production of the biosphere: Integrating terrestrial and oceanic components. *Science*. 281(5374): 237-40.

Fonseca, G., Hutchings, P., Gallucci, F. (2011). Meiobenthic communities of seagrass beds (Zostera capricorni) and unvegetated sediments along the coast of New South Wales, Australia. *Estuarine, Coastal and Shelf Science* 91: 69-77.

FSANZ (2016). Standard 1.4.1 - Contaminants and natural toxicants. Food Standards Australia New Zealand, 2016

FSANZ (2017). Schedule 19 - Maximum levels of contaminants and natural toxicants. Food Standards

Australia New Zealand 2017.

FSANZ (2001). Generally Expected Levels (GELs) for Metal Contaminants. Food Standards Australia New Zealand July 2001.

Gallegos, C.L., Jordan, T.E., Hedrick, S.S. (2010). Long-term dynamics of phytoplankton in the Rhode River, Maryland (USA). *Estuaries and Coasts*. 33(2): 471-84.

Gibbs, P., Collins, A., Collett, L. (1980). Effect of otter prawn trawling on the macrobenthos of a sandy substratum in a New South Wales estuary. Marine and Freshwater Research 31: 509-516.

Gibbs, P. and Jones, K. (2011). Australian Salmon *Arripis trutta* and *A. truttaceus*, individual species assessment, In: Pecl GT, Doubleday Z, Ward T, Clarke S, Day J, Dixon C, Frusher S, Gibbs P, Hobday A, Hutchinson N, Jennings S, Jones K, Li X, Spooner D, and Stoklosa R. Risk Assessment of Impacts of Climate Change for Key Marine *Species in South Eastern Australia. Fisheries Research and Development Corporation, Project 2009/070.*

Gilbert, P.M. (2020). Harmful algae at the complex nexus of eutrophication and climate change. Harmful algae 91 (2020) 101583

Gladstone, W., Lindfield, S., Coleman, M. and Kelaher, B. (2012). Optimisation of baited remote underwater video sampling designs for estuarine fish assemblages. *J. Exp. Mar. Biol.* 429: 28-35.

Glasby, T. and Kingsford, M. (1994). *Atypichys strigatus* (Pisces: Scorpididae): An opportunistic planktivore that responds to benthic disturbances and cleans other fishes. Austral Ecology, 19, 385-394.

Glasby, T.M., Gibson, P.T., West, G., Davies, P., and Voerman, S. (2015). Range and habitat associations of the native macroalga *Caulerpa filiformis* in New South Wales, Australia. *Marine and Freshwater Research*, **66(11):** 1018-1026.

Gorfine, H.K., Hart, A.M., and Callan, M.P. (1996). Evaluation of methods to assess abalone abundance. Final report to Fisheries Research and Development Corporation, FRDC project 93/100.

Gorski, J., and Nugegoda, D. (2006). Sublethal toxicity of trace metals to larvae of the blacklip abalone, *Haliotis rubra. Environmental Toxicology and Chemistry*, 25(5): 1360-67.

Government of South Australia (2012). Underwater Piling Activities Noise Guidelines. Department of Planning, Transport and Infrastructure.

Grant, B.R. (1971). Variation in silicate concentration at Port Hacking station, Sydney, in relation to phytoplankton growth. *Australian Journal of Marine and Freshwater Research*. 22: 49-54.

Grant, B.R., and Kerr, J.D. (1970). Phytoplankton numbers and species at Port Hacking station and their relationship to the physical environment. *Australian Journal of Marine and Freshwater Research*. 21: 35-45.

Gray, J.S. and Elliot, M. (2009). Ecology of Marine Sediments - From Science to Management, Second Edition, Oxoford University Press 2009, 225 pp.

Grigg, R.W. (1994). Effects of sewage discharge, fishing pressure and habitat complexity on coral ecosystems and reef fishes in Hawaii. *Marine Ecology Progress Series* 103, 25-34.

Grigg, R.W. (1995). Coral reefs in an urban embayment in Hawaii: a complex case history controlled by natural and anthropogenic stress. *Coral Reefs* 14, 253-266.

Hallegraeff., G, Beardall. J., Brett. S., Doblin., M., Thompson., P. (2012). Phytoplankton. In *A Marine Climate Change Impacts and Adaptation*. Report Card for Australia 2012.

Hallegraeff GM. (1981). Seasonal study of phytoplankton pigments and species at a coastal station off Sydney: Importance of diatoms and the nanoplankton. Marine Biology. 61(2): 107-18.

Hallegraeff GM, Reid DD. (1986). Phytoplankton species successions and their hydrological environment at a

coastal station off Sydney. *Australian Journal of Marine and Freshwater Research*. 37: 361-77.

Harasti, A.D., Malcolmb, H., Gallen, C., Coleman, M.A, Jordan, A., and Knott, N.A. (2015). Appropriate set times to represent patterns of rocky reef fishes using baited video. Journal of Experimental Marine Biology and Ecology, 463, pp. 173–180

Hart, A.M., Gorfine, H.K. and Callan, M.P. (1997). Abundance estimation of blacklip abalone (*Haliotis rubra*) I. An analysis of diver-survey methods used for large-scale monitoring. *Fisheries Research* 29 (2): 159-169.

Hawkins, A.D. and Popper, A. N. (2017). A sound approach to assessing the impact of undrwater noise on marine fishes and invertebrates. ICES Journal of Marine Science 74(3): 635-651.

Heads of EPAs Australia (2020). PFAS National Environment Management Plan. January 2020.

Henry, G. W., and Lyle, J. M. (2003). The National Recreational and Indigenous Fishing Survey. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.

Hill, K.L., Rintoul, S.R., Coleman, R., Ridgway KR. (2008). Wind forced low frequency variability of the East Australia Current. *Geophysical Research Letters*. 35(8): L08602.

Hobday, A.J., Hartmann, K. (2006). Near real-time spatial management based on habitat predictions for a longline bycatch species. *Fisheries Management and Ecology*. 13(6): 365-80.

Hobday, A.J., Okey, T.A., Poloczanska, E.S., Kunz, T.J., and Richardson, A.J. (eds) (2006). Impacts of climate change on Australian marine life: Part C. Literature Review. Report to the Australian Greenhouse Office, Canberra, Australia. September 2006.

Humphrey GF. (1960). The concentration of planktonic pigments in Australian waters.: CSIRO Division of Fisheries and Oceanography Technical Paper. p. 27.

Humphrey GF. (1963). Seasonal variations in plankton pigments in waters off Sydney. *Australian Journal of Marine and Freshwater Research.*14(1):24-36.

Hutchinson, N. (2011). Snapper *Chrysophrys auratus*, individual species assessment, In: Pecl GT, Doubleday Z, Ward T, Clarke S, Day J, Dixon C, Frusher S, Gibbs P, Hobday A, Hutchinson N, Jennings S, Jones K, Li X, Spooner D, and Stoklosa R. Risk Assessment of Impacts of Climate Change for Key Marine *Species in South Eastern Australia. Fisheries Research and Development Corporation, Project 2009/070.*

INFOMAR (2017). Integrated Mapping For the Sustainable Development of Ireland's Marine Resource, website URL: http://www.infomar.ie/

IWC (2001). Right Whales: worldwide status. International Whaling Commission Eds: PB Best, JL Bannister, RL Brownell and GP Donovan. *Journal of Cetacean Research and Management* Special Issue 2, 309pp.

Jeffrey, S.W., and Carpenter, S.M. (1974). Seasonal succession of phytoplankton at a coastal station off Sydney. *Australian Journal of Marine and Freshwater Research*. 25: 361-9.

Jones, G. and Candy, S. (1981). Effects of dredging on the macrobenthic infauna of Botany Bay. *Marine and Freshwater Research* 32: 379-398.

Leadbitter D. (1996). Sewage and the community—One view of Sydney's deepwater outfalls, the environmental monitoring programme and the future of sewage disposal. Marine Pollution Bulletin 33: 269-272.

Lemly, A.D., 1996. Wastewater discharge may be most hazardous to fish during winter. *Environmental Pollution* 93, 169-174.

Liggins, G.W., and Upston, J. (2010). Investigating and managing the *Perkinsus*-related mortality of blacklip

abalone in NSW. Final report to Fisheries Research and Development Corporation, FRDC project 2004/084. Industry & Investment NSW – Fisheries Final Report Series No. 120 ISSN 1837-2112.

Lincoln-Smith, M. (2003). *Aquatic Ecology in Environmental Impact Assessment – EIA Guideline.* NSW Department of Planning, May 2003.

Lobban, C.S. and Harrison, P.J. (1994). Seaweed ecology and physiology. Cambridge University Press 1994.

Love, M.S., Axell, B., Morris, P., Collins, R., Brooks, A., 1987. Life history and fishery of the Californian scorpionfish, *Scorpaena guttata*, within the southern Californian Bight. *Fish. Bull.* 85, 99-116.

Keller, K., Smith, J.A., Lowry, M.B., Taylor, M.D., and Suthers, I.M. (2017). Multispecies presence and connectivity around a designed artificial reef. Marine and Freshwater Research, 68, 1489-1500.

Macleod, C., Forbes, S. (2004). Guide to the assessment of sediment condition at marine finfish farms in Tasmania. Hobart: Tasmanian Aquaculture and Fisheries Institute, University of Tasmania.

Marine and Earth Sciences (2018). Phase 1 Merimbula Ocean Outfall Project – Geophysical Investigations, Merimbula, New South Wales. 12 February 2018.

Marsh, H., Arnold, P., Freeman, M., Haynes, D., Laist, D., Read, A. and Kasuya, T. (2003). Strategies for conserving marine mammals. Marine Mammals: Fisheries, Tourism and Management Issues. Victoria, Australia: CSIRO Publishing, 1-19.

McClintock, S. (2012). Trace metals in marine food species (*Saccosteria commercialis, Metapenaus macleaya, Girella tricuspidata* and *Platycephalus fuscus*) from Lake Illawarra, New South Wales. Honours Thesis, University of Wollongong, October 2012.

McInerney, P., Rees, G., and Joehnk, K. (2020). The sweet relief of rain after bushfires threatens disaster for our rivers. The Conversation: https://theconversation.com/the-sweet-relief-of-rain-after-bushfires-threatens-disaster-for-our-rivers-129449

McVay, I.R., Maher, W.A., Krikowa, F., Ubrhien, R. (2018). Metal concentrations in waters, sediments and biota of the far south-east coast of New South Wales, Australia, with an emphasis on Sn, Cu and Zn used as marine antifoulant agents. Environ Geochem Health, 21 November 2018.

Meehan, A.J. (1997). Historical changes in seagrass, mangrove and saltmarsh communities in Merimbula and Pambula Lake. Honours thesis (unpubl.), Environmental Science Unit, University of Wollongong.

MHL (2015). Proposed Merimbula Deep Outfall. Relative Hydrodynamic Merits of Different Outfall Locations. Manly Hydrualics Laboratory report MHL2418, prepared for Bega Valley Shire Council, 17 November 2017.

Mundy, C., Stobart, B., Green, C., Ferguson, G., Burnell, O., Chick, R., Mayfield, S., and Hart, A. (2018) Blacklip abalone *Haliotis rubra rubra*, in Carolyn Stewardson et al. (Eds), Status of Australian fish stocks reports 2016, Fisheries Research and Development Corporation, Canberra.

Newell, B., Molloy, R., and Fox, D. (1999). Environmental Impact Assessment and Review of Effluent Disposal Options for Eastern Treatment Plant. Final report prepared by CSIRO for Melbourne Water Corporation. ISBN 0 643 06060 X

NLWRA (2001). National Land and Water Resources Audit - Estuary Assessment Framework for non-pristine estuaries.

NSW EPA (2014). Environment Protection Licence 1741, issued to Bega Valley Shire Council. December 2014.

NSW EPA (2016). Plastic microbeads in products and the environment. July 2016.

OEH (2017). Estuaries of NSW: Physical characteristics, tidal surveys and hydrographic surveys. URL: http://www.environment.nsw.gov.au/estuaries/list.htm

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

OISAS (2016). The NSW Oyster Industry Sustainable Aquaculture Strategy, DPI 2016.

Otway, N.M. (1995). Assessing impacts of deepwater sewage disposal: A case study from New South Wales, Australia. *Marine Pollution Bulletin*, 31(4-12), pp. 347-354.

Pan, Y. and Rao, D.V.S. (1997). Impacts of domestic sewage effluent on phytoplankton from Bedford Basin, Eastern Canada. Marine Pollution Bulletin, 34(12): 1001-1005.

Pearson, T., Rosenberg, R. (1978). Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr. Mar. Biol. Ann. Rev 16: 229-311.

Philip. N. and Pritchard, T. (1996). Australia's first deepwater sewage outfalls: Design considerations and environmental performance monitoring. *Marine Pollution Bulletin* 33: 140-146.

Pollard, D. A. and Rankin, B. K. (2003). Port of Eden, introduced marine pest species study. NSW Fisheries Office of Conservation, Cronulla.

Popper, A.N. and Hawkins, A.D. (2019). An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. J Fish Biology 94: 692-713.

Pritchard T, Lee R, Ajani P, Rendell P, Black K. (2001). How Do Ocean Outfalls Affect Nutrient Patterns in Coastal Waters of New South Wales, Australia? *Journal of Coastal Research*, p96-109.

Pritchard T, Lee R, Ajani P. (1999). Anthropogenic and oceanic nutrients in NSW's dynamic coastal waters and their effect on phytoplankton populations. Coasts & Ports' 99: Challenges and Directions for the New Century; Proceedings of the 14th Australasian Coastal and Ocean Engineering Conference and the 7th Australasian Port and Harbour Conference. p.511.

Puente, A. and Diaz, R.J. (2015). Response of benthos to ocean outfall discharges: does a general pattern exist? Marine Pollution Bulletin 101: 174-181.

Rees, M. J., Knott, N. A., Fenech, G. V. and Davis, A. R. (2015). Rules of attraction: enticing pelagic fish to mid-water remote underwater video systems (RUVS). *Marine Ecology Progress Series*, 529, pp. 213-218.

Richardson AJ, Poloczanska ES (2008). Ocean science - Under-resourced, under threat. *Science*, 320(5881): 1294-5.

Ridgway, K., and Hill, K. (2012). East Australian Current. In *A Marine Climate Change Impacts and Adaptation Report Card for Australia* (Eds ES Poloczanska, AJ Hobday and AJ Richardson)

Ridgway, K.R., Godfrey, J.S. (1997). Seasonal cycle of the East Australian Current. *Journal of Geophysical Research-Oceans*, 102: 22921-36.

Ridgway, K.R. (2007). Long-term trend and decadal variability of the southward penetration of the East Australian Current. Geophysical Research Letters 34, L13613

RLS (2017). Reef Life Survey Data Portal, URL: http://reeflifesurvey.imas.utas.edu.au/portal/search

Roberts, D.E., Smith, A., Ajani, P. and Davis, A.R. (1998). Rapid changes in encrusting marine assemblages exposed to anthropogenic point-source pollution: a 'Beyond BACI' approach. *Marine Ecology Progress Series* 163: 213-224.

Roberts, D.E. and Scanes, P.R. (1999). Spatial patterns in the macrobenthic assemblages inhabiting kelp (Ecklonia radiata) forests exposed to sewage effluent. *Aust. J. of Ecotoxicology*, 5: 89-102.

Scandol, J., Rowling, K. and Graham, K. Eds (2008) Status of Fisheries Resources in NSW 2006/07, NSW Dept. of Primary Industries, Cronulla.

Scanes, P.R., Philip, N. (1995). Environmental impact of deepwater discharge of sewage off Sydney, NSW,

Australia. *Marine Pollution Bulletin* 31: 343-346.

Scanes, P., Coade, G., Doherty, M. and Hill, R. (2007). Evaluation of the utility of water quality based indicators of estuarine lagoon condition in NSW, Australia. Estuarine, Coastal and Shelf Science 74: 306-319.

Seitz, R.D. and Lipicus, R.N. (2001). Variation in top-down and bottom-up control of marine bivalves at differing spatial scales. ICES *Journal of Marine Science, Journal Du Conseil* 58(3). 689-699.

Siddall, R., Pike, A.W., McVicar, A.H. (1994). Parasites of flatfish in relation to sewage sludge dumping. *Journal of Fish Biology* 45, 193-209.

Sim, V.X., Dafforn, K.A., Simpson, S.L., Kelaher, B.P., Johnston, E.L. (2015). Sediment contaminants and infauna associated with recreational boating structures in a multi-use marine park. *PLoS One* 10: e0130537.

Skinner, C. Turoczy, N.J., Jones, P.L., Barnett, D. and Hodges, R. (2004). *Food Chemistry*, 85: 351-356.

Smith, S.D.A. and Simpson, R.D. (1993). Effects of pollution on holdfast macrofauna of the kelp Ecklonia radiate – discrimination at different taxonomic levels. *Marine Ecology Progress Series* 96, pp. 199-208.

Smith S. D. A., Simpson R. D. and Higgins W. D. (1995). Organochlorine Pesticide and Heavymetal Residues in Red Morwong from Coffs Harbour Coastal Waters: Results of Pilot Study. Report to NSW Public Works Department, Coffs Harbour, 20 pp.

Smith, A.K., and Suthers, I.M. (1999). Effects of sewage effluent discharge on the abundance, condition and mortality of hulafish, *Trachinops taeniatus* (Plesiopidae). *Environmental Pollution*, 106, pp. 97-106.

Smith, P.J. (2001). Review of the Conservation Status of Marine Mammal Species in NSW. A report to the NSW Scientific Committee. NSW National Parks and Wildlife Service. Hurstville NSW.

Southern Divers and Total Hydrographic (2017). Merimbula Offshore Artificial Reef – Acoustic Survey. Prepared for NSW Department of Industry. May 2017.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L. (2019). Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. Aquatic Mammals 45(2): 125-232.

TACC Committee (2019). Report and Determination 2019 Abalone Fishery. Report by NSW Total Allowable Catch Setting and Review Committee (Mapstone, B., Crosthwaite, K., Pascoe, S. Sainsbury, K.), 19 November 2018.

TEL (2005). Penguin Head Ocean Release Monitoring, Marine Ecology, Stage IV. January 2005.

TEL (2007). Fishery Management Strategy for the NSW Abalone Fishery. Prepared by The Ecology Lab on behalf of: NSW Department of Primary Industries and Shareholders of the NSW Commercial Abalone Fishery, April 2007.

TEL (2008). Milton-Ulladulla Sewerage Augmentation Ocean Release Monitoring: Analysis of pre- and post-commissioning surveys of intertidal and subtidal habitats. Report No. 60/0506 delivered by The Ecology Lab to Manly Hydraulics Laboratory, February 2008.

Tsai, C. (1975). Effects of Sewage Treatment Plant Effluents on Fish: A Review of Literature (CRC Publication No. 36). University of Maryland, MD.

Underwood, A.J., Kingsford, M.J., and Andrew, N.L. (1991). Patterns in shallow subtidal marine assemblages along the coast of New South Wales. *Australian Journal of Ecology*, 6, pp. 231-249.

Warwick R.M. and Clarke, K.R. (1991) A comparison of methods for analysing changes in benthic community structure. J. Mar. Biol. Assoc. U.K. 71: 225 – 244.

Waters, J.M., Wernberg, T., Connell, S.D., Thomsen, M.S., Zuccarello, G.C., Kraft, G.T., Sanderson, J.C., West, J.A., Gurgel, C.F. (2010). *Australia's marine biogeography revisited: Back to the future?* Austral Ecology 35: 988-992.

Webb, McKeown and Associates (1997). Merimbula Lake and Back Lake Estuary Management Plan and Management Study Summary. Prepared for BVSC, January 1997.

Weisberg, S.B., Thompson, B., Ranasinghe, J.A., Montagne, D.E., Cadien, D.B., Dauer, D.M., Diener, D., Oliver, J., Reish, D.J., Velarde, R.G. (2008). The level of agreement among experts applying best professional judgment to assess the condition of benthic infaunal communities. ecological indicators 8: 389-394.

West, L.D, Stark, K.E., Murphy, J.J., Lyle, J.M. and Ochwada-Doyle, F.A. (2015). *Survey of Recreational Fishing in New South Wales and the ACT, 2013/14,* NSW DPI – Fisheries Final Report Series No. 149, December 2015.

West, R.J. and Jones, M.V. (2001). Shallow water fish communities of New South Wales South coast estuaries. FRDC Project 97/204.

White, I. (2001). Safeguarding Environmental Conditions for Oyster Cultivation in New South Wales. Centre for Resource and Environmental Studies, Australian National University. Report to Healthy Rivers Commission. http://www.hrc.nsw.gov.au/site/pdf/reports/oysters_final.pdf.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P., Tyack, P.L. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals*, 45(2), 125-232.

Wilson, N.G., Stiller, J. and Rouse, G.W. (2016). Barriers to gene flow in common seadragons (Syngnathidae: *Phyllopteryx taeniolatus*), *Conservation Genetics* 18 (1), 53-66.

Young, D.R., Moore, M.D., Jan, T.-K., and Eganhouse, R.P. (1981). Metal in Seafood organisms near a large California municipal outfall. *Marine Pollution Bulletin,* 12 (4): 134-138.

17 Limitations

Elgin Associates Pty Ltd has prepared this report for the sole use of AECOM in accordance with generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Marine Ecology Work Plan dated 18 October 2017.

The methodology adopted and sources of information used by Elgin Associates are outlined in this report. Elgin Associates has made no independent verification of this information beyond the agreed scope of works and Elgin Associates assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to Elgin Associates was false.

Information for this report was gathered between December 2017 and February 2021 and is based on the conditions encountered and information reviewed during that period up to the time of preparation. Elgin Associates disclaims responsibility for any changes that may have occurred after this time. Opinions and recommendations contained in this report are based upon information gained during desktop study and fieldwork and information provided from government authorities' records and other third parties. The information in this report is considered to be accurate at the date of issue and reflects at the site at the dates sampled. This document and the information contained herein should only be regarded as validly representing the site conditions at the time of the fieldwork unless otherwise explicitly stated in a preceding section of this report.

This report should be read in full together with all other reports referenced by this report. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

APPENDIX A

SUB-TIDAL ASSESSMENT

APPENDIX A

1. Data Analysis

Cluster Analysis

Cluster analysis was undertaken to identify groups of samples (i.e. quadrats) from each transect that were composed of similar species assemblages that could be attributed to one of the broad sub-tidal habitat types as described by Underwood et al. (1991). Based on the clusters identified, these groupings were then used for further analysis to describe community composition.

The cluster analysis revealed groupings at 40% similarity level as shown in the dendogram in **Figure A1**. The dendogram presents the full set of 331 quadrats (as samples) on the x axis, and the y axis defining a similarity level at which two samples or groups are considered to have fused.

A factor named 'Habitat40' was created to assign each quadrat to the corresponding groupings a-e. These groupings were investigated further using MDS and SIMPER functions in Primer.

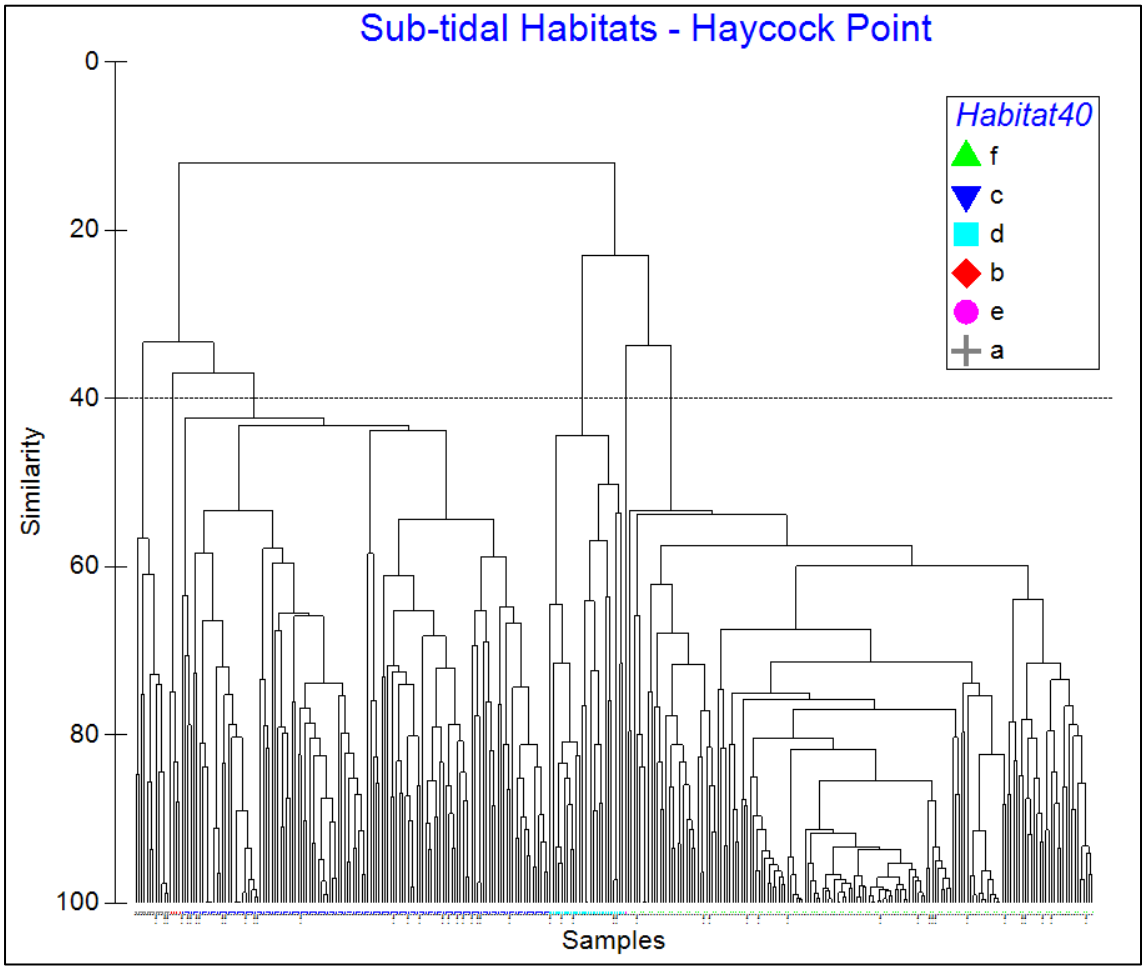


Figure A1. Dendogram output from cluster analysis showing the groups of samples at 40% similarity.

Species Diversity and Community Composition

Species diversity was estimated by total taxa count (*i.e.* taxon richness as *S*) and community composition of the sub-tidal habitats was explored using a combination of CLUSTER analysis, MDS ordinations, and SIMPER, all multivariate statistical methods available in software PRIMER. The raw data were fourth root transformed to down-weight the influence of highly abundant species in

describing community structure. Data transformation balances the contributions from common and rare species in the measure of similarity between two samples. Using the transformed species counts and percent cover data, Bray-Curtis similarities/dissimilarities between samples were calculated and patterns in community structure were evaluated by portraying these results in a two-dimensional ordination using non-metric multidimensional scaling (nMDS). The 'stress' value is an indication of how well the high-dimensional relationships among the samples are represented in a two-dimensional MDS plot with values near to zero providing best representation.

MDS ordination was used to investigate similarities and patterns within the Habitat40 groups identified in cluster analysis. The MDS ordination of the Habitat40 groups shows five groups of points clustering together based on the 40% similarity (**Figure A2**), indicating that samples within each group are closely related. The stress value of 0.12 indicate that the plot is a reliable ordination, and that the position of each sample relative to other samples within the same group are well placed in the ordination.

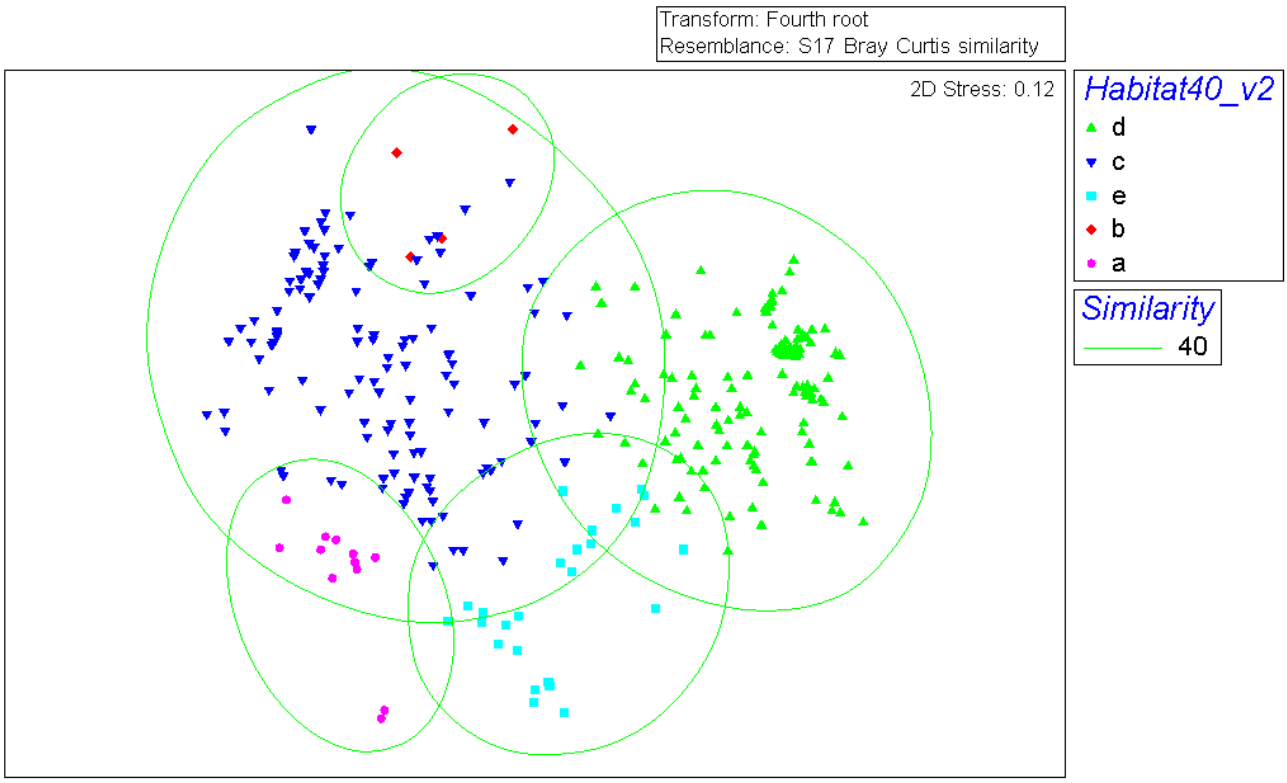


Figure A2 MDS plot of sub-tidal habitat samples by Habitat40 factor created using cluster analysis

The habitat groups identified by cluster analysis were confirmed as being significantly different (ANOSIM global R-value 0.9; p=0.1). SIMPER was then used to identify the most dominant taxa or substrates contributing to the patterns observed in the dendogram (**Figure A1**) and MDS ordination (**Figure A2**). Outputs from the SIMPER analysis are reported in **Table A1**.

The 'Habitat' code was assigned based on an assessment of the taxa and/or substrate that contributed to each cluster (A-E) and comparing to habitats described in DECCW (2010). For each of the habitat types - Deep Reef (A), Mixed Algae / Fringe habitat (B), *Ecklonia* (C), Barrens habitat (D), Turf habitat (E) – greater than 90% of the similarity between samples was contributed by only three or four species or substrates (**Table A1**).

APPENDIX A

Table A1 SIMPER results for the five habitat groups identified in the MDS plot and the species/substrates that contribute to the similarity.

CODE	HABITAT	Avg Sim	SPECIES	Av. Abund	Av. Sim	Sim/ SD	Contrib%	Cum.%
A (n=12) ●	DEEP REEF	67.77	Sand (SND)	2.6	38.06	3.13	56.16	56.16
			Ecklonia radiata (ECK)	1.88	21.23	1.42	31.32	87.48
			Codium fragile (COD)	1.2	8	0.64	11.8	**99.29**
B (n=4) ◆	MIXED ALGAE / FRINGE	79.92	*Sargassum sp. (SAR)*	2.53	25.02	16.99	31.31	31.31
			Cystophora moniliformis (CYS)	2.18	19.89	3.96	24.89	56.2
			Phyllospora comosa (PHY)	1.85	18.52	8.63	23.17	79.37
			Ecklonia radiata (ECK)	1.53	9.77	0.91	12.23	**91.6**
C (n=127) ▼	ECKLONIA	51.21	*Ecklonia radiata* (ECK)	2.49	28.7	2.66	56.03	56.03
			Geniculate coralline algae (GCA)	1.33	9.44	0.84	18.44	74.47
			Turf Community (TUR)	1.14	6.04	0.59	11.8	86.27
			Sargassum sp. (SAR)	0.79	3.17	0.44	6.19	**92.47**
D (N=161) ▲	BARREN	67.17	Bare Rock (REEF)	3	38.74	3.94	57.68	57.68
			Centrostephanus rodgersii	1.34	12.74	1.44	18.97	76.65
			Limpet sp	1.45	11.8	1.11	17.56	**94.21**
E (n=25) ■	TURF	54.84	Turf Community (TUR)	2.54	30.87	2.32	56.3	56.3
			Sand (SND)	1.68	14.43	1	26.32	82.63
			Bare Rock (REEF)	1	5.06	0.49	9.23	**91.85**

2. Descriptions of sub-tidal habitats at Haycock Point

Barrens Habitat

Barrens habitat was the most common sub-tidal habitat sampled at Haycock Point recorded within 161 quadrats representing 48% of total quadrats sampled. Barrens habitat was encountered on all sides of Haycock Point ranging from 4 to 19 m depth. The highest proportion of barrens habitat was observed along transects on the northern side of Haycock Point.

A total of thirteen (13) taxa were recorded from barrens habitat including three (3) mobile invertebrates, two (2) sessile invertebrates and six (6) algal taxa. Species richness per sample ranged from one to six with overall mean species richness of 2.6. The overall low mean species richness is because seven of the species observed in barrens habitat were relatively rare, recorded in fewer than 11% of total samples.

In terms of percentage cover, barrens habitat is characterised overwhelmingly by bare rock (mean cover 85%) with sessile invertebrates (sponge and bryozoans) and turfing algae the next most dominant community components with mean cover of 4% and 6% respectively. Other minor community components recorded within barrens habitat represented by less than 1% mean cover include foliose algae *Ecklonia radiata*, *Cystophora moniliformis, Sargassum* sp., non-geniculate coralline algae and geniculate coralline algae (*Corallina officinalis* and *Amphiroa anceps*). Encrusting non-geniculate coralline algae (appears as pink rock) is the most common algae in barrens habitat, as it is able to tolerate the intense grazing pressure of urchins and other gastropods.

APPENDIX A

Three grazing invertebrates were recorded in barrens habitat that included the long-spined urchin *Centrostephanus rodgersii*, tent shell *Astralium tentoriiforme,* and limpets. The mean density of individuals for each of the grazing invertebrates includes:

- *Centrostephanus rodgersii* - 6.8 individuals per m^2;
- Limpets (*Cellana tramoserica, Scutellastra chapmani* and *Patelloida insignis*) – 14.2 individuals per m^2; and
- *Astralium tentoriiforme* – 0.2 individuals per m^2.

The density of *Centrostephanus rodgersii* observed in Barrens habitat in this study is comparable with previous surveys of urchins at Haycock Point where densities of over 50 individuals per 10 m^2 have been reported by Andrew and O'Neill (2000) equivalent to 5 individuals per 1 m^2. The pattern of low species diversity is common to barrens habitat throughout NSW (Underwood *et al* 1991; Andrews and Underwood 1989) and is not unexpected given the grazing pressure of *Centrostephanus rodgersii* that maintains a typically bare rock surface devoid of foliose canopy-forming brown algae.

***Ecklonia* habitat**

Ecklonia habitat, dominated by the canopy forming kelp *Ecklonia radiata*, was recorded in 127 quadrats occurring on all sides of Haycock Point ranging from 4 to 17m depth. The highest proportion of *Ecklonia* habitat was observed along transects on the southern side (n=67) of Haycock Point with less *Ecklonia* habitat recorded on the northern (n=46) and eastern aspects (n=14).

A total of eighteen (18) taxa were recorded from *Ecklonia* habitat including three (3) mobile invertebrates, seven (7) sessile invertebrates and eight (8) algal taxa. However, species richness per sample ranged from one to eight with a mean species richness of 3.5. The overall low mean species richness is because majority of species observed in *Ecklonia* habitat were relatively rare, recorded in fewer than 14% of total samples.

In terms of percentage cover, *Ecklonia* habitat is characterised by four dominant community components that include (in order dominance):

- *Ecklonia* radiata (mean cover 47%).
- Turfing algae (mean cover 15.5%) that consists of varying proportions of small brown algae such as *Sphacelaria* sp., *Halopteris* sp., *Zonaria* sp., *Lobophora variegata*, and *Padina sp.*
- Geniculate coralline algae (mean cover of 13.8%) that includes *Corallina officinalis* and *Amphiroa anceps*.
- *Sargassum* spp. (mean cover 7.4%).

Other algal species recorded within *Ecklonia* habitat in minor proportions (i.e. <2% cover) include brown algae *Cystophora moniliformis* and *Phyllospora comosa,* and the green alga *Codium fragile*. Sessile invertebrates are also minor components of *Ecklonia* habitat that include bryozoans (*Membranipora* sp. and lace bryozoan), stalked ascidian (*Pyura gibbosa*), and encrusting sponges. Bare rock is also a minor component comprising less than 3% mean cover.

Three mobile invertebrates were recorded in *Ecklonia* habitat that included the carnivorous trumpet shell *Cabestana spengleri,* and herbivores such as the long-spined urchin (*Centrostephanus rodgersii*) and limpets. The urchin *Centrostephanus rodgersii* was recorded in low numbers with mean density of 0.64 individuals per m^2. The mean density of limpets and *Cabestana* were 0.09 and 0.03 individuals per m^2 respectively.

It is acknowledged that the low abundance and diversity of mobile invertebrates recorded in *Ecklonia* habitat is likely an artefact of the drop camera quadrat method as cryptic species and individuals occurring below the *Ecklonia* canopy are not visible in quadrat photographs.

APPENDIX A

Mixed Algae-Fringe Habitat

Mixed algae–fringe habitat was recorded in only four quadrats on the northern side of Haycock Point in 6 to 7 m depth. A total of six algal species were recorded with mean species richness of 4.8 per sample. In terms of percentage cover, mixed algae-fringe habitat is characterised by six algal taxa that include (in order dominance):

- *Sargassum spp.* (mean cover 42%).
- *Cystophora moniliformis* (mean cover 28%).
- *Ecklonia radiata* (mean cover 13%).
- *Phyllospora comosa* (mean cover 12%).
- Turfing algae (mean cover 4%) that consists of varying proportions of small brown algae such as *Sphacelaria* sp., *Halopteris* sp., *Zonaria* sp., *Lobophora variegata*, and *Padina sp.*.
- Geniculate coralline algae (mean cover of 1%) that includes *Corallina officinalis* and *Amphiroa anceps.*

No mobile invertebrates were recorded from within mixed algae–fringe habitat although this is likely to be an artefact of the method for the same reasons discussed for *Ecklonia* habitat above.

Turf Habitat

Turf habitat, dominated by a variety of small turfing macroalgal species, was recorded in 25 quadrats and occurred on all sides of Haycock Point in 8 to 17 m depth. A total of thirteen (13) taxa were recorded from turf habitat including three (3) mobile invertebrates, four (4) sessile invertebrates and six (6) algal taxa. Mean species richness per sample ranged from one to five with a mean species richness of 2.6. In terms of percent cover, turf habitat is characterised by three dominant community components that include (in order dominance):

- Turfing algae (mean cover 56%) that consists of varying proportions of small brown algae such as *Sphacelaria* sp., *Halopteris* sp., *Zonaria* sp., *Lobophora variegata*, and *Padina sp.*
- Sand (mean cover 24%).
- Bare rock (mean cover 12%).

Other algal species recorded within turf habitat in minor proportions (i.e. <1% cover) include brown algae *Ecklonia radiata* and *Phyllospora comosa,* the green alga *Codium fragile,* geniculate coralline algae and encrusting non-geniculate coralline algae. Sessile invertebrates are also relative minor components (i.e. 1-3% cover) of turf habitat that include bryozoans, colonial cnidarians, and sponges.

Three mobile invertebrates were recorded in turf habitat that included the carnivorous gastropod *Dicathais orbita,* and herbivores long-spined urchin (*Centrostephanus rodgersii*), and limpets. The urchin *Centrostephanus rodgersii* was recorded in low numbers with mean density of 0.12 individuals per m^2. The mean density of limpets and *Dicathais* were 0.08 and 0.23 individuals per m^2 respectively.

Deep reef habitat

Deep reef habitat (relative to the other shallower habitats) was recorded in 12 quadrats and was found at the reef margins adjacent to sand and consequently, sand covering the reef is a common feature. A total of five (5) taxa were recorded from deep reef habitat including three (3) algae and two (2) sessile invertebrates. Mean species richness per sample ranged from one to four with a mean species richness of 1.8.

In terms of percent cover, deep reef habitat is characterised by three dominant community components that include (in order dominance):

- Sand over reef (mean cover 54%);
- *Ecklonia radiata* (mean cover 25%); and
- Green alga *Codium fragile* (mean cover 14%)

Sessile invertebrates that include sponges and the stalked ascidian *Pyura gibbosa* are relative minor community components (*i.e.* 1-3% cover) of deep reef habitat.

No mobile invertebrates were recorded from within the deep reef habitat sampled. The absence of mobile invertebrates may be attributed to the high percent cover of sand and lack of bare rock that is a preferred substrate for grazing invertebrates such as urchins, limpets and gastropods.

APPENDIX A

Appendix A-2 Species list for shallow sub-tidal habitats at Haycock Point

APPENDIX A-2. List of invertebrates and algae recorded on subtidal reef transects at Haycock Point, NSW.
Note: Species list compiled from review of both quadrat photos and video footage.

					SITE										
Phylum	**Class**	**Order**	**Family**	**Taxon**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
INVERTEBRATES															
Annelida	Polychaeta	Sabellida	Serpulidae	*Galeolaria caespitiosa*	x			x		x			x		
Arthropoda (subphylum Crustacea)	Hexanauplia	Sessilia	Balanidae	*Austromegabalanus nigrescens*	x	x								x	x
				Balanus trigonus	x										
				Small barnacle sp.	x	x	x	x			x		x		x
Bryozoa	Gymnolaemata	Cheilostomatida	Membraniporidae	*Membranipora* sp.	x	x	x	x	x	x	x	x	x	x	x
				Filamentous bryozoan	x				x		x			x	x
				Lace byrozoan	x			x						x	x
			Watersiporidae	*Watersipora* sp.	x			x						x	x
Chordata	Ascidiacea	Stolidobranchia	Pyuridae	*Pyura gibbosa*	x	x	x	x				x			
				Pyura stolonifera				x		x	x	x			
				Pyura spinifera					x					x	
				Herdmania sp.									x		
Cnidaria	Anthozoa	Scleractinia	Scleractinia incertae sedis	*Plesiastrea* sp.	x						x				x
		Actiniaria	Sagartiidae	*Anthothoe albocincta*											
				Colonial cnidarian					x		x			x	
				Feather hydroid					x					x	
Echinodermata	Echinoidea	Diadematoida	Diadematidae	*Centrostephanus rodgersii*	x	x	x	x		x	x	x	x		x
	Asteroidea	Spinulosida	Echinasteridae	*Plectaster decanus*									x		
Mollusca	Gastropoda	Neogastropoda	Muricidae	*Dicathais orbita*											
		Lepetellida	Haliotidae	*Haliotis rubra*											
		Littorinimorpha	Ranellidae	*Cabestana spengleri*								x			
		Patellogastropoda	Nacellidae	*Cellana tramoserica*		x	x	x			x		x		x
			Lottiidae	*Patelloida insignis*		x	x	x			x		x		x
			Patellidae	*Scutellastra chapmani*		x	x	x			x		x		x
		Trochida	Turbinidae	*Astralium tentoriiforme*	x	x	x								
				Lunella torquata											
	Bivalvia	Mytilida	Mytilidae	*Mytilus galloprovincialis*											
Porifera	Demospongiae	Polymastiida	Polymastiidae	*Polymastia* sp.					x		x			x	
				Various sponge sp.	x	x			x		x		x	x	x
				Unknown green encrusting sponge sp.	x	x		x			x				x

APPENDIX A-2. List of invertebrates and algae recorded on subtidal reef transects at Haycock Point, NSW.
Note: Species list compiled from review of both quadrat photos and video footage.

					SITE										
Phylum	**Class**	**Order**	**Family**	**Taxon**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
ALGAE															
Chlorophyta	Ulvophyceae	Bryopsidales	Codiaceae	*Codium fragile*	x	x			x			x		x	
Ochrophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Lobophora variegata*											
				Padina sp.											x
				Zonaria sp.					x	x					
		Ectocarpales	Scytosiphonaceae	*Colpomenia sinuosa*			x			x	x				
		Fucales	Seirococcaceae	*Phyllospora comosa*	x	x						x			x
			Sargassaceae	*Sargassum* sp.	x	x	x			x	x	x		x	x
				Cystophora moniliformis	x	x	x			x	x	x	x		x
		Laminariales	Lessoniaceae	*Ecklonia radiata*	x	x	x	x	x	x	x	x	x	x	x
		Sphacelariales	Sphacelariaceae	*Sphacelaria* sp.				x	x						
			Stypocaulaceae	*Halopteris* sp.											
				Filamentous brown algae					x		x			x	x
Rhodophyta	Florideophyceae	Bonnemaisoniales	Bonnemaisoniaceae	*Delisea pulchra*											
		Corallinales	Corallinaceae	Geniculate coralline algae (*Amphiroa anceps* & *Corallina officinalis*)	x	x	x	x	x	x	x	x	x	x	x
		Corallinales	Corallinaceae	non-geniculate encrusting coralline algae	x	x	x		x	x	x	x	x		x
		Plocamiales	Plocamiaceae	*Plocamium* sp.											
				Unid. red algae sp.					x						

Note
Taxonomy follows currently accpeted nomenclature from:
WoRMS Editorial Board (2017). World Register of Marine Species. Available from URL: http://www.marinespecies.org at VLIZ. Accessed 2017-03-32

APPENDIX A

Appendix A-3 Species list for intermediate reef

Appendix A-3. List of invertebrates and algae recorded on intermediate subtidal reefs at Hunter Reef, Haycock Point and Long Point.
Note: Taxon list compiled from review of both photo quadrats and video footage.

				Location	Hunter Reef		Outer Haycock		Long Point	
				Round	1	2	1	2	1	2
Phyllum	**Class**	**Order**	**Family**	**Taxon**	A1	A2	B1	B2	D1	D2
Invertebrates										
Annelida	Polychaeta	Sabellida	Sabellidae	*Sabellastarte* sp.						
Bryozoa	Gymnolaemata	Cheilostomatida	Adeonidae	*Adeona grisea*		X		X	X	X
			Steginoporellidae	*Steginoporella truncata*	X	X	X	X	X	X
			Phidoloporidae	*Triphyllozoon moniliferum*	X	X		X	X	X
				Unidentified Bryozoa Hard Fenestrate_1						
				Unidentified Bryozoa Hard Fenestrate_2						
				Unidentified Bryozoa Hard Fenestrate_3				X		X
				Unidentified Bryozoa Hard Massive_1	X		X			
				Unidentified Bryozoa Soft Dendroid_1	X		X		X	X
				Unidentified Bryozoa Soft Foliaceous_1		X				
				Unidentified Bryozoa_1			X			X
Chordata	Ascidiacea	Stolidobranchia	Pyuridae	*Cnemidocarpa pedata*	X	X	X	X	X	X
				Herdmania grandis			X		X	
				Pyura spinifera	X	X	X	X	X	X
		Aplousobranchia	Polycitoridae	*Polycitor giganteus*						
				Polycitor sp.	X	X				
				Unidentified Colonial Ascidian_1	X	X		X		X
Cnidaria	Anthozoa	Alcyonacea	Nephtheidae	*Capnella gaboensis*			X	X		X
			Isididae	*Sphaerokodisis australis*	X		X	X		X
			Primnoidae	*Primnoella australasiae*	X	X	X	X	X	X
		Scleractinia	Coscinaraeidae	*Coscinaraea mcneilli*		X		X	X	X
			Dendrophylliidae	*Balanophyllia* sp.		X	X	X		X
				Unidentified Black Coral Arborescent_1			X	X		
				Unidentified Black Coral Branching Fleshy_1		X				X
				Unidentified Black Coral Fern-frond_1			X	X	X	X
				Unidentified Black Coral Rigid Fan_1			X	X	X	
				Unidentified Black Coral Rigid Fan_2						
				Unidentified Hydrocoral Branching_1		X	X	X		
				Unidentified Hydrocoral Branching_2		X	X	X	X	X
				Unidentified Hydrocoral Branching_3				X		X
			`	Unidentified Hydrocoral Branching_4			X	X		X
				Unidentified Hydroid_1						
				Unidentified Hydroid_2						
				Unidentified Hydroid_3		X		X		
				Unidentified Anemone_1						
				Unidentified Cnidarian_1						
				Unidentified Cnidarian_2	X	X		X		X
				Unidentified Cnidarian_3						
				Unidentified Cnidarian_4	X	X	X			X
				Unidentified Cnidarian_5		X	X	X		
				Unidentified Cnidarian_6				X		

Appendix A-3. List of invertebrates and algae recorded on intermediate subtidal reefs at Hunter Reef, Haycock Point and Long Point.
Note: Taxon list compiled from review of both photo quadrats and video footage.

				Location	Hunter Reef		Outer Haycock		Long Point	
				Round	1	2	1	2	1	2
Phyllum	**Class**	**Order**	**Family**	**Taxon**	A1	A2	B1	B2	D1	D2
Echinodermata	Asteroidea	Spinulosida	Echinasteridae	*Plectaster decanus*			X	X	X	X
		Valvatida	Asterodiscididae	*Asterodiscides truncatus*				X		
			Goniasteridae	*Fromia polypora*						
				Nectria ocellata	X					
				Pentagonaster duebeni		X	X	X		
	Echinoidea	Cidaroida	Cidaridae	*Phyllacanthus parvispinus*	X	X		X		X
	Ophiuroidea	Euryalida	Gorgonocephalidae	*Astrosierra amblyconus*				X		X
				Unidentified Basket Star_1						
Mollusca	Gastropoda			Unidentified Gastropod_1						
				Unidentified Gastropod_2						
				Unidentified Gastropod_3						
				Unidentified Gastropod_4						
				Unidentified Gastropod_5						
				Unidentified Gastropod_6						X
	Cephalopoda	Octopoda		Unidentified Octopus_1			X			
Porifera				Unidentified Sponge Barrel_1	X	X	X	X		X
				Unidentified Sponge Barrel_2						
				Unidentified Sponge Creeping/Ramose_1	X	X	X	X	X	X
				Unidentified Sponge Creeping/Ramose_2	X		X		X	
				Unidentified Sponge Cup/Goblet_1	X	X	X	X	X	X
				Unidentified Sponge Encrusting_1	X	X	X	X	X	X
				Unidentified Sponge Encrusting_2		X	X		X	
				Unidentified Sponge Encrusting_3	X	X	X	X	X	X
				Unidentified Sponge Encrusting_4	X	X	X	X	X	X
				Unidentified Sponge Encrusting_5		X			X	X
				Unidentified Sponge Encrusting_6	X	X		X	X	X
				Unidentified Sponge Encrusting_7						X
				Unidentified Sponge Encrusting_8	X	X	X			
				Unidentified Sponge Encrusting_9	X	X	X	X	X	X
				Unidentified Sponge Encrusting_10						
				Unidentified Sponge Encrusting_11			X			
				Unidentified Sponge Encrusting_12		X	X	X	X	X
				Unidentified Sponge Encrusting_13		X	X	X	X	X
				Unidentified Sponge Encrusting_14				X		X
				Unidentified Sponge Encrusting_15		X	X		X	
				Unidentified Sponge Encrusting_16		X	X	X	X	X
				Unidentified Sponge Encrusting_17		X	X	X	X	X
				Unidentified Sponge Encrusting_18	X	X				
				Unidentified Sponge Encrusting_19		X	X	X	X	X
				Unidentified Sponge Encrusting_20		X	X		X	X
				Unidentified Sponge Encrusting_21	X	X	X	X	X	X
				Unidentified Sponge Encrusting_22	X	X		X		X
				Unidentified Sponge Encrusting_23	X				X	
				Unidentified Sponge Encrusting_24						X
				Unidentified Sponge Erect Branching_1	X	X				
				Unidentified Sponge Erect Branching_2	X	X	X	X	X	X
				Unidentified Sponge Erect Branching_3		X	X	X	X	X
				Unidentified Sponge Erect Branching_4			X			X
				Unidentified Sponge Erect Branching_5	X	X	X	X		X
				Unidentified Sponge Erect Branching_6	X					
				Unidentified Sponge Erect Branching_7	X	X	X	X		X
				Unidentified Sponge Erect Branching_8	X	X	X			X

Appendix A-3. List of invertebrates and algae recorded on intermediate subtidal reefs at Hunter Reef, Haycock Point and Long Point.
Note: Taxon list compiled from review of both photo quadrats and video footage.

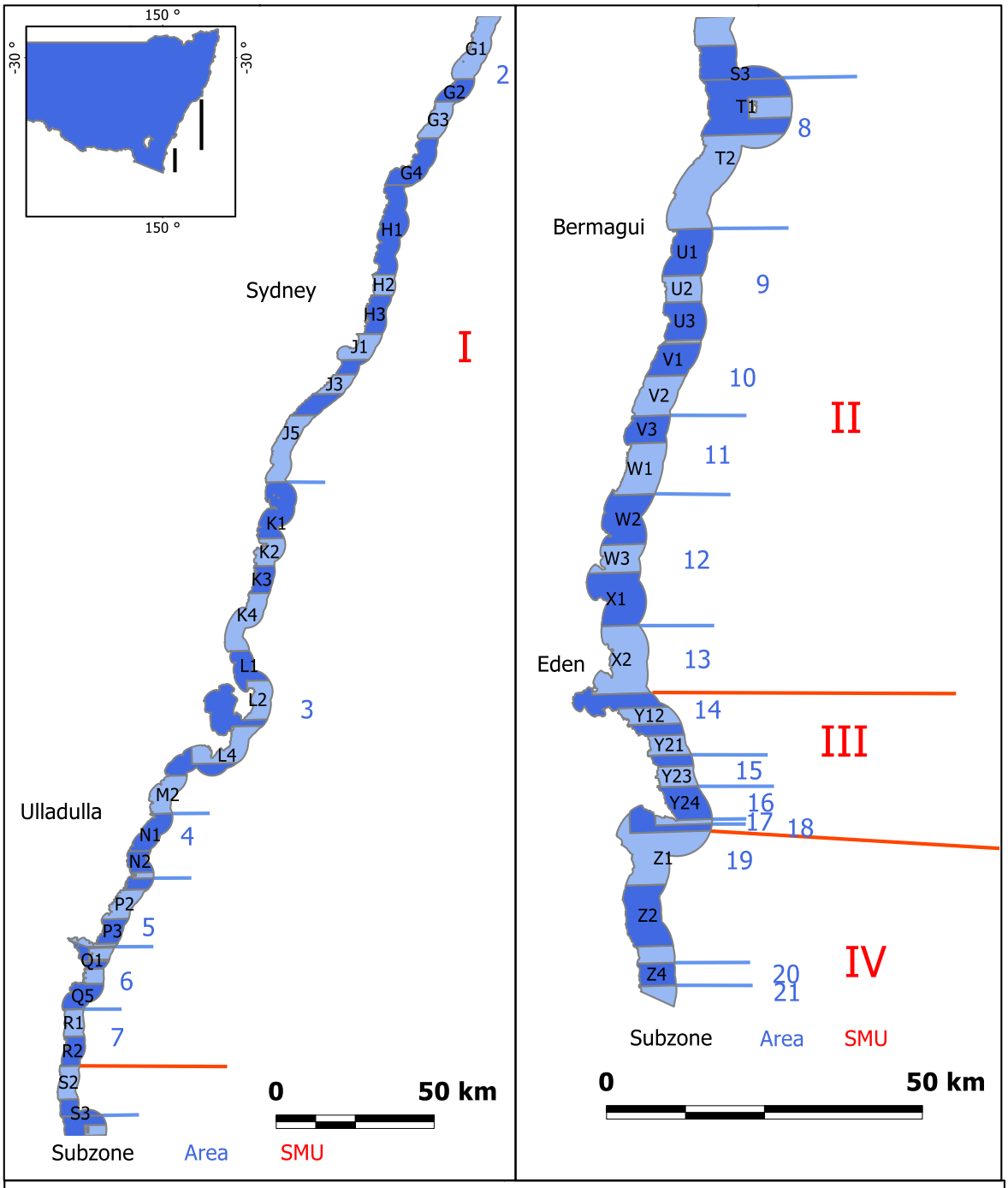
				Location	Hunter Reef		Outer Haycock		Long Point	
				Round	1	2	1	2	1	2
Phyllum	Class	Order	Family	Taxon	A1	A2	B1	B2	D1	D2
				Unidentified Sponge Erect Branching_9	X				X	
				Unidentified Sponge Erect Branching_10				X		
				Unidentified Sponge Erect Branching_11		X	X	X	X	X
				Unidentified Sponge Erect Branching_12				X		X
				Unidentified Sponge Erect Branching_13						X
				Unidentified Sponge Erect Palmate_1						
				Unidentified Sponge Incomplete Cup/Fan_1		X				
				Unidentified Sponge Incomplete Cup/Fan_2	X	X	X	X	X	X
				Unidentified Sponge Laminar_1			X			
				Unidentified Sponge Laminar_2		X	X	X	X	X
				Unidentified Sponge Laminar_3			X			
				Unidentified Sponge Laminar_4		X	X	X		
				Unidentified Sponge Laminar_5			X			X
				Unidentified Sponge Laminar_6			X		X	
				Unidentified Sponge Laminar_7			X			
				Unidentified Sponge Massive_1		X	X	X	X	
				Unidentified Sponge Massive_2	X	X	X	X	X	X
				Unidentified Sponge Massive_3			X			X
				Unidentified Sponge Massive_4						
				Unidentified Sponge Massive_5	X	X	X			
				Unidentified Sponge Massive_6		X		X		
				Unidentified Sponge Massive_7						
				Unidentified Sponge Massive_8			X			
				Unidentified Sponge Massive_9						
				Unidentified Sponge Massive_10			X	X	X	
				Unidentified Sponge Massive_11		X	X	X		
				Unidentified Sponge Massive_12		X	X		X	
				Unidentified Sponge Massive_13		X		X		X
				Unidentified Sponge Massive_14		X		X		
				Unidentified Sponge Massive_15		X		X		X
				Unidentified Sponge Massive Ball_1	X	X	X	X		
				Unidentified Sponge Massive Ball_2			X			X
				Unidentified Sponge Massive Cryptic_1			X	X	X	
Algae										
Rhodophyta				Macroalgae Encrusting Red Calcareous	X	X	X	X	X	X
				Macroalgae Encrusting Red Non Calcareous		X				
				Macroalgae Unknown 1			X			
				Macroalgae Unknown 2					X	
				Macroalgae Unknown 3		X				
				Macroalgae Unknown 3				X		

APPENDIX B

ABALONE ASSESSMENT

APPENDIX B

Appendix B-1. Boundary definition of abalone management Areas, Subzones and Spatial Management Units (from Abalone Council 2019).



Appendix 1. Map of NSW (top left) showing two insets for the the central coast (left) from Terrigal to Narooma, and for the south coast (right) from Narooma to Cape Howe. Subzones are coloured to highlight adjacent subzones and overlapping labels are not shown, Areas are numbered from 1 to 21 in blue, with blue borders shown between Areas, and Spatial Management Units (SMU) are numbered with borders in red from I to IV. Insets are shown in the MGA 1994, Zone 56 Projection.

APPENDIX B

Appendix B-1. Boundary definition of abalone management Regions (from TACC Committee 2019).

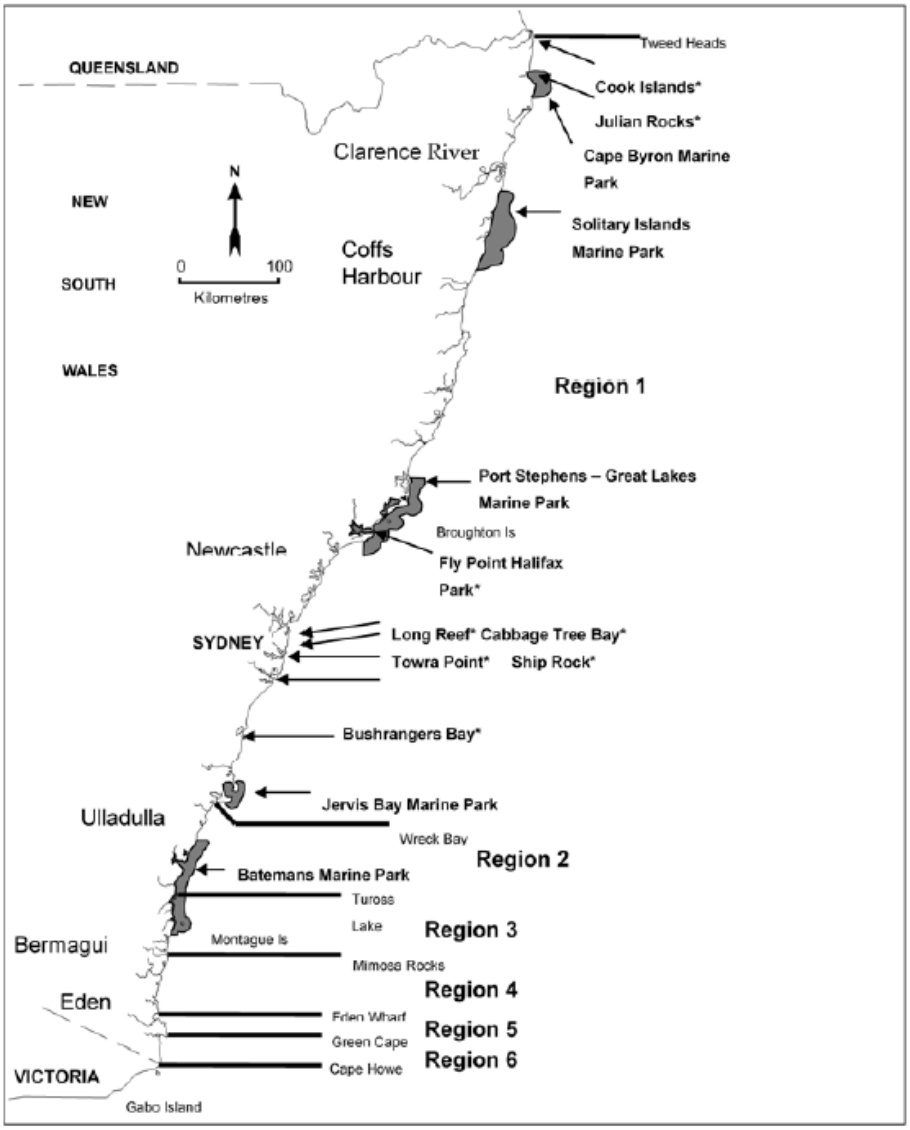


Figure A6.1. The NSW Coast showing marine parks and regions by which the commercial abalone fishery is classified by the Department of Primary Industries. Figure courtesy NSW DPI.

APPENDIX B

Appendix B-2 Abalone Survey Sites

Given the commercial sensitivity of this information, the location of survey sites is not provided in public versions of this report.

APPENDIX B

Appendix B-3 Abalone Count Data

Appendix B-3. Abalone count data recorded at Haycock Point, 7-9 January 2018

Site/Transect	Depth	Diver	Bearing	GoPro Camera #	Transect Interval	Small	Medium	Large
						0-60	60-117	>117
S1T1	3-6m	NY	NW 350	#3	0-10	0	0	0
					11-20	0	0	0
					21-30	0	0	0
					31-40	0	3	1
					41-50	0	12	6
S1T2	3-6m	PM	SE 160	#1	0-10	0	0	0
					11-20	0	0	0
					21-30	1	0	0
					31-40	0	0	0
					41-50	0	0	0
S1T3	3-6m	NY	NE 30	#3	0-10	0	0	0
					11-20	0	0	0
					21-30	0	0	0
					31-40	0	1	0
					41-50	0	0	0
S1T4	3-6m	PM	NW 340	#1	0-10	0	1	5
					11-20	0	10	10
					21-30	3	18	15
					31-40	0	0	0
					41-50	0	0	0
					TOTAL	**4**	**45**	**37**
S2T1	5-6m	NY	SE 120	#3	0-10	0	0	0
					11-20	0	0	0
					21-30	0	0	0
					31-40	0	0	0
					41-50	0	0	0
S2T2	5-6m	LF	SE 160	#2	0-10	0	0	0
					11-20	0	0	0
					21-30	0	0	0
					31-40	0	3	0
					41-50	0	0	10
S2T3	5-6m	NY	NW 290	#3	0-10	0	0	0
					11-20	0	3	1
					21-30	0	0	0
					31-40	0	0	0
					41-50	0	20	5
S2T4	5-6m	LF	NW 300	#2	0-10	0	0	0
					11-20	0	0	0
					21-30	0	1	0
					31-40	0	3	0
					41-50	0	7	1
					TOTAL	**0**	**37**	**17**

Appendix B-3. Abalone count data recorded at Haycock Point, 7-9 January 2018

Site/Transect	Depth	Diver	Bearing	GoPro Camera #	Transect Interval	Small	Medium	Large
						0-60	60-117	>117
S3T1	6-9m	NY	SE 120	#3	0-10	0	14	2
					11-20	0	0	0
					21-30	0	0	0
					31-40	0	0	0
					41-50	0	0	0
S3T2	6-9m	NY	SW 230	#3	0-10	0	2	0
					11-20	0	1	1
					21-30	0	2	1
					31-40	0	17	5
					41-50	0	1	9
S3T3	6-9m	LF	SE 120		0-10	1	7	9
					11-20	0	3	3
					21-30	0	0	0
					31-40	0	1	0
					41-50	0	0	0
S3T4	6-9m	LF	SW 230		0-10	0	0	0
					11-20	0	12	12
					21-30	3	9	6
					31-40	1	7	9
					41-50	0	1	4
					TOTAL	**5**	**77**	**61**
S4T1	7m	NY	NW 330	#4	0-10	0	0	0
					11-20	0	1	1
					21-30	0	0	0
					31-40	0	4	1
					41-50	0	1	0
S4T2	7m	PM	NW 320		0-10	0	2	2
					11-20	0	1	4
					21-30	0	0	2
					31-40	0	4	5
					41-50	0	1	4
S4T3	7m	NY	SE 160	#4	0-10	0	0	0
					11-20	0	0	1
					21-30	0	0	2
					31-40	0	2	0
					41-50	0	0	1
S4T4	7m	PM	SE 130		0-10	0	3	0
					11-20	0	0	0
					21-30	0	0	0
					31-40	5	12	2
					41-50	2	4	0
					TOTAL	**7**	**35**	**25**

Appendix B-3. Abalone count data recorded at Haycock Point, 7-9 January 2018

Site/Transect	Depth	Diver	Bearing	GoPro Camera #	Transect Interval	Small	Medium	Large
						0-60	60-117	>117
S5T1	5m	LF	NE 40	#1	0-10	0	3	1
					11-20	0	1	0
					21-30	0	0	0
					31-40	0	0	0
					41-50	0	0	0
S5T2	5m	PM	NE50	#2	0-10	0	1	4
					11-20	0	5	15
					21-30	0	4	2
					31-40	0	3	0
					41-50	0	0	0
S5T3	5m	LF	W 270	#1	0-10	0	7	7
					11-20	0	6	5
					21-30	0	16	6
					31-40	0	8	2
					41-50	0	10	2
S5T4	5m	PM	W260	#2	0-10	0	6	4
					11-20	1	12	6
					21-30	1	22	3
					31-40	2	35	3
					41-50	0	16	4
					TOTAL	**4**	**155**	**64**
S6T1	7m	NY	SW 230	#1	0-10	0	0	0
					11-20	0	0	0
					21-30	0	1	0
					31-40	0	14	6
					41-50	0	0	0
S6T2	7m	LF	SW 230	#2	0-10	1	3	1
					11-20	1	6	1
					21-30	0	5	2
					31-40	0	1	2
					41-50	2	12	0
S6T3	7m	NY	E 80	#1	0-10	0	2	0
					11-20	0	14	3
					21-30	0	5	0
					31-40	0	5	16
					41-50	0	0	0
S6T4	7m	LF	E 90	#2	0-10	0	2	2
					11-20	0	13	6
					21-30	1	2	0
					31-40	0	9	1
					41-50	0	2	1
					TOTAL	**5**	**96**	**41**

APPENDIX C

FISH ASSEMBLAGE

APPENDIX C-1. List of fish species recorded between Batemans Bay (NSW) and Mallacoota (VIC) and those observed in BVSC region and the study

Order	Family	Taxon	Common name	Threatened Species		Recorded by RLS in BVSC region [3]	Observed in Study Area [4]
				EPBC Act 1999 [1]	FM Act 1994 [2]		
Bony Fishes (Actinopterygii)							
Anguilliformes	Muraenidae	*Gymnothorax prasinus*	Yellow moray			x	x
Aulopiformes	Aulopidae	*Latropiscis purpurissatus*	Sergeant baker			x	x
Beryciformes	Trachichthyidae	*Optivus agastos*	Violet roughy			x	
Beryciformes	Trachichthyidae	*Trachichthys australis*	Roughy			x	
Bleniformes	Hemiramphidae	*Hyporhamphus australis*	Eastern sea garfish			x	
Clupeiformes	Clupeidae	*Clupeiformes spp.*	Herring, anchovy				
Enoplosidae	Enoplosidae	*Enoplosus armatus*	Old wife			x	x
Gasterosteiformes	Pegasidae	*Pegasus spp.*	Seamoths		p		
Gladiformes	Moridae	*Lotella rhacina*	Rock cod				
Gladiformes	Moridae	*Pseudophycis barbata*	Southern bastard codling				
Gobiesociformes	Gobiesocidae	*Aspasmogaster liorhyncha*	Smooth-snout clingfish				
Gobiesociformes	Gobiesocidae	*Aspasmogaster tasmaniensis*	Tasmanian clingfish			x	
Gobiesociformes	Gobiesocidae	*Cochleoceps orientalis*	Eastern cleaner-clingfish				
Perciformes	Acanthuridae	*Acanthurus nigrofuscus*	Brown surgeonfish			x	
Perciformes	Acanthuridae	*Acanthurus olivaceus*	Orangespot surgeonfish				
Perciformes	Acanthuridae	*Prionurus maculatus*	Yellowspotted sawtail				
Perciformes	Acanthuridae	*Prionurus microlepidotus*	Sixplate sawtail				
Perciformes	Aplodactylidae	*Aplodactylus arctidens*	Marblefish			x	x
Perciformes	Aplodactylidae	*Aplodactylus lophodon*	Rock cale			x	x
Perciformes	Apogonidae	*Rhabdamia cypselurus*	Swallowtail cardinalfish				
Perciformes	Apogonidae	*Siphamia cephalotes*	Wood's siphonfish			x	
Perciformes	Arripidae	*Arripis trutta*	Australian salmon			x	xx
Perciformes	Berycidae	*Centroberyx affinis*	Nannygai			x	x
Perciformes	Blenniidae	*Blenniid spp.*	Blennies			x	
Perciformes	Blenniidae	*Parablennius intermedius*	Horned blenny			x	
Perciformes	Blenniidae	*Petroscirtes fallax*	Yellow/Deceiver fangblenny				
Perciformes	Blenniidae	*Plagiotremus rhinorhynchos*	Blue-lined fangblenny			x	
Perciformes	Blenniidae	*Plagiotremus tapeinosoma*	Piano fangblenny			x	
Perciformes	Bovichtidae	*Bovichtus angustifrons*	Horny thornfish				
Perciformes	Callionymidae	*Eocallionymus papilio*	Painted stinkfish				
Perciformes	Carangidae	*Pseudocaranx georgianus*	Silver trevally			x	x
Perciformes	Carangidae	*Seriola lalandi*	Yellowtail Kingfish			x	
Perciformes	Carangidae	*Trachurus novaezelandiae*	Yellowtail horse mackerel			x	x
Perciformes	Chaetodontidae	*Chaetodon guentheri*	Crochet butterflyfish				
Perciformes	Cheilodactylidae	*Cheilodactylus fuscus*	Red Morwong			x	x
Perciformes	Cheilodactylidae	*Cheilodactylus spectabilis*	Banded Morwong			x	xx
Perciformes	Cheilodactylidae	*Cheilodactylus nigripes*	Magpie perch				xx
Perciformes	Cheilodactylidae	*Nemadactylus douglasii*	Blue Morwong			x	x
Perciformes	Cheilodactylidae	*Nemadactylus valenciennesi*	Queen Morwong				
Perciformes	Chironemidae	*Chironemus georgianus*	Western kelpfish				
Perciformes	Chironemidae	*Chironemus marmoratus*	Eastern Kelpfish			x	x
Perciformes	Cirrhitidae	*Cirrhitichthys aprinus*	Spotted hawkfish				
Perciformes	Clinidae	*Cristiceps aurantiacus*	Golden weedfish				
Perciformes	Clinidae	*Cristiceps australis*	Southern crested weedfish				
Perciformes	Clinidae	*Heteroclinus heptaeolus*	Ogilby's weedfish			x	
Perciformes	Clinidae	*Heteroclinus nasutus*	Large-nose weedfish				
Perciformes	Clinidae	*Heteroclinus perspicillatus*	Common weedfish			x	
Perciformes	Clinidae	*Heteroclinus roseus*	Rosy weedfish				
Perciformes	Clinidae	*Heteroclinus tristis*	Sharp-nose weedfish				
Perciformes	Clinidae	*Heteroclinus whiteleggii*	Banded weedfish				
Perciformes	Clinidae	*Heteroclinus wilsoni*	Wilson's weedfish				
Perciformes	Creediidae	*Limnichthys fasciatus*	Barred sand burrower				
Perciformes	Cyttidae	*Cyttus australis*	Silver Dory				x
Perciformes	Dinolestidae	*Dinolestes lewini*	Longfin pike			x	x
Perciformes	Gerreidae	*Parequula melbournensis*	Silverbelly			x	
Perciformes	Gobiidae	*Callogobius depressus*	Flathead goby				
Perciformes	Gobiidae	*Eviota spp.*	Dwarfgobies				
Perciformes	Gobiidae	*Nesogobius spp.*	Gobies				

APPENDIX C-1. List of fish species recorded between Batemans Bay (NSW) and Mallacoota (VIC) and those observed in BVSC region and the study

Order	Family	Taxon	Common name	Threatened Species		Recorded by RLS in BVSC region [3]	Observed in Study Area [4]
				EPBC Act 1999 [1]	FM Act 1994 [2]		
Perciformes	Kyphosidae	*Girella cyanea*	Blue drummer/ Bluefish		p		
Perciformes	Kyphosidae	*Girella elevata*	Black drummer			x	
Perciformes	Kyphosidae	*Girella tricuspidata*	Luderick			x	x
Perciformes	Kyphosidae	*Girella zebra*	Zebra fish				x
Perciformes	Kyphosidae	*Kyphosus sydneyanus*	Silver drummer			x	
Perciformes	Kyphosidae	*Scorpis aequipinnis*	Sea sweep			x	
Perciformes	Kyphosidae	*Scorpis lineolata*	Silver sweep			x	x
Perciformes	Labridae	*Achoerodus viridis*	Eastern blue groper			x	x
Perciformes	Labridae	*Anampses caeruleopunctatus*	Bluespotted wrasse			x	
Perciformes	Labridae	*Austrolabrus maculatus*	Black-spotted wrasse			x	
Perciformes	Labridae	*Coris dorsomacula*	Pale-barred coris				
Perciformes	Labridae	*Coris picta*	Comb wrasse			x	
Perciformes	Labridae	*Coris sandeyeri*	Sandager's wrasse				
Perciformes	Labridae	*Dotalabrus aurantiacus*	Castelnau's wrasse			x	
Perciformes	Labridae	*Eupetrichthys angustipes*	Snakeskin wrasse			x	
Perciformes	Labridae	*Halichoeres nebulosus*	Nebulous wrasse			x	
Perciformes	Labridae	*Labroides dimidiatus*	Bluestreak cleaner wrasse			x	
Perciformes	Labridae	*Notolabrus fucicola*	Yellow-saddled wrasse			x	
Perciformes	Labridae	*Notolabrus gymnogenis*	Crimson-banded wrasse			x	x
Perciformes	Labridae	*Notolabrus tetricus*	Blue-throated wrasse			x	x
Perciformes	Labridae	*Ophthalmolepis lineolatus*	Maori wrasse			x	x
Perciformes	Labridae	*Pictilabrus laticlavius*	Senator wrasse			x	x
Perciformes	Labridae	*Pseudolabrus guentheri*	Gunther's wrasse				
Perciformes	Labridae	*Pseudolabrus luculentus*	Orange wrasse			x	
Perciformes	Labridae	*Pseudolabrus mortonii*	Rosy wrasse				
Perciformes	Labridae	*Stethojulis interrupta*	Brokenline/Cutribbon wrasse			x	
Perciformes	Labridae	*Suezichthys arquatus*	Painted rainbow wrasse				
Perciformes	Labridae	*Thalassoma amblycephalum*	Bluntheaded wrasse				
Perciformes	Labridae	*Thalassoma lunare*	Moon wrasse				
Perciformes	Latridae	*Latridopsis forsteri*	Bastard trumpeter			x	x
Perciformes	Microcanthidae	*Atypichthys strigatus*	Australian mado			x	x
Perciformes	Microdesmidae	*Ptereleotris evides*	Blackfin dartfish				
Perciformes	Monodactylidae	*Schuettea scalaripinnis*	Eastern pomfred				
Perciformes	Mullidae	*Parupeneus multifasciatus*	Manybar goatfish				
Perciformes	Mullidae	*Parupeneus spilurus*	Blackspot goatfish			x	
Perciformes	Mullidae	*Upeneichthys lineatus*	Bluestriped goatfish				
Perciformes	Mullidae	*Upeneichthys sp*	Goatfish			x	x
Perciformes	Mullidae	*Upeneichthys vlamingii*	Bluespotted goatfish			x	
Perciformes	Odacidae	*Heteroscarus acroptilus*	Rainbow cale			x	x
Perciformes	Odacidae	*Olisthops cyanomelas*	Herring cale			x	x
Perciformes	Pempheridídae	*Parapriacanthus elongatus*	Elongate bullseye				
Perciformes	Pempheridídae	*Pempheris affinis*	Black-tipped bullseye			x	
Perciformes	Pempheridídae	*Pempheris compressa*	Smallscale bullseye			x	xx
Perciformes	Pempheridídae	*Pempheris multiradiata*	Bigscale bullseye				xx
Perciformes	Pentacerotidae	*Pentaceropsis recurvirostris*	Longsnout boarfish				xx
Perciformes	Pinguipedidae	*Parapercis allporti*	Eastern Barred Grubfish				x
Perciformes	Plesiopidae	*Paraplesiops bleekeri*	Eastern blue devil		p		
Perciformes	Plesiopidae	*Trachinops taeniatus*	Eastern hulafish			x	x
Perciformes	Pomacentridae	*Abudefduf sexfasciatus*	Scissortail sergeant				
Perciformes	Pomacentridae	*Abudefduf vaigiensis*	Indo-Pacific sergeant				
Perciformes	Pomacentridae	*Chromis hypsilepis*	Onespot Puller			x	x
Perciformes	Pomacentridae	*Chrysiptera rollandi*	Rolland's demoiselle				
Perciformes	Pomacentridae	*Mecaenichthys immaculatus*	Immaculate damsel			x	
Perciformes	Pomacentridae	*Parma microlepis*	White-ear scalyfin			x	x
Perciformes	Pomacentridae	*Parma unifasciata*	Girdled scalyfin				
Perciformes	Pomacentridae	*Parma victoriae*	Victorian scalyfin				
Perciformes	Pomacentridae	*Pomacentrus australis*	Australian damsel				
Perciformes	Pomacentridae	*Pomacentrus coelestis*	Neon damselfish			x	
Perciformes	Scombridae	*Sarda australis*	Australian bonito				
Perciformes	Scombridae	*Thunnus maccoyii*	Southern bluefin tuna		e		

APPENDIX C-1. List of fish species recorded between Batemans Bay (NSW) and Mallacoota (VIC) and those observed in BVSC region and the study

Order	Family	Taxon	Common name	Threatened Species		Recorded by RLS in BVSC region [3]	Observed in Study Area [4]
				EPBC Act 1999 [1]	FM Act 1994 [2]		
Perciformes	Serranidae	*Acanthistius cinctus*	Yellowbanded perch				
Perciformes	Serranidae	*Acanthistius ocellatus*	Eastern wirrah			x	x
Perciformes	Serranidae	*Caesioperca lepidoptera*	Butterfly perch			x	x
Perciformes	Serranidae	*Caesioperca rasor*	Barber Perch				x
Perciformes	Serranidae	*Epinephelus daemelii*	Black cod	V	V		
Perciformes	Serranidae	*Hypoplectrodes annulatus*	Blackbanded seaperch			x	
Perciformes	Serranidae	*Hypoplectrodes maccullochi*	Half-banded seaperch			x	x
Perciformes	Serranidae	*Hypoplectrodes nigroruber*	banded seapearch			x	xx
Perciformes	Sillaginidae	*Sillago bassensis*	Southern School Whiting				
Perciformes	Sillaginidae	*Sillago flindersi*	Eastern School Whiting				x
Perciformes	Sparidae	*Acanthopagrus australis*	Yellowfin bream				
Perciformes	Sparidae	*Sparus aurata*	Snapper			x	x
Perciformes	Sparidae	*Rhabdosargus sarba*	Goldlined seabream			x	
Perciformes	Sphyraenidae	*Sphyraena novaehollandiae*	Australian barracuda				
Perciformes	Tripterygiidae	*Enneapterygius rufopileus*	Redcal triplefin				
Perciformes	Tripterygiidae	*Trinorfolkia clarkei*	Clarke's triplefin			x	
Perciformes	Zanclidae	*Zanclus cornutus*	Moorish idol				
Pleuronectiformes	Paralichthyidae	*Pseudorhombus jenynsii*	Smalltoothed flounder				
Scorpaeniformes	Aploactinidae	*Aploactisoma milesii*	Southern velvetfish				
Scorpaeniformes	Platycephalidae	*Platycephalus bassensis*	Sand flathead				x
Scorpaeniformes	Platycephalidae	*Platycephalus caeruleopunctatus*	Bluespotted flathead				x
Scorpaeniformes	Platycephalidae	*Platycephalus fuscus*	Dusky flathead				
Scorpaeniformes	Platycephalidae	*Thysanophrys cirronasa*	Tasselsnout flathead				
Scorpaeniformes	Scorpaenidae	*Centropogon australis*	Eastern fortescue				
Scorpaeniformes	Scorpaenidae	*Neosebastes scorpaenoides*	Common gurnard perch				
Scorpaeniformes	Scorpaenidae	*Scorpaena cardinalis*	Cook's scorpionfish			x	
Scorpaeniformes	Scorpaenidae	*Scorpaena jacksoniensis*	Eastern red scorpionfish				x
Scorpaeniformes	Scorpaenidae	*Scorpaena papillosa*	Red rock cod			x	
Siluriformes	Plotosidae	*Cnidoglanis macrocephalus*	Estuary cobbler			x	
Sygnathiformes	Fistulariidae	*Fistularia petimba*	Red cornetfish	p	p		
Sygnathiformes	Fistulariidae	*Fistularia commersonii*	Smooth flutefish	p	p		
Sygnathiformes	Syngnathidae	*Hippocampus whitei*	White's seahorse	p	p		
Sygnathiformes	Syngnathidae	*Phyllopteryx taeniolatus*	Weedy seadragon	p	p		
Syngnathiformes	Syngnathidae	*Hippocampus abdominalis*	Big-belly seahorse	p	p		
Syngnathiformes	Syngnathidae	*Lissocampus runa*	Javelin Pipefish	p	p		
Syngnathiformes	Syngnathidae	*Solegnathus spinosissimus*	Spiny pipehorse	p	p		
Syngnathiformes	Syngnathidae	*Stigmatopora argus*	Spotted pipefish	p	p		
Syngnathiformes	Syngnathidae	*Stigmatopora nigra*	Widebody pipefish	p	p		
Syngnathiformes	Syngnathidae	*Urocampus carinirostris*	Hairy pipefish	p	p		
Syngnathiformes	Syngnathidae	*Vanacampus margaritifer*	Mother-of-pearl pipefish	p	p		
Syngnathiformes	Syngnathidae	*Vanacampus phillipi*	Port Phillip pipefish	p	p		
Tetradontiformes	Diodontidae	*Dicotylichthys punctulatus*	Threebar porcupinefish				xx
Tetradontiformes	Diodontidae	*Diodon nicthemerus*	Slenderspine porcupine fish			x	
Tetradontiformes	Monacanthidae	*Acanthaluteres spilomelanurus*	Bridled leatherjacket				
Tetradontiformes	Monacanthidae	*Acanthaluteres vittiger*	Toothbrush leatherjacket			x	x
Tetradontiformes	Monacanthidae	*Brachaluteres jacksonianus*	Southern pygmy leatherjacket				
Tetradontiformes	Monacanthidae	*Eubalichthys bucephalus*	Black reef leatherjacket			x	xx
Tetradontiformes	Monacanthidae	*Eubalichthys mosaicus*	Mosaic leatherjacket			x	x
Tetradontiformes	Monacanthidae	*Meuschenia flavolineata*	Yellow-striped leatherjacket			x	x
Tetradontiformes	Monacanthidae	*Meuschenia freycineti*	Six-spined leatherjacket			x	x
Tetradontiformes	Monacanthidae	*Meuschenia scaber*	Velvet leatherjacket			x	x
Tetradontiformes	Monacanthidae	*Meuschenia trachylepis*	Yellowfin leatherjacket			x	
Tetradontiformes	Monacanthidae	*Meuschenia venusta*	Stars and stripes leatherjacket			x	
Tetradontiformes	Monacanthidae	Monacanthidae sp	Leatherjacket				x
Tetradontiformes	Monacanthidae	*Nelusetta ayraudi*	Chinaman leatherjacket				x
Tetradontiformes	Monacanthidae	*Scobinichthys granulatus*	Rough leatherjacket			x	x
Tetradontiformes	Ostraciidae	*Anoplocapros inermis*	Eastern smooth boxfish			x	
Tetradontiformes	Tetraodontidae	*Tetractenos glaber*	Smooth toadfish				
Tetradontiformes	Tetraodontidae	*Tetractenos hamiltoni*	Common toadfish				
Tetradontiformes	Tetraodontidae	*Torquigener pleurogramma*	Weeping toadfish				

APPENDIX C-1. List of fish species recorded between Batemans Bay (NSW) and Mallacoota (VIC) and those observed in BVSC region and the study

Order	Family	Taxon	Common name	Threatened Species		Recorded by RLS in BVSC region [3]	Observed in Study Area [4]
				EPBC Act 1999 [1]	FM Act 1994 [2]		
Rays and Sharks (Elasmobranchii)							
Carcharhiniformes	Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler Shark				x
Carcharhiniformes	Scyliorhinidae	*Cephaloscyllium laticeps*	Draughtboard shark			x	x
Carcharhiniformes	Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead shark		e		
Carcharhiniformes	Triakidae	*Galeorhinus galeus*	School shark				x
Carcharhiniformes	Triakidae	*Mustelus antarcticus*	Gummy shark				x
Heterodontiformes	Heterodontidae	*Heterodontus galeatus*	Crested hornshark				
Heterodontiformes	Heterodontidae	*Heterodontus portusjacksoni*	Port Jackson shark			x	x
Lamniformes	Lamnidae	*Carcharodon carcharias*	Great white shark	v	v		
Lamniformes	Lamnidae	*Lamna nasus*	Porbeagle	p			
Lamniformes	Odontaspididae	*Carcharias taurus*	Grey nurse/ Sand tiger shark	ce	ce		
Myliobatiformes	Dasyatidae	*Dasyatis brevicaudata*	Smooth stingray			x	x
Myliobatiformes	Dasyatidae	*Dasyatis thetidis*	Thorntail stingray				
Myliobatiformes	Myliobatidae	*Myliobatis australis*	Southern eagle ray				x
Myliobatiformes	Urolophidae	*Trygonoptera imitata*	Eastern shovelnose stingaree			x	x
Myliobatiformes	Urolophidae	*Trygonoptera mucosa*	Western shovelnose stingaree				
Myliobatiformes	Urolophidae	*Trygonoptera testacea*	Common stingaree			x	x
Myliobatiformes	Urolophidae	*Urolophus cruciatus*	Banded stingaree				x
Myliobatiformes	Urolophidae	*Urolophus kapalensis*	Kapala stingaree			x	x
Myliobatiformes	Urolophidae	*Urolophus paucimaculatus*	Sparsely-spotted stingaree				x
Myliobatiformes	Urolophidae	*Urolophus sp*	Stingaree sp.				x
Orectolobiformes	Brachaeluridae	*Brachaelurus waddi*	Blind shark				
Orectolobiformes	Orectolobidae	*Orectolobus maculatus*	Gilf wobbegong			x	
Orectolobiformes	Orectolobidae	*Orectolobus maculatus*	Spotted wobbegong			x	
Orectolobiformes	Orectolobidae	*Orectolobus ornatus*	Ornate wobbegong				
Pristiophoriformes	Pristiophoridae	*Pristiophorus nudipinnis*	Southern sawshark				x
Rajiformes	Rajidae	*Spiniraja whitleyi*	Melbourne Skate				x
Rhinopristiformes	Rhinobatidae	*Aptychotrema rostrata*	Eastern Shovelnose Ray				x
Rhinopristiformes	Rhinobatidae	*Trygonorrhina fasciata*	Eastern fiddler ray			x	x
Scyliorhinidae	Scyliorhinidae	*Scyliorhinid spp.*	Catsharks				
Torpediniformes	Hypnidae	*Hypnos monopterygius*	Coffin ray				
	TOTALS	**208**				**93**	**73**

Note

Taxonomy follows currently accpeted nomenclature from:

WoRMS Editorial Board (2020). World Register of Marine Species. Available from URL: http://www.marinespecies.org

[1] EPBC Act = Commonwealth *Environment Protection Biodiversity Conservation Act 1999*

[2] FM Act = NSW *Fisheries Managament Act 1994*

p = protected, v = vulnerable, endangered, ce = critically endangered, pe = presumed extinct

[3] Observed in one or more RLS (2017) sites in the Bega Valley Shire region

[4] Observed in study area during marine ecology investigations (2-10 November 2017, 10 October 2019). X = recorded with BRUV, xx = recorded in tow video or observed by divers

APPENDIX C-2. Rank order of average annual catch (gross kg) for Pambula area based on reported commercial wild harvest in years 2009/10 to 2016/16.

Species Code	CommonName	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	AVERAGE ANNUAL CATCH (gross kg)
SAL-01	Australian Salmon	456.1	95.9	97250.9	66560.9	5927.8	16357.3	14123	119850	40,077.7
PIL-01	Australian Sardine						21052	28510	54257	34,606.3
ABA-01	Blacklip Abalone	3679	6508.4	8674.1	9195.6	5525.4	4138.8	3142.6	4286.8	5,643.8
COC-02	Estuary Cockle	1176.5	11954	3888	5917.1	2573	1333			4,473.6
LUD-01	Luderick	3573.7	874.3	1063.7	4631.7	3162.3	3861.3	94		2,465.9
WHI-01	Eastern School Whiting	3047.5	425	3216.2	256	130	107.4	900	300	1,047.8
TRE-01	Silver Trevally	1810.6	418.5	270.3	1858	990.5	1853	70		1,038.7
FLA-04	Tiger Flathead	766		959.3	936	955	990	620	349	796.5
SHK-24	Gummy Shark	2246.2	212.1	1099.3	1688.3	594.3	110.3	20	10	747.6
GAR-01	Eastern Sea Garfish	363.8	1328.1		146.4		468.2		862.7	633.8
MAC-01	Blue Mackerel			70	6	904	1246			556.5
TAI-01	Tailor	87.8	80.1	38.3	507.8	1160.1	1102.6	134		444.4
BRM-01	Yellowfin Bream	237.1	69.9	169.2	1083.6	344.6	557.3			410.3
MUL-01	Sea Mullet	1054.7	154	24.8	82.9	635.5	495.2			407.9
MUL-03	Fantail Mullet	4			25.3	380.9	1104.7	80		319.0
JKT-02	Ocean Jacket	655	60		477	400	239	50		313.5
EEL-01	Longfin Eel				127	771.9	10.6			303.2
FLA-01	Flathead (other)			285.3	222.4	385	283.9			294.2
WHI-02	Sand Whiting	471.3	16.6		264.4	74.1	564.8			278.2
SNA-01	Snapper	126.7	10	571.4	194.8	796.6	181		7	269.6
SHK-41	Draughtboard Shark	956		31	69.5	12.3				267.2
JKT-01	Leatherjacket (other)	488.5		142	615.2	15	3			252.7
YEL-01	Yellowtail Scad						83.6	360		221.8
SQU-01	Pencil Squid			400.5	14					207.3
MAC-06	Jack Mackerel	180								180.0
RAY-01	Stingrays/Stingarees	98.5	82.2	165.7	189.1	210	208			158.9
TUN-02	Skipjack Tuna			285	26					155.5
MIX-01	Species Identification Pending	159.5		146.4	348.9	94.4	14			152.6
MOR-01	Grey Morwong	372.5		107.9	2.5	145	38.3		13	113.2
BRM-02	Black Bream	67.8	12.2		30.2	371.2	81.8			112.6
JKT-03	Estuary Leatherjacket (rough/fanbelly)	69	3.5		441.5	8	21			108.6
DOR-01	John Dory	276.5	40	3.5	221.8	62	65.6	50		102.8
SHK-12	Bronze Whaler	45.2		22.5	85.1	207.3				90.0
SHK-18	Sharpnose Sevengill Shark	97.5		80						88.8
KIN-01	Yellowtail Kingfish	70.5		253.5	17	7.9	21			74.0
TUN-07	Albacore					73.3				73.3
MAC-04	Frigate Mackerel	73								73.0
FLA-03	Bluespotted Flathead	30		125.6	32	3	149	80	72	70.2
SHK-55	Ghost Shark (Inc. Elephant)						70			70.0
SHK-36	Eastern Angelshark	33			38		135.5			68.8
CUT-02	Cuttlefish (other)	26	40	40	28	197	133.8	15		68.5
CAL-01	Southern Calamari	135		31.5	56	98	77	10		67.9
SHK-51	Eastern Shovelnose Ray	8		61.3	211.5	23.8	26			66.1
SHK-42	Saddled Swellshark			127.5	4					65.8
FLA-02	Dusky Flathead	173.8	55.8	16.8	76.1	12	44.9			63.2
SHK-21	Southern Dogfish (Protected since February 2013)		63							63.0
CAT-01	Eeltail Catfish (cobblers)	92.5	12.4	17.4	86.9	22.5	120.7			58.7
CUT-01	Giant Cuttlefish	105.5		10	46.1					53.9
WAH-01	Blue Warehou	82		23						52.5
LAT-01	Latchet	123		98.9	15	12	23	40		52.0
GUR-01	Red Gurnard	66		50	109.5		3	25	22	45.9
SCO-01	Eastern Red Scorpionfish						45.6			45.6
SHK-37	Australian Angelshark			60		30				45.0
SQU-02	Gould's Squid (Arrow)	64					20			42.0
MUL-02	Sand Mullet	2	16.1		47.3		51	84		40.1
RED-01	Redfish			2.7		69				35.9
MUL-10	Mulloway	5	48.7	6.8	64.8	32.6	52.7			35.1
MUL-06	Red Mullet (Goatfish-undifferentiated)	76.5			7	11	30.5	37		32.4
JKT-04	Sixspine Leatherjacket (Reef)	30		30	5		59.9			31.2
OCT-02	Maori Octopus (South Coast)				26.6	61.9	24	10		30.6
SHK-34	Scalloped Hammerhead (Protected since May 2012)			30						30.0
SHK-50	Whitespotted Guitarfish	30								30.0
SHK-52	Giant Shovelnose Ray	30								30.0
COD-01	Bastard Red Cod			2.9	55.5					29.2
WRA-01	Southern Maori Wrasse	40					41.5		6	29.2
SHK-49	Eastern FIddler Ray	30	25.8							27.9
BOA-01	Giant Boarfish	48.5		13.5		37	29.5	10		27.7
SHK-30	Thresher Shark				27.2					27.2
OCT-01	Trawl Octopus (Hammer, North Coast)	57		13	25.5	17.1	22.2			27.0
SQU-04	Luminous Bay Squid (Bottle)		25							25.0
BLU-01	Blue-Eye Trevalla	24.5								24.5
WHI-04	Trumpeter Whiting						12	37		24.5
GAR-02	River Garfish	23.5								23.5
PER-08	Pearl Perch				23.5					23.5
SHK-01	Sandbar Shark			24.5	15		16.5			18.7
SHK-38	Banded Wobbegong			7.4	27.1					17.3
BID-01	Common Silverbiddy						17			17.0
MOR-03	Jackass Morwong				17					17.0
CAT-02	Forktail Catfishes	16								16.0
MUL-04	Goldspot Mullet	16								16.0
TUN-01	Yellowfin Tuna					16				16.0
SHK-33	Great Hammerhead (Protected since May 2012)			15.3						15.3
TAR-01	Tarwhine	30.3			4.5	13.2	7			13.8
SHK-46	Southern Sawshark	20.5		21			7		5	13.4
MIX-02	Fisheries Compliance Investigation						12			12.0
SHK-26	School Shark	26.6		1.8	6.3					11.6
WRA-03	Bluethroat Wrasse						8.4		14.1	11.3
CRA-08	Male Mud Crab					16.6	4.4			10.5
SHK-11	Bull Shark				10.2					10.2
GOA-01	Blacksaddle Goatfish								10	10.0
SHK-47	Common Sawshark			5	13					9.0
OCT-03	Pale Octopus (South Coast)	15.5				2				8.8
LIN-02	Rock Ling			8.5						8.5
CRA-02	Male Blue Swimmer Crab	8		8.4	8.3	2.8	14.2			8.3
MUL-05	Pinkeye Mullet	7.9								7.9
FLO-01	Flounders (large/small) toothed/slender	16.5			5		2			7.8
SHK-06	Tiger Shark				7.7					7.7

APPENDIX C-2. Rank order of average annual catch (gross kg) for Pambula area based on reported commercial wild harvest in years 2009/10 to 2016/16.

Species Code	CommonName	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	AVERAGE ANNUAL CATCH (gross kg)
SHK-03	Dusky Whaler				7.4					7.4
PER-02	Ocean Reef Perch			7						7.0
WRA-02	Crimsonband Wrasse						12.8		1	6.9
MOR-02	Red Morwong	9.5					3.5			6.5
WIR-01	Eastern Wirrah	4					3		9.4	5.5
BUG-01	Balmain Bug					5				5.0
SHK-19	Dark-tailed Dogfisher				5					5.0
SOL-02	Black Sole	3.2			2.8	1.8	11.8			4.9
COB-01	Cobia						4.8			4.8
SHK-28	Shortfin Mako			4.6						4.6
MAC-05	School Mackerel	4.5								4.5
PRN-01	King Prawn						4.5			4.5
EEL-02	Southern Shortfin Eel					3.5				3.5
SER-01	Sergeant Baker	3								3.0
SOL-01	Sole (other)	0.4		3.4			4.5			2.8
MOR-04	Blue Morwong			2.3						2.3
WHI-05	King George Whiting	2								2.0
PIK-01	Longfin Pike	1							2.5	1.8
SHK-35	Smooth Hammerhead	3			0.5					1.8
SHK-43	Whitefin Swellshark	1.5								1.5
SNA-04	Rosy Snapper	1.5								1.5
SWE-10	Sweep								1.5	1.5
EEL-04	Eastern Conger Eel					1.3				1.3
BLA-01	Rock Blackfish	1								1.0
LIN-01	Pink Ling			0.7						0.7
BON-01	Australian Bonito									
FLA-05	Marbled Flathead									
MUS-01	Blue Mussel									
PIP-01	Pipi									
SWE-01	Sweetlip									
WHE-01	Whelks									
WOR-01	Beachworms (Polychaete Worms)									
	Total	**24523.2**	**22876.4**	**120407.3**	**97971.4**	**27645.1**	**58006.3**	**48501.6**	**180079**	**72501.3**

Note

Data Source: NSW DPI (Excluding Rock Lobster and Sea Urchin & Turban Shell fisheries due to privacy), Pambula area as at 25-08-2017

Note: Reported commercial wild harvest landings data alone is not a robust indicator of abundance due to Environmental, Economic, Social and Legislative factors.

APPENDIX C-3

IMAGES OF HABITATS AND DEPTH SAMPLED USING BAITED UNDERWATER VIDEO (BRUV)

APPENDIX C-3

Plate 1. BRUV deployments 01 to 08.

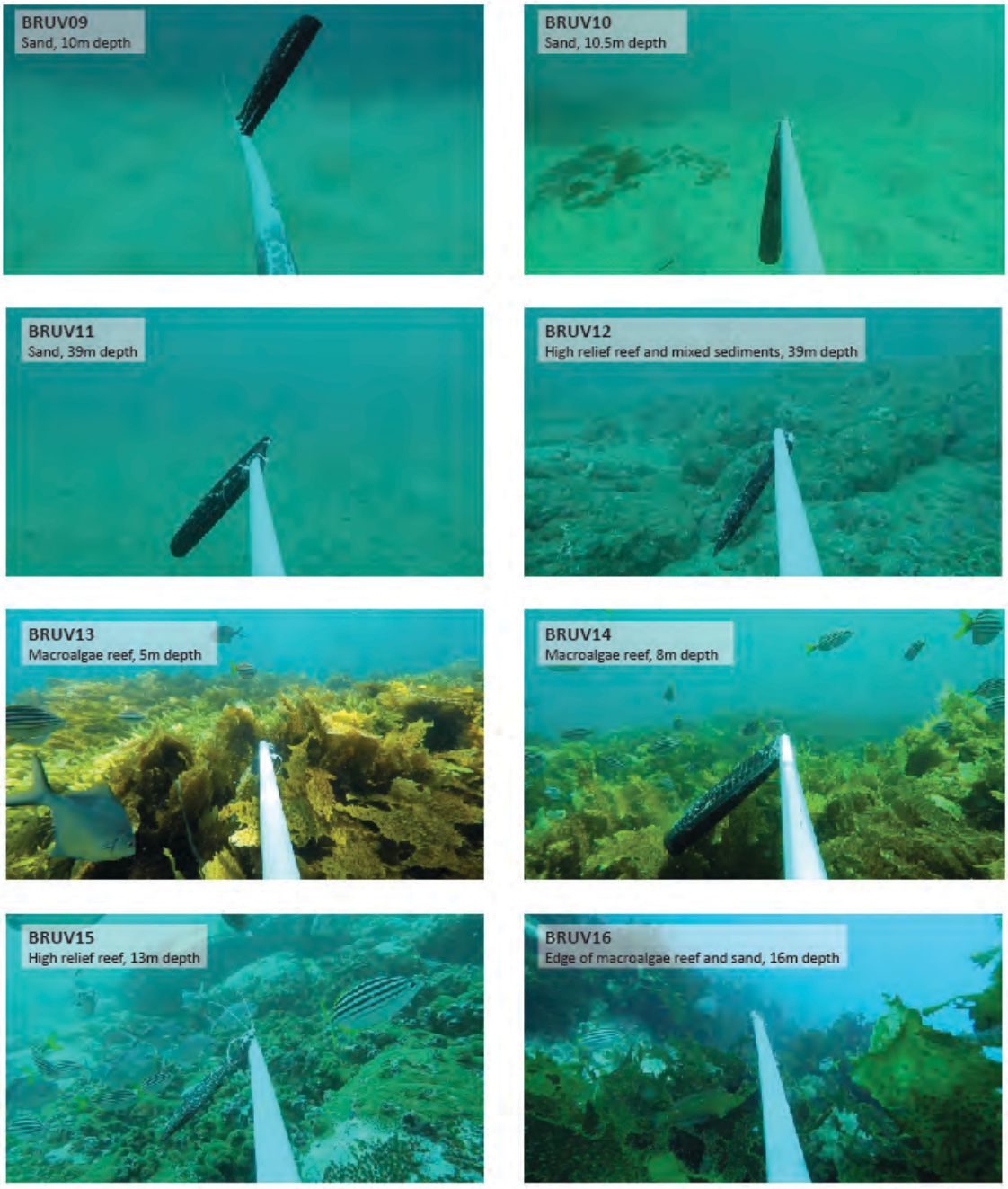


Plate 2. BRUV deployments 09 to 16.

APPENDIX C-3

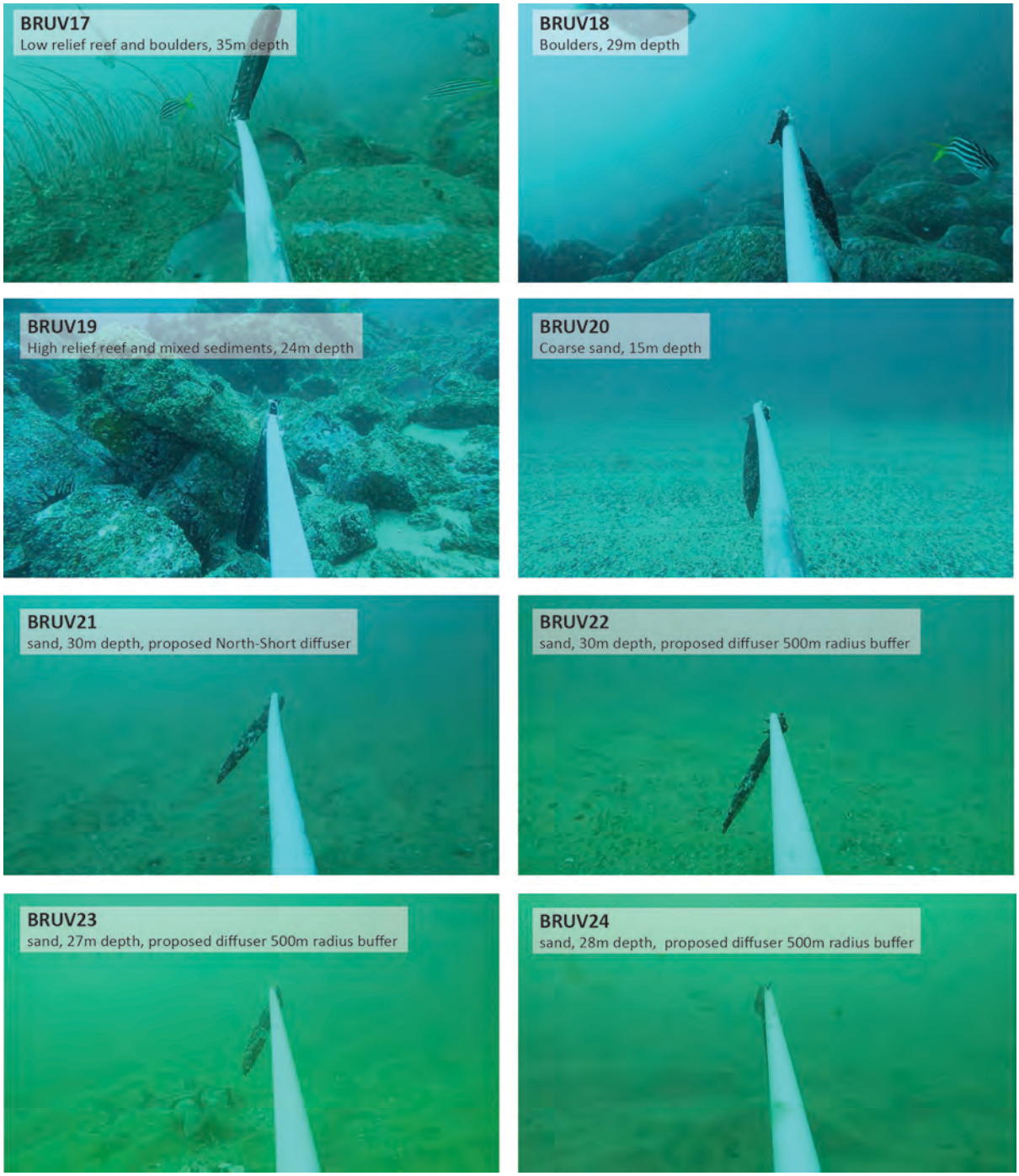


Plate 3. BRUV deployments 17 to 24.

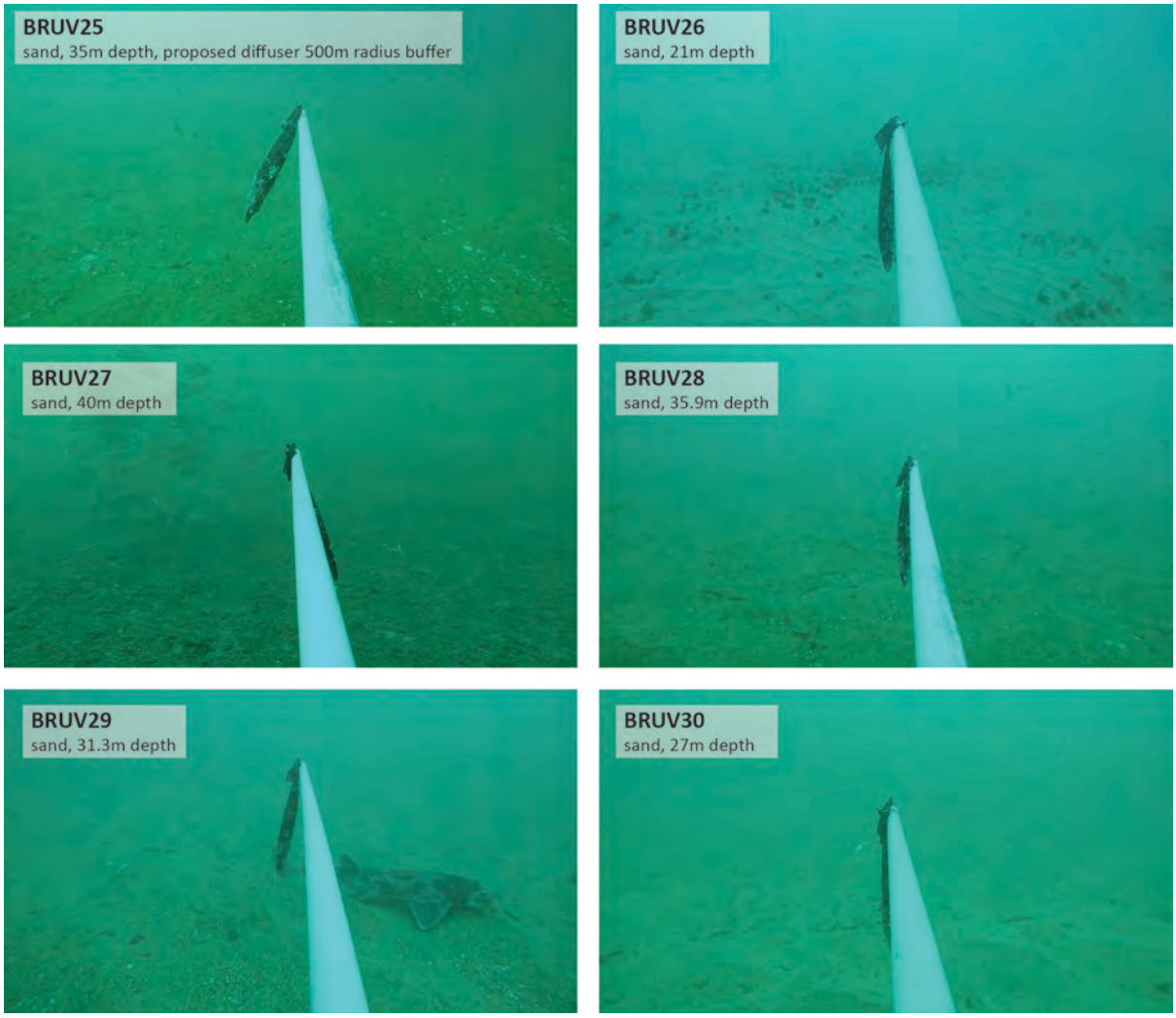


Plate 4. BRUV deployments 25 to 30.

APPENDIX C-4. Fish taxa and maxN observations recorded by BRUV survey on sand, reef and macroalgal habitats, Merimbula Bay.

		BRUV #	**BRUV01**	**BRUV02**	**BRUV03**	**BRUV04**	**BRUV05**	**BRUV06**	**BRUV07**
		DATE	3/11/17	3/11/17	3/11/17	3/11/17	4/11/17	4/11/17	8/11/17
		LOCATION	HR	HR	HP	HP	HR	HR	HP
		DEPTH (M)	29	28	20	21	23	20	21
		HABITAT	reef	reef	macroalgae	sand	reef	reef	sand
FAMILY	**GENUS SPECIES**	**COMMON NAME**							
Bony Fishes (Actinopterygii)									
Aplodactylidae	*Aplodactylus arctidens*	Marblefish				1			
Aplodactylidae	*Aplodactylus lophodon*	Rock cale							
Aulopidae	*Latropiscis purpurissatus*	Sergeant baker		1					
Berycidae	*Centroberyx affinis*	Nannygai	1	1					
Carangidae	*Pseudocaranx georgianus*	Silver trevally		7	1	1	1		
Carangidae	*Trachurus novaezelandiae*	Yellowtail horse mackerel		23	18	45			21
Cheilodactylidae	*Cheilodactylus fuscus*	Red Morwong	1	2	2				
Cheilodactylidae	*Nemadactylus douglasii*	Blue Morwong		1	1	1	1	1	
Chironemidae	*Chironemus marmoratus*	Eastern Kelpfish							
Cyttidae	*Cyttus australis*	Silver Dory			1				
Dinolestidae	*Dinolestes lewini*	Longfin pike		6			10		
Enoplosidae	*Enoplosus armatus*	Old wife		2					
Kyphosidae	*Girella tricuspidata*	Luderick							
Kyphosidae	*Girella zebra*	Zebra fish							
Kyphosidae	*Scorpis lineolata*	Silver sweep	4	3	2		17	3	
Labridae	*Achoerodus viridis*	Eastern blue groper	1				1		
Labridae	*Notolabrus gymnogenis*	Crimson-banded wrasse							
Labridae	*Notolabrus tetricus*	Blue-throated wrasse			1			1	
Labridae	*Ophthalmolepis lineolatus*	Maori wrasse	2	1	3	2	2	2	
Labridae	*Pictilabrus laticlavius*	Senator wrasse			1	1			
Latridae	*Latridopsis forsteri*	Bastard trumpeter					1		
Microcanthidae	*Atypichthys strigatus*	Australian mado	6	35	7	110			
Monacanthidae	*Acanthaluteres vittiger*	Toothbrush leatherjacket			1				
Monacanthidae	*Eubalichthys mosaicus*	Mosaic leatherjacket	1				1		
Monacanthidae	*Meuschenia flavolineata*	Yellow-striped leatherjacket						2	
Monacanthidae	*Meuschenia freycineti*	Six-spined leatherjacket	1	1			1		
Monacanthidae	*Meuschenia scaber*	Velvet leatherjacket	8	2				1	
Monacanthidae	Monacanthidae sp	Leatherjacket					1		
Monacanthidae	*Nelusetta ayraudi*	Chinaman leatherjacket							
Monacanthidae	*Scobinichthys granulatus*	Rough leatherjacket							
Mullidae	*Upeneichthys sp*	Goatfish				1	1		
Muraenidae	*Gymnothorax prasinus*	Yellow moray	2	1	1		2	3	
Odacidae	*Heteroscarus acroptilus*	Rainbow cale				1			
Odacidae	*Olisthops cyanomelas*	Herring cale			1	3			
Platycephalidae	*Platycephalus bassensis*	Sand flathead							
Platycephalidae	*Platycephalus caeruleopunctatus*	Bluespotted flathead							3
Plesiopidae	*Trachinops taeniatus*	Eastern hulafish							
Paralichthyidae	*Pseudorhombus sp.*	Flounder							
Pinguipedidae	*Parapercis allporti*	Eastern Barred Grubfish							
Pomacentridae	*Chromis hypsilepis*	Onespot Puller						10	
Pomacentridae	*Parma microlepis*	White-ear scalyfin		1	2				
Scorpaenidae	*Scorpaena jacksoniensis*	Eastern red scorpionfish		2					
Scorpaenidae	*Centropogon australis*	Eastern Fortesque							
Serranidae	*Acanthistius ocellatus*	Eastern wirrah							
Serranidae	*Caesioperca lepidoptera*	Butterfly perch					2	2	
Serranidae	*Caesioperca rasor*	Barber Perch		1					
Serranidae	*Hypoplectrodes maccullochi*	Half-banded seaperch		1					
Sillaginidae	*Sillago flindersi*	Eastern School Whiting							20
Sparidae	*Sparus aurata*	Snapper		3	2	1	2	1	
Rays and Sharks (Elasmobranchii)									
Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler Shark							
Dasyatidae	*Dasyatis brevicaudata*	Smooth stingray				1			
Heterodontidae	*Heterodontus portusjacksoni*	Port Jackson shark			1				
Triakidae	*Galeorhinus galeus*	School shark					1		
Triakidae	*Mustelus antarcticus*	Gummy shark	1	1					
Myliobatidae	*Myliobatis australis*	Southern eagle ray		1		1	1		
Rhinobatidae	*Aptychotrema rostrata*	Eastern Shovelnose Ray							
Rhinobatidae	*Trygonorrhina fasciata*	Eastern fiddler ray							1
Rajidae	*Spiniraja whitleyi*	Melbourne Skate							
Scyliorhinidae	*Cephaloscyllium laticeps*	Draughtboard shark							
Urolophidae	*Trygonoptera testacea*	Common stingaree			1				
Urolophidae	*Urolophus kapalensis*	Kapala stingaree							
Urolophidae	*Urolophus paucimaculatus*	Sparsely-spotted stingaree							
Urolophidae	*Urolophus cruciatus*	Banded stingaree							
		SPECIES RICHNESS	***11***	***21***	***17***	***13***	***16***	***10***	***4***
		***maxN* (all species)**	***28***	***96***	***46***	***169***	***45***	***26***	***45***

Note

[1] Observed in study area using BRUV during Stage 1 fieldwork (3-9 November 2017), Stage 2 fieldwork (10 October 2019)

Taxonomy follows currently accpeted nomenclature from:
WoRMS Editorial Board (2020). World Register of Marine Species. Available from URL: http://www.marinespecies.org

APPENDIX C-4. Fish taxa and maxN observations recorded by BRUV sur

		BRUV #	BRUV08	BRUV09	BRUV10	BRUV11	BRUV12	BRUV13	BRUV14
		DATE	8/11/17	6/11/17	6/11/17	8/11/17	8/11/17	8/11/17	8/11/17
		LOCATION	HP	HP	HP	HR	HR	HP	HP
		DEPTH (M)	22	10	10.5	39	39	5	8
		HABITAT	sand	sand	sand	sand	reef	macroalgae	macroalgae
FAMILY	**GENUS SPECIES**	**COMMON NAME**							
Bony Fishes (Actinopterygii)									
Aplodactylidae	*Aplodactylus arctidens*	Marblefish							
Aplodactylidae	*Aplodactylus lophodon*	Rock cale						1	
Aulopidae	*Latropiscis purpurissatus*	Sergeant baker							
Berycidae	*Centroberyx affinis*	Nannygai							
Carangidae	*Pseudocaranx georgianus*	Silver trevally			1	30			2
Carangidae	*Trachurus novaezelandiae*	Yellowtail horse mackerel	24		98	3			16
Cheilodactylidae	*Cheilodactylus fuscus*	Red Morwong							
Cheilodactylidae	*Nemadactylus douglasii*	Blue Morwong					1		
Chironemidae	*Chironemus marmoratus*	Eastern Kelpfish							
Cyttidae	*Cyttus australis*	Silver Dory							
Dinolestidae	*Dinolestes lewini*	Longfin pike			1				1
Enoplosidae	*Enoplosus armatus*	Old wife							
Kyphosidae	*Girella tricuspidata*	Luderick							1
Kyphosidae	*Girella zebra*	Zebra fish							
Kyphosidae	*Scorpis lineolata*	Silver sweep			4		2	13	
Labridae	*Achoerodus viridis*	Eastern blue groper			1		1		1
Labridae	*Notolabrus gymnogenis*	Crimson-banded wrasse							
Labridae	*Notolabrus tetricus*	Blue-throated wrasse			2			1	
Labridae	*Ophthalmolepis lineolatus*	Maori wrasse			4		2		
Labridae	*Pictilabrus laticlavius*	Senator wrasse						1	
Latridae	*Latridopsis forsteri*	Bastard trumpeter							
Microcanthidae	*Atypichthys strigatus*	Australian mado					1	61	111
Monacanthidae	*Acanthaluteres vittiger*	Toothbrush leatherjacket							
Monacanthidae	*Eubalichthys mosaicus*	Mosaic leatherjacket							
Monacanthidae	*Meuschenia flavolineata*	Yellow-striped leatherjacket							
Monacanthidae	*Meuschenia freycineti*	Six-spined leatherjacket							
Monacanthidae	*Meuschenia scaber*	Velvet leatherjacket					2		
Monacanthidae	Monacanthidae sp	Leatherjacket							
Monacanthidae	*Nelusetta ayraudi*	Chinaman leatherjacket		1			2		
Monacanthidae	*Scobinichthys granulatus*	Rough leatherjacket		2					
Mullidae	*Upeneichthys sp*	Goatfish							
Muraenidae	*Gymnothorax prasinus*	Yellow moray			2			1	
Odacidae	*Heteroscarus acroptilus*	Rainbow cale							
Odacidae	*Olisthops cyanomelas*	Herring cale						2	1
Platycephalidae	*Platycephalus bassensis*	Sand flathead							
Platycephalidae	*Platycephalus caeruleopunctatus*	Bluespotted flathead	4			4	1		
Plesiopidae	*Trachinops taeniatus*	Eastern hulafish							
Paralichthyidae	*Pseudorhombus sp.*	Flounder							
Pinguipedidae	*Parapercis allporti*	Eastern Barred Grubfish							
Pomacentridae	*Chromis hypsilepis*	Onespot Puller							
Pomacentridae	*Parma microlepis*	White-ear scalyfin					1		
Scorpaenidae	*Scorpaena jacksoniensis*	Eastern red scorpionfish							
Scorpaenidae	*Centropogon australis*	Eastern Fortesque							
Serranidae	*Acanthistius ocellatus*	Eastern wirrah			1				
Serranidae	*Caesioperca lepidoptera*	Butterfly perch					2		
Serranidae	*Caesioperca rasor*	Barber Perch							
Serranidae	*Hypoplectrodes maccullochi*	Half-banded seaperch					2		
Sillaginidae	*Sillago flindersi*	Eastern School Whiting	22						
Sparidae	*Sparus aurata*	Snapper				5	1		
Rays and Sharks (Elasmobranchii)									
Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler Shark							
Dasyatidae	*Dasyatis brevicaudata*	Smooth stingray							
Heterodontidae	*Heterodontus portusjacksoni*	Port Jackson shark							
Triakidae	*Galeorhinus galeus*	School shark							
Triakidae	*Mustelus antarcticus*	Gummy shark							
Myliobatidae	*Myliobatis australis*	Southern eagle ray		1					
Rhinobatidae	*Aptychotrema rostrata*	Eastern Shovelnose Ray	1						
Rhinobatidae	*Trygonorrhina fasciata*	Eastern fiddler ray	2	1		1			
Rajidae	*Spiniraja whitleyi*	Melbourne Skate							
Scyliorhinidae	*Cephaloscyllium laticeps*	Draughtboard shark							
Urolophidae	*Trygonoptera testacea*	Common stingaree		1	1				
Urolophidae	*Urolophus kapalensis*	Kapala stingaree							
Urolophidae	*Urolophus paucimaculatus*	Sparsely-spotted stingaree							
Urolophidae	*Urolophus cruciatus*	Banded stingaree			1				
		SPECIES RICHNESS	***5***	***5***	***11***	***5***	***12***	***7***	***7***
		***maxN* (all species)**	***53***	***6***	***116***	***43***	***18***	***80***	***133***

Note

[1] Observed in study area using BRUV during Stage 1 fieldwork (3-9 November 2017), Stage 2 fieldwork (10 October 2019)

Taxonomy follows currently accpeted nomenclature from:

WoRMS Editorial Board (2020). World Register of Marine Species. Available from URL: http://ww

APPENDIX C-4. Fish taxa and maxN observations recorded by BRUV sur

		BRUV #	BRUV15	BRUV16	BRUV17	BRUV18	BRUV19	BRUV20
		DATE	8/11/17	9/11/17	9/11/17	9/11/17	9/11/17	9/11/17
		LOCATION	HR	HP	HR	HR	HP	HP
		DEPTH (M)	13	16	35	29	24	15
		HABITAT	reef	macroalage	reef	reef	reef	sand
FAMILY	**GENUS SPECIES**	**COMMON NAME**						
Bony Fishes (Actinopterygii)								
Aplodactylidae	*Aplodactylus arctidens*	Marblefish		1				
Aplodactylidae	*Aplodactylus lophodon*	Rock cale						
Aulopidae	*Latropiscis purpurissatus*	Sergeant baker			2	1		
Berycidae	*Centroberyx affinis*	Nannygai						
Carangidae	*Pseudocaranx georgianus*	Silver trevally		3	1		1	1
Carangidae	*Trachurus novaezelandiae*	Yellowtail horse mackerel		4			2	26
Cheilodactylidae	*Cheilodactylus fuscus*	Red Morwong		2		1		1
Cheilodactylidae	*Nemadactylus douglasii*	Blue Morwong	2	1	3	1	2	2
Chironemidae	*Chironemus marmoratus*	Eastern Kelpfish		2				1
Cyttidae	*Cyttus australis*	Silver Dory						
Dinolestidae	*Dinolestes lewini*	Longfin pike	1				1	
Enoplosidae	*Enoplosus armatus*	Old wife		2			1	
Kyphosidae	*Girella tricuspidata*	Luderick						
Kyphosidae	*Girella zebra*	Zebra fish				1		
Kyphosidae	*Scorpis lineolata*	Silver sweep	16	7	21	14	5	5
Labridae	*Achoerodus viridis*	Eastern blue groper				1		1
Labridae	*Notolabrus gymnogenis*	Crimson-banded wrasse		2			1	
Labridae	*Notolabrus tetricus*	Blue-throated wrasse	1	1				
Labridae	*Ophthalmolepis lineolatus*	Maori wrasse	1	2		2	2	1
Labridae	*Pictilabrus laticlavius*	Senator wrasse						
Latridae	*Latridopsis forsteri*	Bastard trumpeter						
Microcanthidae	*Atypichthys strigatus*	Australian mado	16	72	10	10	5	23
Monacanthidae	*Acanthaluteres vittiger*	Toothbrush leatherjacket						
Monacanthidae	*Eubalichthys mosaicus*	Mosaic leatherjacket						
Monacanthidae	*Meuschenia flavolineata*	Yellow-striped leatherjacket						
Monacanthidae	*Meuschenia freycineti*	Six-spined leatherjacket	1		1	1		1
Monacanthidae	*Meuschenia scaber*	Velvet leatherjacket				2	1	
Monacanthidae	Monacanthidae sp	Leatherjacket						
Monacanthidae	*Nelusetta ayraudi*	Chinaman leatherjacket					3	
Monacanthidae	*Scobinichthys granulatus*	Rough leatherjacket						
Mullidae	*Upeneichthys sp*	Goatfish			1			1
Muraenidae	*Gymnothorax prasinus*	Yellow moray	7	2	4	4	8	
Odacidae	*Heteroscarus acroptilus*	Rainbow cale		1				
Odacidae	*Olisthops cyanomelas*	Herring cale		2				
Platycephalidae	*Platycephalus bassensis*	Sand flathead						
Platycephalidae	*Platycephalus caeruleopunctatus*	Bluespotted flathead					1	1
Plesiopidae	*Trachinops taeniatus*	Eastern hulafish				10		
Paralichthyidae	*Pseudorhombus sp.*	Flounder						
Pinguipedidae	*Parapercis allporti*	Eastern Barred Grubfish						
Pomacentridae	*Chromis hypsilepis*	Onespot Puller	15					
Pomacentridae	*Parma microlepis*	White-ear scalyfin	1		1	3		
Scorpaenidae	*Scorpaena jacksoniensis*	Eastern red scorpionfish	1	1		1	1	
Scorpaenidae	*Centropogon australis*	Eastern Fortesque						
Serranidae	*Acanthistius ocellatus*	Eastern wirrah	3				1	
Serranidae	*Caesioperca lepidoptera*	Butterfly perch			1	2	2	
Serranidae	*Caesioperca rasor*	Barber Perch					3	
Serranidae	*Hypoplectrodes maccullochi*	Half-banded seaperch			1	1	4	
Sillaginidae	*Sillago flindersi*	Eastern School Whiting						
Sparidae	*Sparus aurata*	Snapper		1	2	1	1	
Rays and Sharks (Elasmobranchii)								
Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler Shark		1				
Dasyatidae	*Dasyatis brevicaudata*	Smooth stingray		1	1			1
Heterodontidae	*Heterodontus portusjacksoni*	Port Jackson shark					1	1
Triakidae	*Galeorhinus galeus*	School shark						
Triakidae	*Mustelus antarcticus*	Gummy shark						
Myliobatidae	*Myliobatis australis*	Southern eagle ray		1				
Rhinobatidae	*Aptychotrema rostrata*	Eastern Shovelnose Ray						
Rhinobatidae	*Trygonorrhina fasciata*	Eastern fiddler ray						
Rajidae	*Spiniraja whitleyi*	Melbourne Skate						
Scyliorhinidae	*Cephaloscyllium laticeps*	Draughtboard shark						
Urolophidae	*Trygonoptera testacea*	Common stingaree						
Urolophidae	*Urolophus kapalensis*	Kapala stingaree						
Urolophidae	*Urolophus paucimaculatus*	Sparsely-spotted stingaree						
Urolophidae	*Urolophus cruciatus*	Banded stingaree						
		SPECIES RICHNESS	***12***	***20***	***13***	***17***	***20***	***14***
		***maxN* (all species)**	***65***	***109***	***49***	***56***	***46***	***66***

Note

[1] Observed in study area using BRUV during Stage 1 fieldwork (3-9 November 2017), Stage 2 fieldwork (10 October 2019)

Taxonomy follows currently accpeted nomenclature from:

WoRMS Editorial Board (2020). World Register of Marine Species. Available from URL: http://ww

APPENDIX C-4. Fish taxa and maxN observations recorded by BRUV sur

		BRUV #	BRUV21	BRUV22	BRUV23	BRUV24	BRUV25	BRUV26	BRUV27
		DATE	10/10/19	10/10/19	10/10/19	10/10/19	10/10/19	10/10/19	10/10/19
		LOCATION	MB	MB	MB	MB	MB	MB	MB
		DEPTH (M)	30	30	27	28	33	21	40
		HABITAT	sand	sand	sand	sand	sand	sand	sand
FAMILY	**GENUS SPECIES**	**COMMON NAME**							
Bony Fishes (Actinopterygii)									
Aplodactylidae	*Aplodactylus arctidens*	Marblefish							
Aplodactylidae	*Aplodactylus lophodon*	Rock cale							
Aulopidae	*Latropiscis purpurissatus*	Sergeant baker							
Berycidae	*Centroberyx affinis*	Nannygai							
Carangidae	*Pseudocaranx georgianus*	Silver trevally		1					96
Carangidae	*Trachurus novaezelandiae*	Yellowtail horse mackerel							1
Cheilodactylidae	*Cheilodactylus fuscus*	Red Morwong							
Cheilodactylidae	*Nemadactylus douglasii*	Blue Morwong							
Chironemidae	*Chironemus marmoratus*	Eastern Kelpfish							
Cyttidae	*Cyttus australis*	Silver Dory							
Dinolestidae	*Dinolestes lewini*	Longfin pike							
Enoplosidae	*Enoplosus armatus*	Old wife							
Kyphosidae	*Girella tricuspidata*	Luderick							
Kyphosidae	*Girella zebra*	Zebra fish							
Kyphosidae	*Scorpis lineolata*	Silver sweep							
Labridae	*Achoerodus viridis*	Eastern blue groper							
Labridae	*Notolabrus gymnogenis*	Crimson-banded wrasse							
Labridae	*Notolabrus tetricus*	Blue-throated wrasse							
Labridae	*Ophthalmolepis lineolatus*	Maori wrasse							
Labridae	*Pictilabrus laticlavius*	Senator wrasse							
Latridae	*Latridopsis forsteri*	Bastard trumpeter							
Microcanthidae	*Atypichthys strigatus*	Australian mado							
Monacanthidae	*Acanthaluteres vittiger*	Toothbrush leatherjacket							
Monacanthidae	*Eubalichthys mosaicus*	Mosaic leatherjacket							
Monacanthidae	*Meuschenia flavolineata*	Yellow-striped leatherjacket							
Monacanthidae	*Meuschenia freycineti*	Six-spined leatherjacket							
Monacanthidae	*Meuschenia scaber*	Velvet leatherjacket							
Monacanthidae	Monacanthidae sp	Leatherjacket							
Monacanthidae	*Nelusetta ayraudi*	Chinaman leatherjacket					1		
Monacanthidae	*Scobinichthys granulatus*	Rough leatherjacket							
Mullidae	*Upeneichthys sp*	Goatfish							
Muraenidae	*Gymnothorax prasinus*	Yellow moray							
Odacidae	*Heteroscarus acroptilus*	Rainbow cale							
Odacidae	*Olisthops cyanomelas*	Herring cale							
Platycephalidae	*Platycephalus bassensis*	Sand flathead		2	1		3		
Platycephalidae	*Platycephalus caeruleopunctatus*	Bluespotted flathead	3	3	3	2		4	3
Plesiopidae	*Trachinops taeniatus*	Eastern hulafish							
Paralichthyidae	*Pseudorhombus sp.*	Flounder	1						
Pinguipedidae	*Parapercis allporti*	Eastern Barred Grubfish							1
Pomacentridae	*Chromis hypsilepis*	Onespot Puller							
Pomacentridae	*Parma microlepis*	White-ear scalyfin							
Scorpaenidae	*Scorpaena jacksoniensis*	Eastern red scorpionfish							
Scorpaenidae	*Centropogon australis*	Eastern Fortesque	1	2	2	1	1		
Serranidae	*Acanthistius ocellatus*	Eastern wirrah							
Serranidae	*Caesioperca lepidoptera*	Butterfly perch							
Serranidae	*Caesioperca rasor*	Barber Perch							
Serranidae	*Hypoplectrodes maccullochi*	Half-banded seaperch							
Sillaginidae	*Sillago flindersi*	Eastern School Whiting		20	5	1	5	5	
Sparidae	*Sparus aurata*	Snapper							
Rays and Sharks (Elasmobranchii)									
Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler Shark							
Dasyatidae	*Dasyatis brevicaudata*	Smooth stingray							
Heterodontidae	*Heterodontus portusjacksoni*	Port Jackson shark			3			1	
Triakidae	*Galeorhinus galeus*	School shark							
Triakidae	*Mustelus antarcticus*	Gummy shark					1		
Myliobatidae	*Myliobatis australis*	Southern eagle ray		1					
Rhinobatidae	*Aptychotrema rostrata*	Eastern Shovelnose Ray					3		
Rhinobatidae	*Trygonorrhina fasciata*	Eastern fiddler ray		4	1		1	2	2
Rajidae	*Spiniraja whitleyi*	Melbourne Skate			1				
Scyliorhinidae	*Cephaloscyllium laticeps*	Draughtboard shark			1				
Urolophidae	*Trygonoptera testacea*	Common stingaree							
Urolophidae	*Urolophus kapalensis*	Kapala stingaree							
Urolophidae	*Urolophus paucimaculatus*	Sparsely-spotted stingaree							
Urolophidae	*Urolophus cruciatus*	Banded stingaree		1					
		SPECIES RICHNESS	***3***	***8***	***8***	***3***	***7***	***4***	***5***
		***maxN* (all species)**	***5***	***34***	***17***	***4***	***15***	***12***	***103***

Note

[1] Observed in study area using BRUV during Stage 1 fieldwork (3-9 November 2017), Stage 2 fieldwork (10 October 2019)

Taxonomy follows currently accpeted nomenclature from:

WoRMS Editorial Board (2020). World Register of Marine Species. Available from URL: http://ww

APPENDIX C-4. Fish taxa and maxN observations recorded by BRUV sur

		BRUV #	**BRUV28**	**BRUV29**	**BRUV30**
		DATE	10/10/19	10/10/19	10/10/19
		LOCATION	MB	MB	MB
		DEPTH (M)	35.9	31.3	27
		HABITAT	sand	sand	sand
FAMILY	**GENUS SPECIES**	**COMMON NAME**			
Bony Fishes (Actinopterygii)					
Aplodactylidae	*Aplodactylus arctidens*	Marblefish			
Aplodactylidae	*Aplodactylus lophodon*	Rock cale			
Aulopidae	*Latropiscis purpurissatus*	Sergeant baker			
Berycidae	*Centroberyx affinis*	Nannygai			
Carangidae	*Pseudocaranx georgianus*	Silver trevally			1
Carangidae	*Trachurus novaezelandiae*	Yellowtail horse mackerel	1	10	1
Cheilodactylidae	*Cheilodactylus fuscus*	Red Morwong			
Cheilodactylidae	*Nemadactylus douglasii*	Blue Morwong			
Chironemidae	*Chironemus marmoratus*	Eastern Kelpfish			
Cyttidae	*Cyttus australis*	Silver Dory			
Dinolestidae	*Dinolestes lewini*	Longfin pike			
Enoplosidae	*Enoplosus armatus*	Old wife			
Kyphosidae	*Girella tricuspidata*	Luderick			
Kyphosidae	*Girella zebra*	Zebra fish			
Kyphosidae	*Scorpis lineolata*	Silver sweep			
Labridae	*Achoerodus viridis*	Eastern blue groper			
Labridae	*Notolabrus gymnogenis*	Crimson-banded wrasse			
Labridae	*Notolabrus tetricus*	Blue-throated wrasse			
Labridae	*Ophthalmolepis lineolatus*	Maori wrasse			
Labridae	*Pictilabrus laticlavius*	Senator wrasse			
Latridae	*Latridopsis forsteri*	Bastard trumpeter			
Microcanthidae	*Atypichthys strigatus*	Australian mado			
Monacanthidae	*Acanthaluteres vittiger*	Toothbrush leatherjacket			
Monacanthidae	*Eubalichthys mosaicus*	Mosaic leatherjacket			
Monacanthidae	*Meuschenia flavolineata*	Yellow-striped leatherjacket			
Monacanthidae	*Meuschenia freycineti*	Six-spined leatherjacket		1	
Monacanthidae	*Meuschenia scaber*	Velvet leatherjacket			
Monacanthidae	Monacanthidae sp	Leatherjacket			
Monacanthidae	*Nelusetta ayraudi*	Chinaman leatherjacket			
Monacanthidae	*Scobinichthys granulatus*	Rough leatherjacket			
Mullidae	*Upeneichthys sp*	Goatfish			
Muraenidae	*Gymnothorax prasinus*	Yellow moray			
Odacidae	*Heteroscarus acroptilus*	Rainbow cale			
Odacidae	*Olisthops cyanomelas*	Herring cale			
Platycephalidae	*Platycephalus bassensis*	Sand flathead	4	4	2
Platycephalidae	*Platycephalus caeruleopunctatus*	Bluespotted flathead	1	1	1
Plesiopidae	*Trachinops taeniatus*	Eastern hulafish			
Paralichthyidae	*Pseudorhombus sp.*	Flounder			
Pinguipedidae	*Parapercis allporti*	Eastern Barred Grubfish			
Pomacentridae	*Chromis hypsilepis*	Onespot Puller			
Pomacentridae	*Parma microlepis*	White-ear scalyfin			
Scorpaenidae	*Scorpaena jacksoniensis*	Eastern red scorpionfish			
Scorpaenidae	*Centropogon australis*	Eastern Fortesque			1
Serranidae	*Acanthistius ocellatus*	Eastern wirrah			
Serranidae	*Caesioperca lepidoptera*	Butterfly perch			
Serranidae	*Caesioperca rasor*	Barber Perch			
Serranidae	*Hypoplectrodes maccullochi*	Half-banded seaperch			
Sillaginidae	*Sillago flindersi*	Eastern School Whiting	2	7	15
Sparidae	*Sparus aurata*	Snapper			
Rays and Sharks (Elasmobranchii)					
Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler Shark			
Dasyatidae	*Dasyatis brevicaudata*	Smooth stingray			
Heterodontidae	*Heterodontus portusjacksoni*	Port Jackson shark	1	1	1
Triakidae	*Galeorhinus galeus*	School shark			
Triakidae	*Mustelus antarcticus*	Gummy shark			
Myliobatidae	*Myliobatis australis*	Southern eagle ray			
Rhinobatidae	*Aptychotrema rostrata*	Eastern Shovelnose Ray			
Rhinobatidae	*Trygonorrhina fasciata*	Eastern fiddler ray		2	2
Rajidae	*Spiniraja whitleyi*	Melbourne Skate			
Scyliorhinidae	*Cephaloscyllium laticeps*	Draughtboard shark		1	
Urolophidae	*Trygonoptera testacea*	Common stingaree			
Urolophidae	*Urolophus kapalensis*	Kapala stingaree		1	
Urolophidae	*Urolophus paucimaculatus*	Sparsely-spotted stingaree		1	1
Urolophidae	*Urolophus cruciatus*	Banded stingaree			
		SPECIES RICHNESS	***5***	***10***	***9***
		***maxN* (all species)**	***9***	***29***	***25***

Note

[1] Observed in study area using BRUV during Stage 1 fieldwork (3-9 November 2017), Stage 2 fieldwork (10 October 2019)

Taxonomy follows currently accpeted nomenclature from:

WoRMS Editorial Board (2020). World Register of Marine Species. Available from URL: http://ww

APPENDIX C-5

IMAGES OF FISH TAXA RECORDED IN BAITED REMOTE UNDERWATER VIDEO (BRUV) SURVEYS

APPENDIX C-5

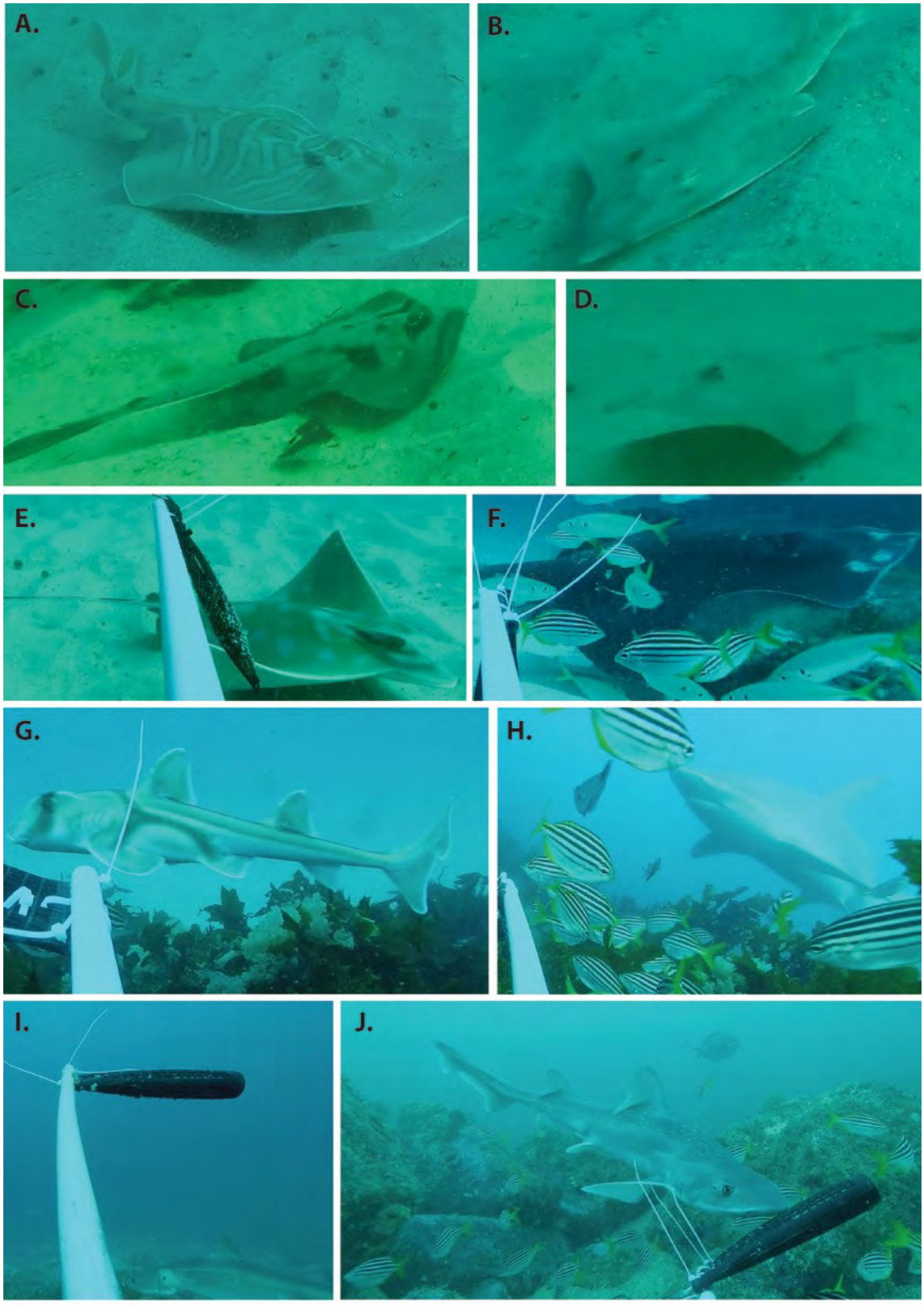


Plate 1. Sharks and Rays.
A. Eastern fiddler ray (*Trygonorrhina fasciata*), **B.** Eastern Shovelnose Ray (*Aptychotrema rostrata*), **C.** Banded stingaree (*Urolophus cruciatus*), **D.** Common stingaree (*Trygonoptera testacea*), **E.** Southern eagle ray (*Myliobatis australis*), **F.** Smooth stingray (*Dasyatis brevicaudata*), **G.** Port Jackson shark (*Heterodontus portusjacksoni*), **H.** Bronze whaler shark (*Carcharhinus brachyurus*), **I.** School shark (*Galeorhinus galeus*), **J.** Gummy shark (*Mustelus antarcticus*).

APPENDIX C-5

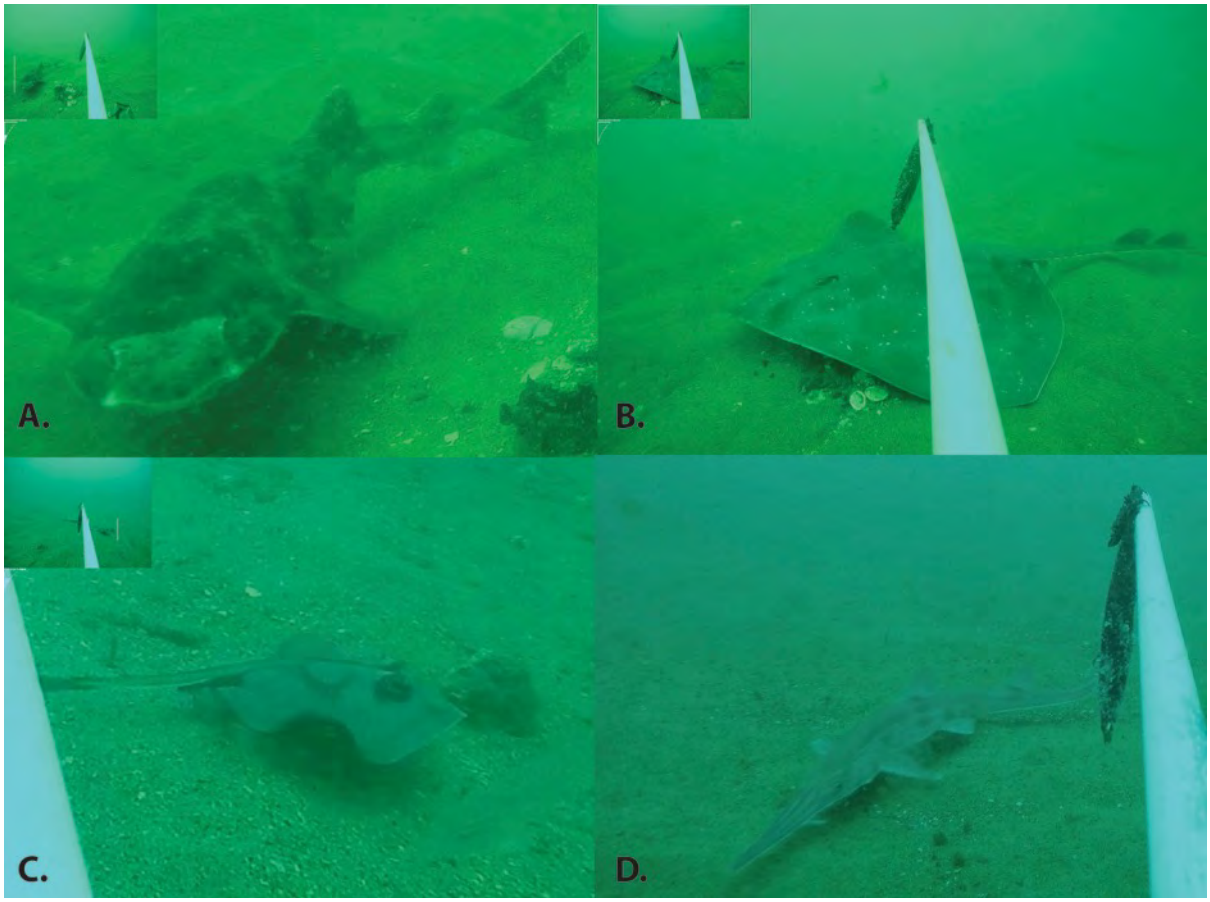


Plate 2. Sharks and Rays.
A. Draughtboard shark (*Cephaloscyllium laticeps*), **B.** Melbourne skate (*Spiniraja whitleyi*), **C.** Kapala stingaree (*Urolophus kapalensis*), **D.** Southern sawshark (*Pristiophorus nudipinnis*)

Note
Southern sawshark was recorded in BRUV28 after the 30 minute video analysis.

APPENDIX C-5

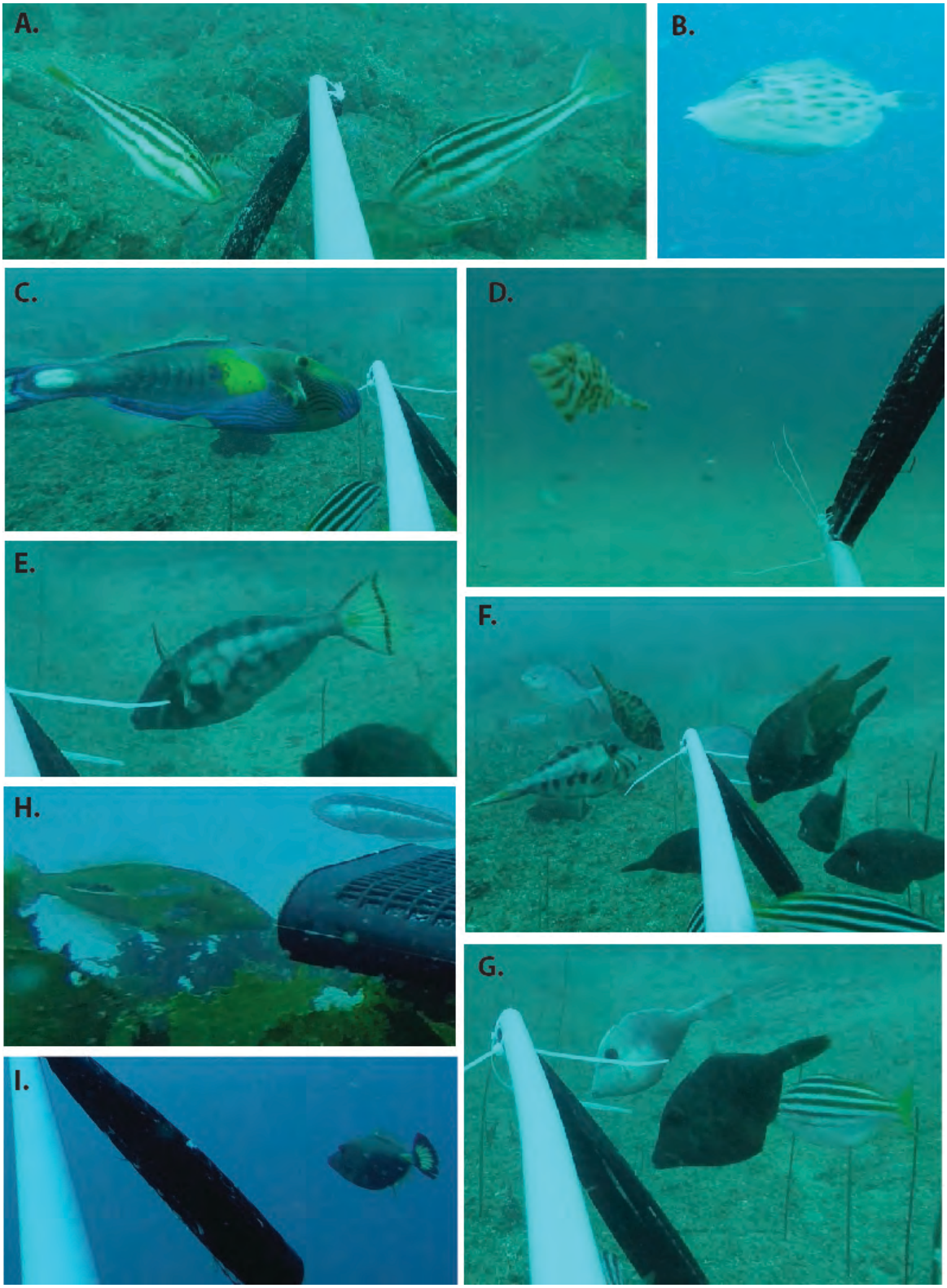


Plate 3. Leatherjackets (Family Monacanthidae)
A. Chinamans leatherjacket – juvenile (*Nelusetta ayraudi*), **B.** Mosaic leatherjacket (*Eubalichthys mosaicus*), **C.** Six-spined leatherjacket (*Meuschenia freycineti*), **D.** Rough leatherjacket (*Scobinichthys granulatus*), **E.** Velvet leatherjacket (*Meuschenia scaber*), **F, G.** Color variants of Velvet Leatherjacket (*Meuschenia scaber*), **H.** Tootbrush leatherjacket (*Acanthaluteres vittiger*), **I.** Yellow-striped leatherjacket (*Meuschenia flavolineata*).

APPENDIX C-5

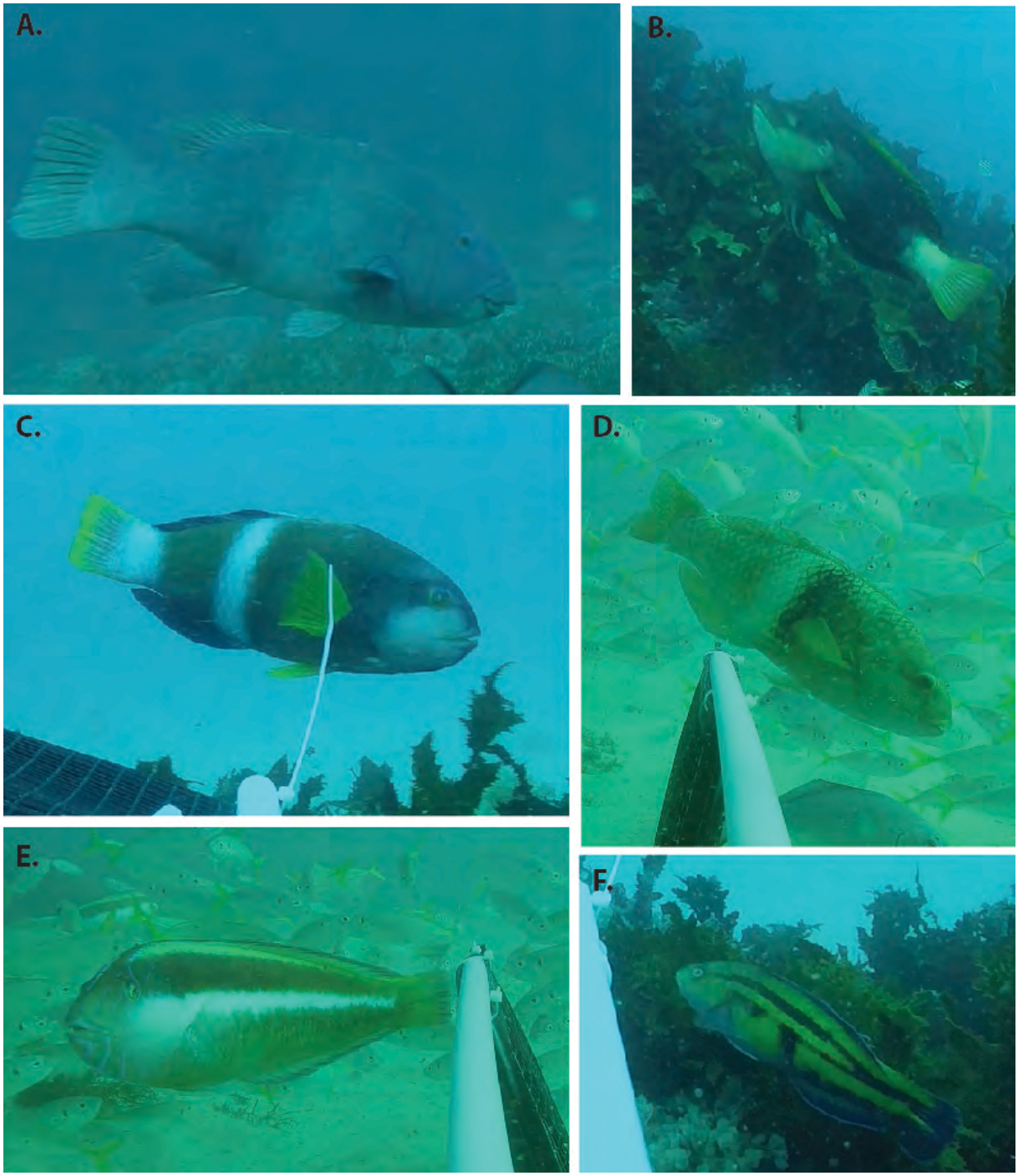


Plate 4. Wrasses (Family Labridae)
A. Eastern Blue Groper (*Achoerodus viridis*), **B.** Crimson-banded wrasse (*Notolabrus gymnogenis*), **C.** Blue-throated wrasse – male (*Notolabrus tetricus*), **D.** Blue-throated wrasse – female (*Notolabrus tetricus*), **E.** Maori wrasse (*Ophthalmolepis lineolatus*), **F.** Senator wrasse (*Pictilabrus laticlavius*).

APPENDIX C-5

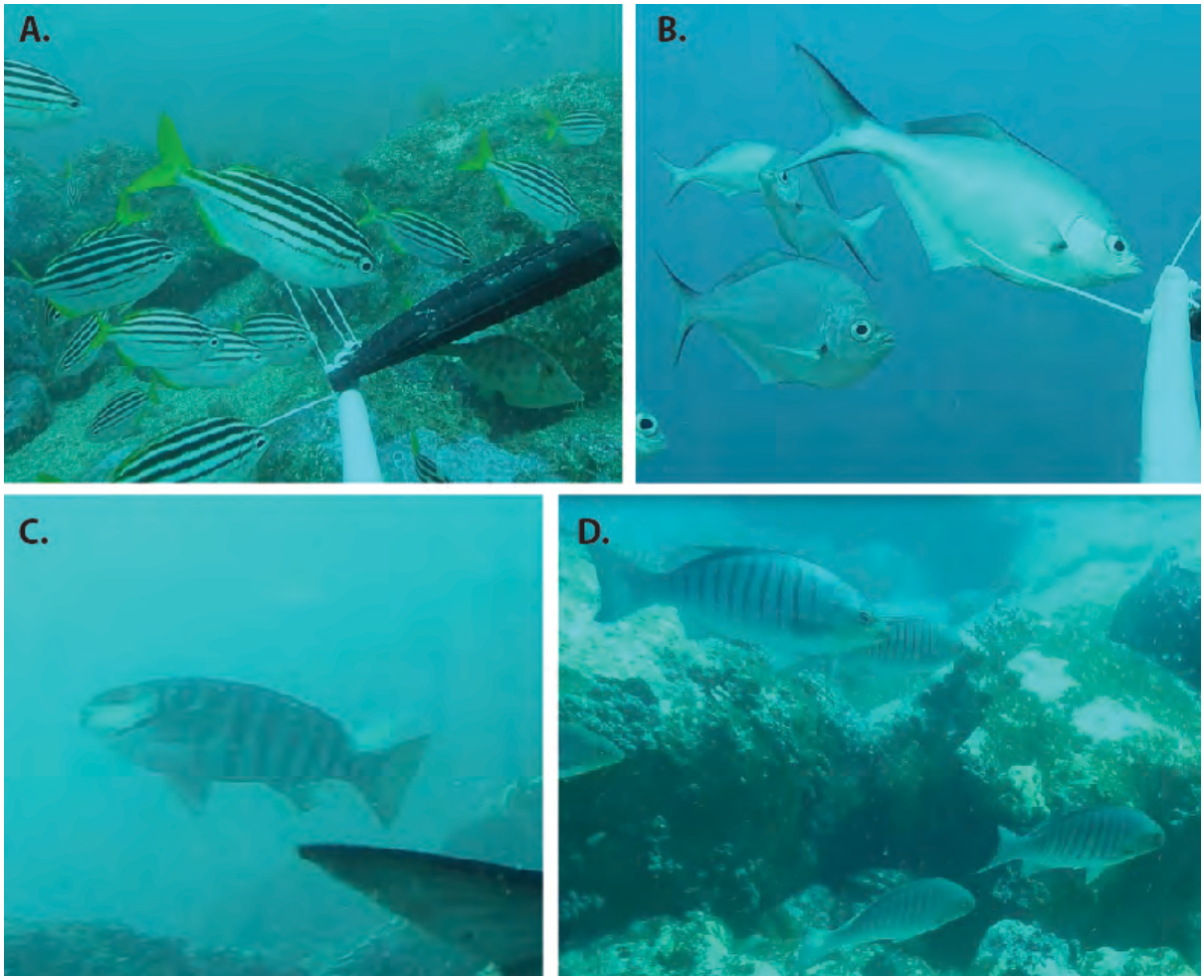


Plate 5. Mados (Family Microcanthidae) and Drummers (Family Kyphosidae)
A. Australian Mado (Family Microcanthidae - *Atypichthys strigatus*), **B.** Silver sweep (Family Kyphosidae - *Scorpis lineolata*), **C.** Zebra fish (Family Kyphosidae - *Girella zebra*), **D.** Luderick (Family Kyphosidae - *Girella tricuspidata*)

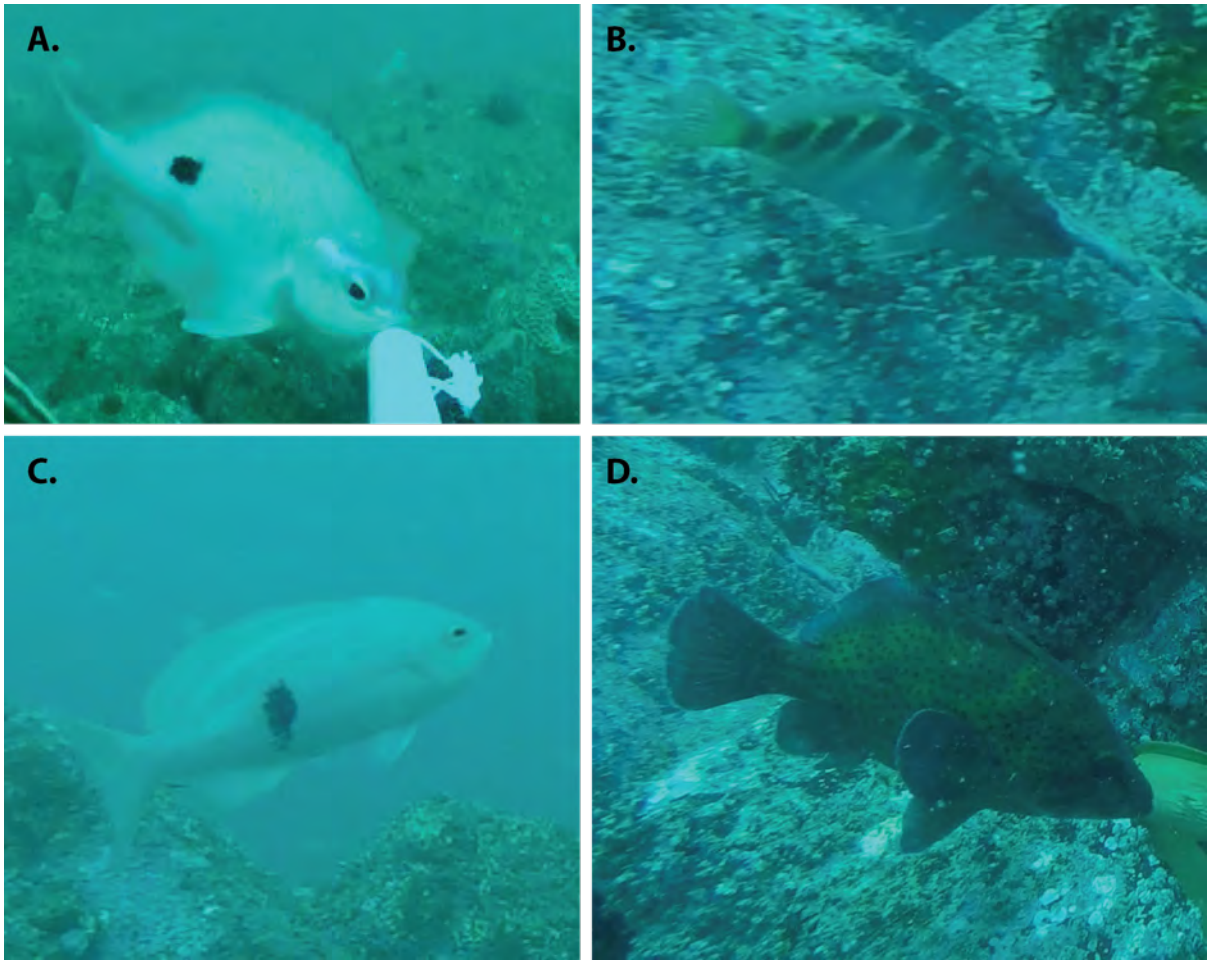


Plate 6. Family Serranidae
A. Butterfly perch (*Caesioperca lepidoptera*), **B.** Half-banded sea perch (*Hypoplectrodes maccullochi*), **C.** Barber perch (*Caesioperca rasor*), **D.** Eastern Wirrah (*Acanthistius ocellatus*).

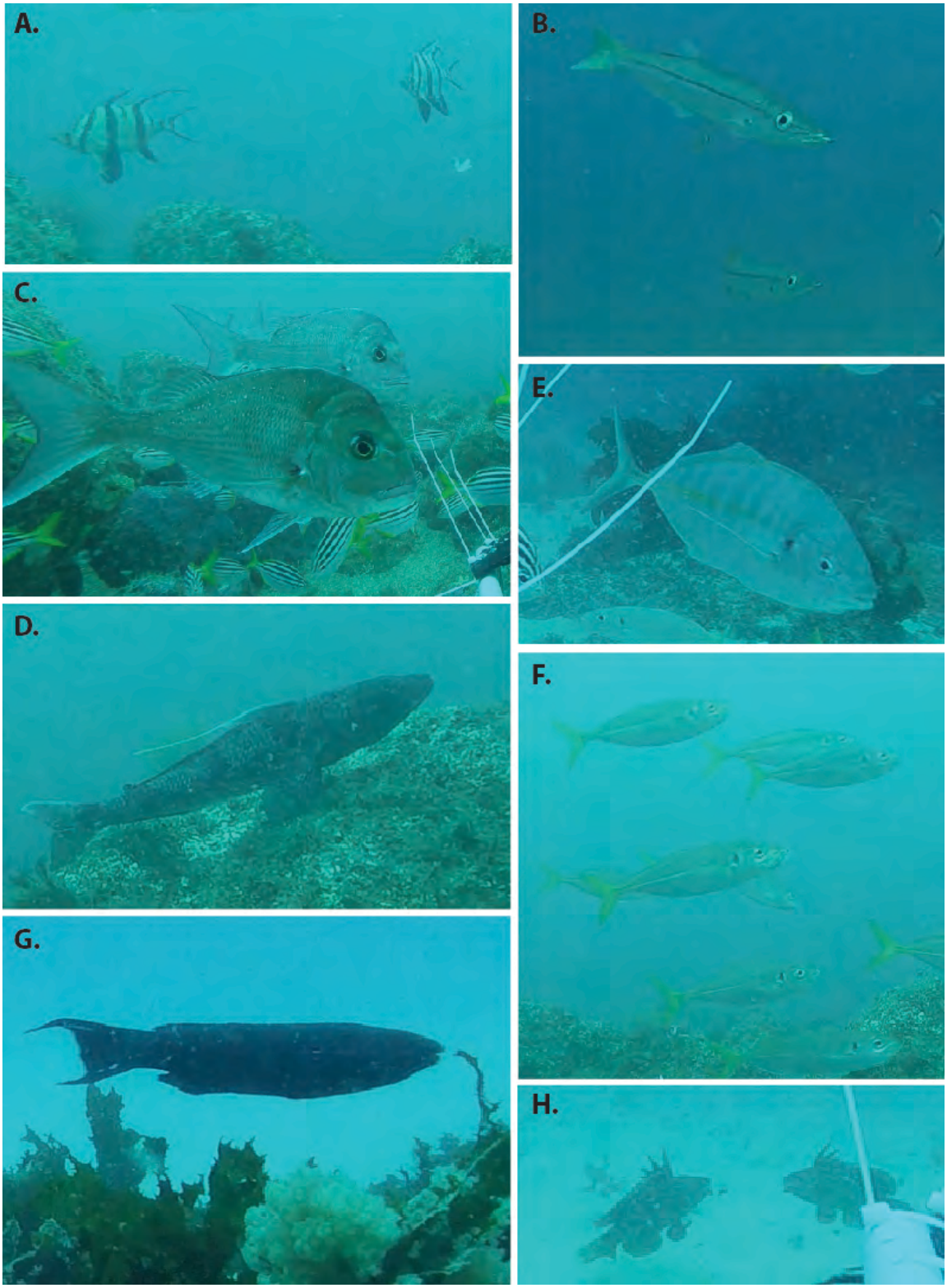


Plate 7. Various other families

A. Old wife (Family Enoplosidae - *Enoplosus armatus*), **B.** Longfin pike (Family Dinolestidae - *Dinolestes lewini*), **C.** Snapper (Family Sparidae - *Sparus aurata*), **D.** Sergeant Baker (Family Aulopidae - *Latropiscis purpurissatus*), **E.** Silver trevally (Family Carangidae - *Pseudocaranx georgianus*), **F.** Yellowtail horse mackerel (Family Carangidae - *Trachurus novaezelandiae*), **G.** Herring cale (Family Odacidae - *Olisthops cyanomelas*), **H.** Rainbow cale (Family Odacidae - *Heteroscarus acroptilus*).

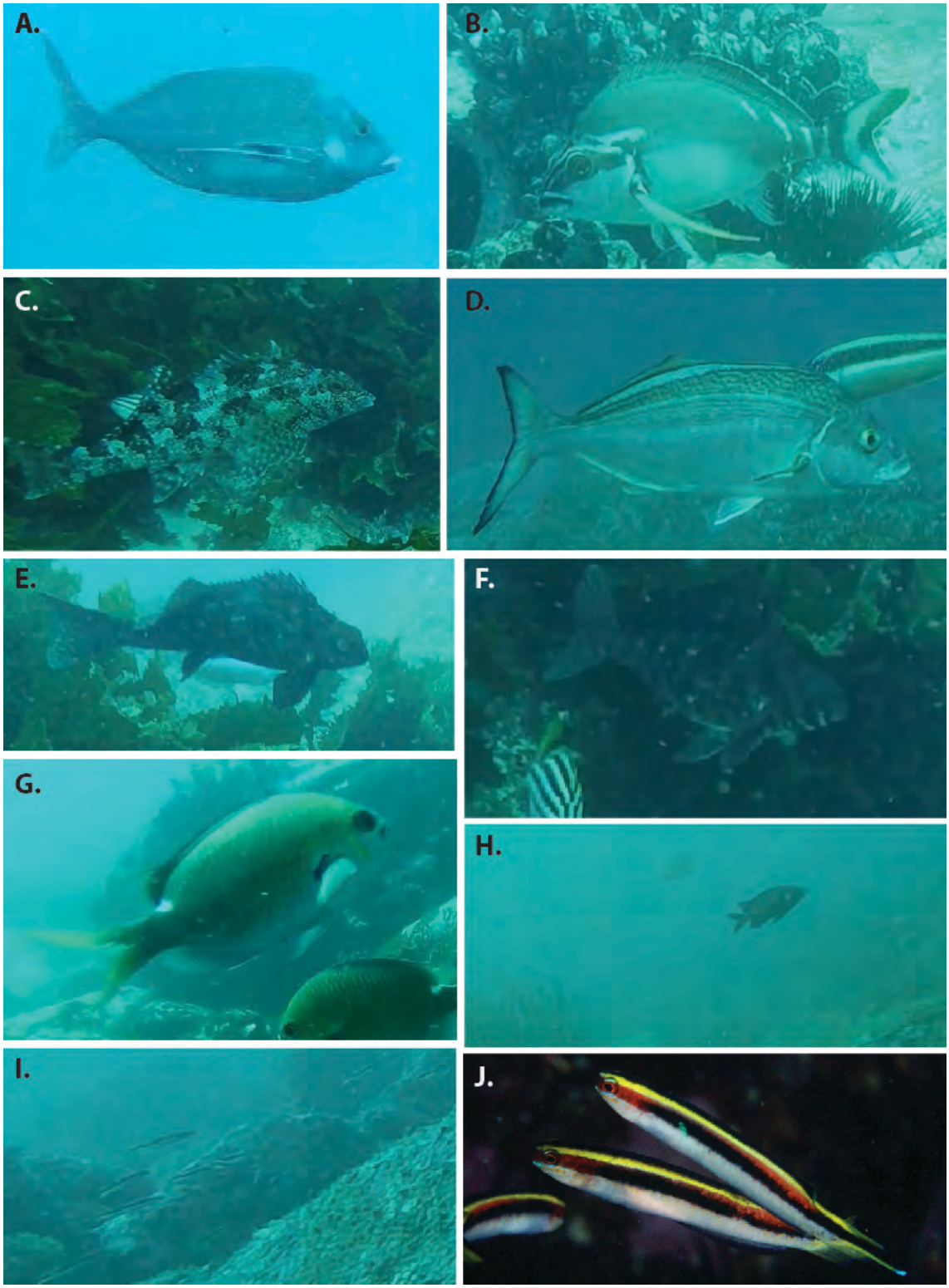


Plate 8. Various other families

A. Blue morwong (Family Cheiodactylidae - *Nemadactylus douglasii*), **B.** Red morwong (Family Cheiodactylidae - *Cheilodactylus fuscus*). **C.** Eastern kelpfish (Family Chironemidae - *Chironemus marmoratus*), **D.** Bastard trumpeter (Family Latridae - *Latridopsis forsteri*), **E.** Rock cale (Family Aplodactylidae - *Aplodactylus lophodon*), **F.** Marblefish (Family Aplodactylidae - *Aplodactylus arctidens*), **G.** One spot puller (Family Pomacentridae - *Chromis hypsilepis*), **H.** White-ear scalyfin (Family Pomacentridae - *Chromis hypsilepis*), **I.** Eastern hulafish (Family Plesiopidae - *Trachinops taeniatus*), **J.** Eastern hulafish (image from Fishes of Australia website).

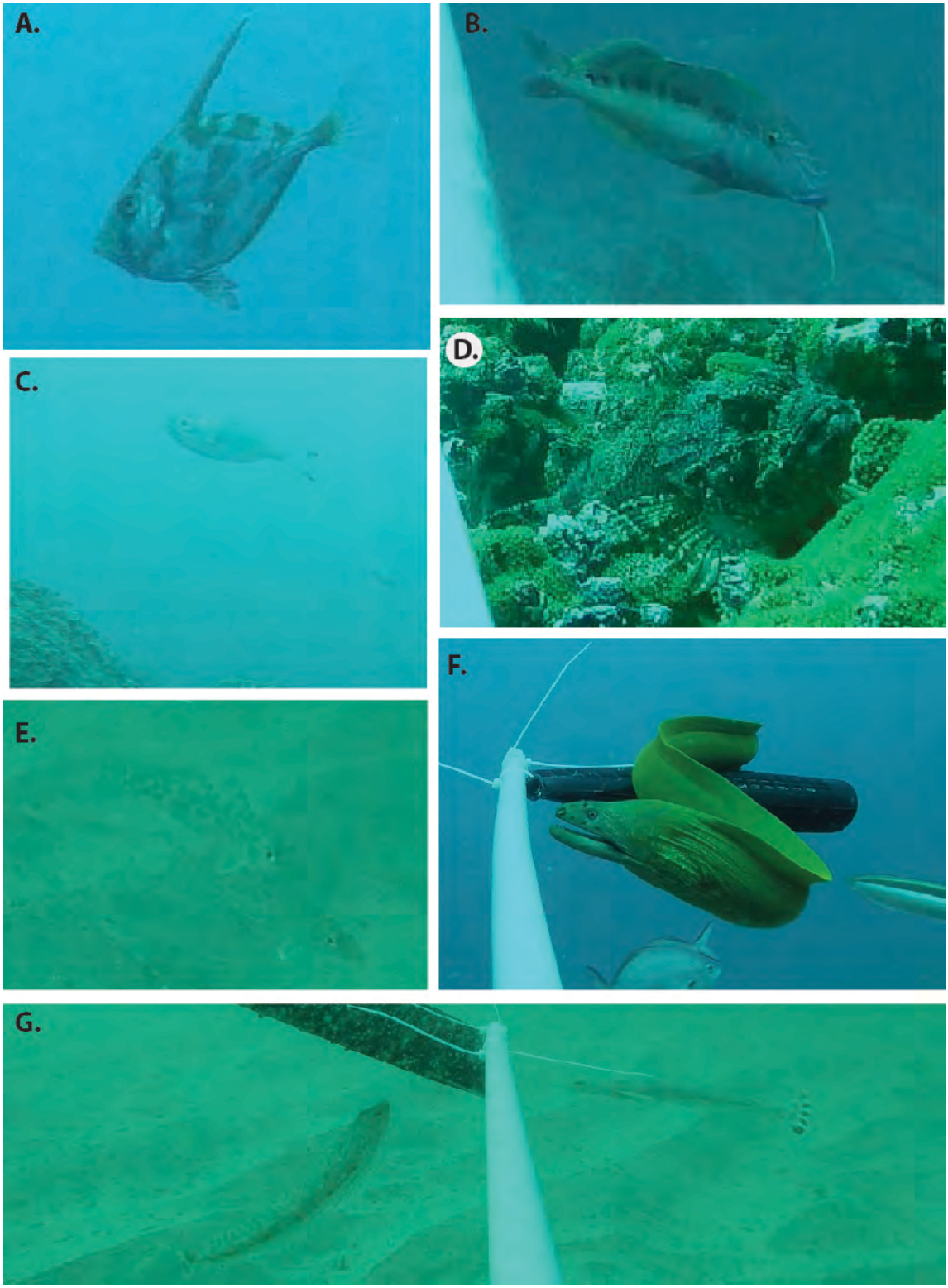


Plate 9. Various other families

A. Silver dory - juvenile (Family Cyttidae - *Cyttus australis*), **B.** Goatfish (Family Mullidae - *Upeneichthys* sp). **C.** Nannygai (Family Berycidae - *Centroberyx affinis*), **D.** Eastern red scorpionfish (Family Scorpaenidae - *Scorpaena jacksoniensis*), **E.** Eastern school whiting (Family Sillaginidae - *Sillago flindersi*), **F.** Yellow moray (Family Muraenidae - *Gymnothorax prasinus*), **G.** Bluespotted flathead (Family Platycephalidae - *Platycephalus caeruleopunctatus*).

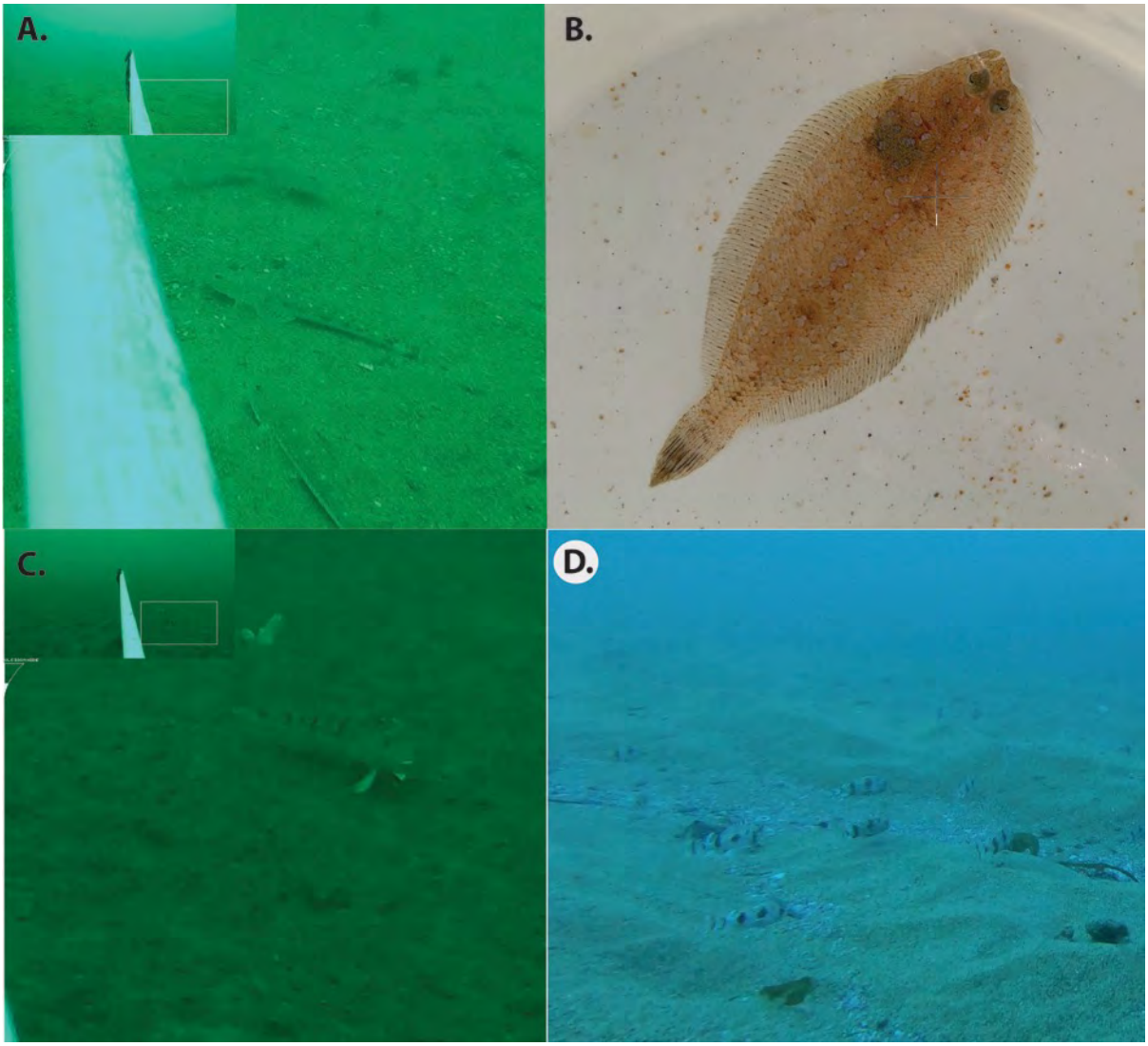


Plate 10. Various other families
A. Sand flathead (Family Platycephalidae - *Platycephalus bassensis*), **B.** Flounder (Family Paralichthyidae - *Pseudorhombus sp.*). **C.** Eastern Barred Grubfish (Family Pinguipedidae - *Parapercis allporti*), **D.** Eastern fortesque (Family Scorpaenidae - *Centropogon australis*).

APPENDIX C-6

IMAGES OF FISH AND CEPHALOPOD TAXA RECORDED USING OTHER SURVEY METHODS (TOW VIDEO, DIVING)

APPENDIX C-6

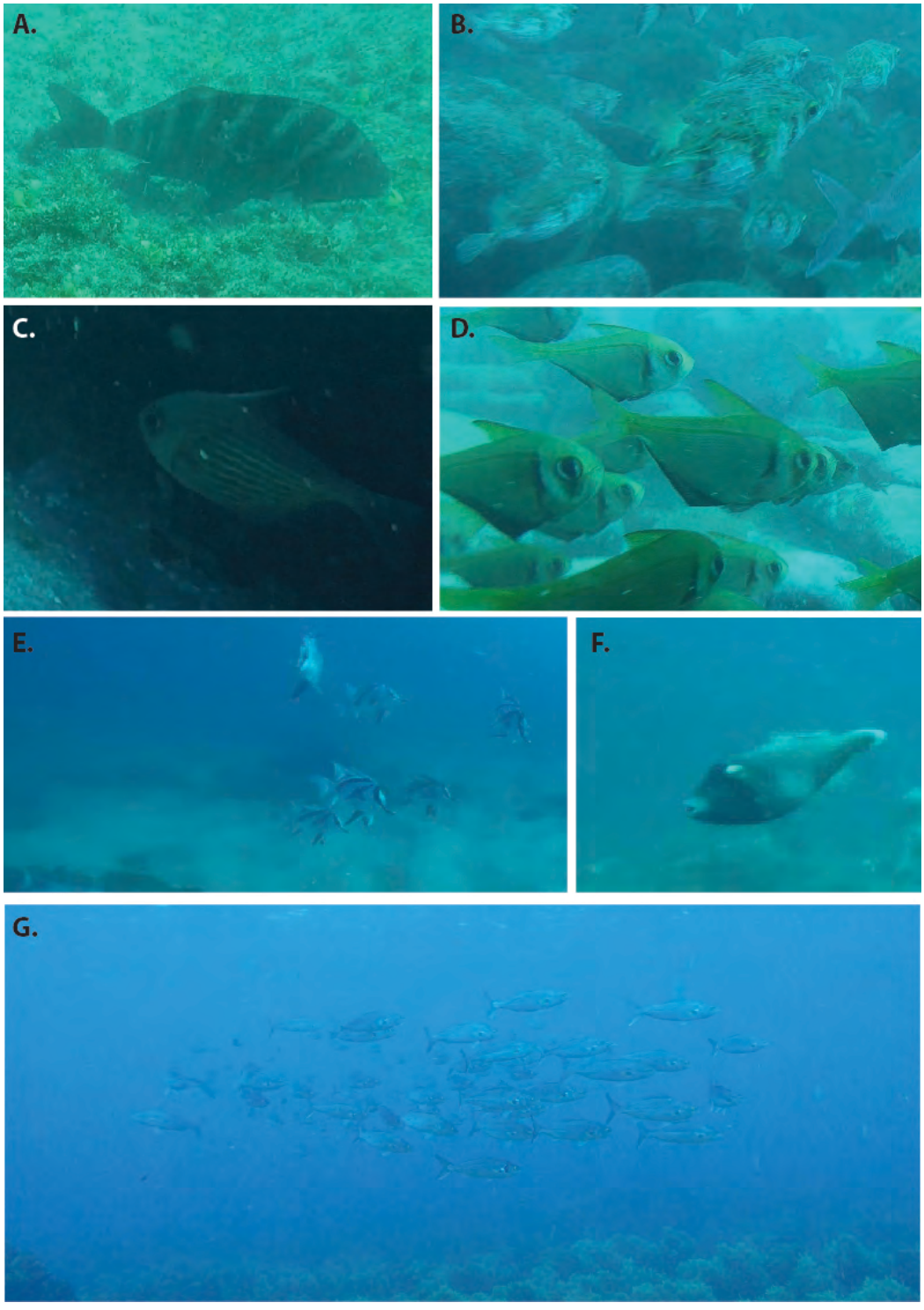


Plate 1. Various other fish taxa.
A. Banded morwong (Family Cheilodactylidae - *Cheilodactylus spectabilis*), **B.** Threebar porcupinefish (Family Diodontidae - *Dicotylichthys punctulatus*), **C.** Bigscale bullseye (Family Pempheridídae - *Pempheris multiradiata*), **D.** Smallscale bullseye (Family Pempheridídae - *Pempheris compressa*), **E.** Longsnout boarfish (Family Pentacerotidae - *Pentaceropsis recurvirostris*), **F.** Black reef leatherjacket (Family Monocanthidae - *Eubalichthys bucephalus*), **G.** Australian salmon (Family Arripidae - *Arripis trutta*).

Plate 2. Cephalopoda (Cuttlefish, Squid, Octopus)
A. Cuttlefish (Family Sepiidae - *Sepia sp.*), **B.** Octopus (Family Octopodidae - *Octopus* sp.), **C.** Southern calamari (Family Loliginidae - *Sepioteuthis australis*).

APPENDIX D

Bioaccumulation Risk to Fish and Shellfish

APPENDIX D

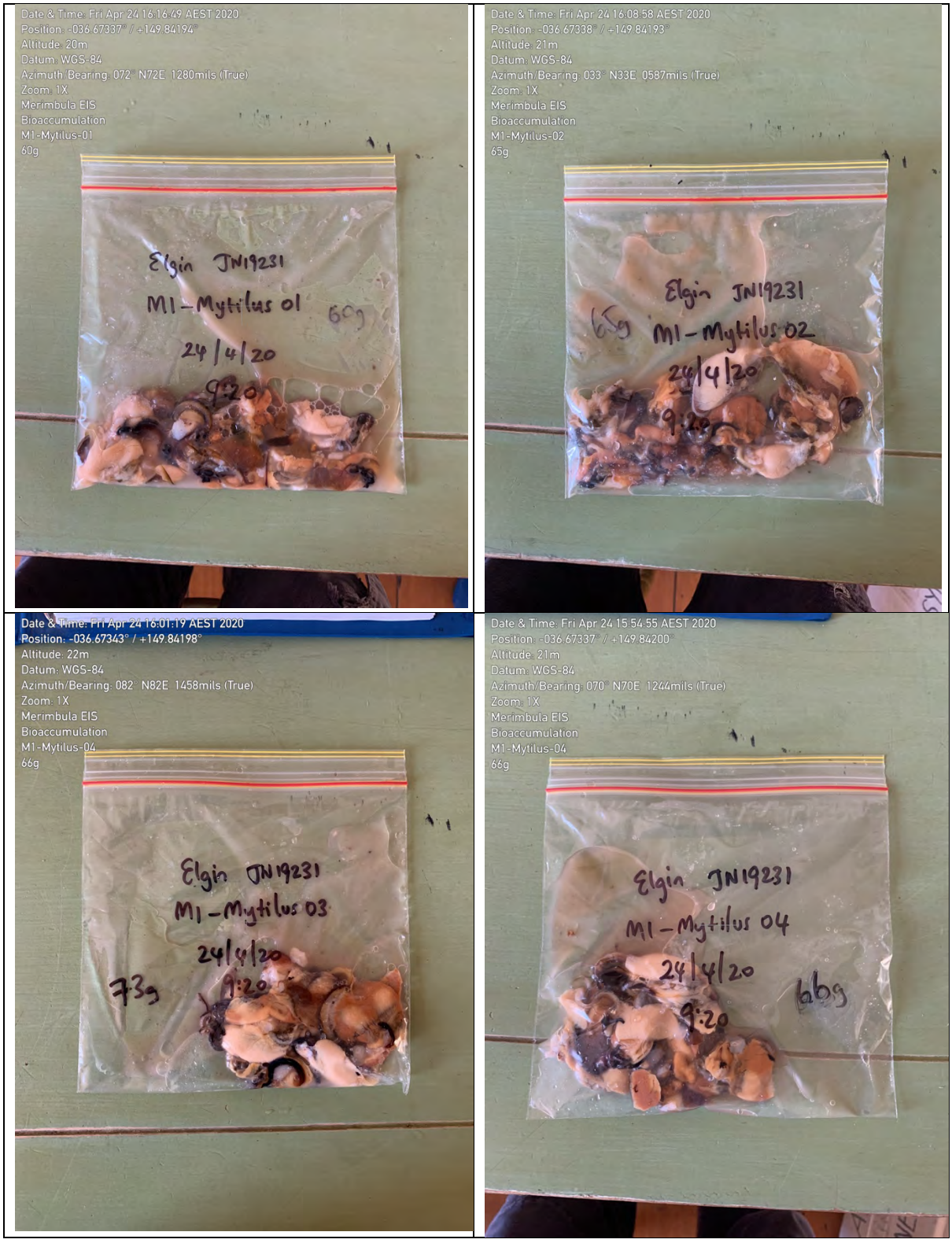
APPENDIX D-1

Field data sheets and Sample Photos

Table Mussel and Abalone sample locations

Site Code	Location	Coordinates/WPT	Sample Code	Sample Weight (g)	Comment (composite)
M1	Hunter Reef	S36.94027° E149.94557°	M1-Mytilus01	60	composite of 4 individuals, flesh
			M1-Mytilus02	65	composite of 4 individuals, flesh
			M1-Mytilus03	73	composite of 4 individuals, flesh
			M1-Mytilus04	66	composite of 4 individuals, flesh
M2	Haycock Point	S36.94771° E149.93810°	M2-Mytilus01	60	composite of 4 individuals, flesh
			M2-Mytilus02	70	composite of 4 individuals, flesh
			M2-Mytilus03	72	composite of 4 individuals, flesh
			M2-Mytilus04	56	composite of 4 individuals, flesh
M3	Long Point	S36.90295° E149.93644°	M3-Mytilus01	85	composite of 4 individuals, flesh
			M3-Mytilus02	62	composite of 4 individuals, flesh
			M3-Mytilus03	80	composite of 4 individuals, flesh
			M3-Mytilus04	78	composite of 4 individuals, flesh
M4	Tura Head	S36.85748° E149.94900°	M4-Mytilus01	90	composite of 4 individuals, flesh
			M4-Mytilus02	82	composite of 4 individuals, flesh
			M4-Mytilus03	95	composite of 4 individuals, flesh
			M4-Mytilus04	90	composite of 4 individuals, flesh
M5	Lennards Island	S37.01682° E149.94790°	M5-Mytilus01	50	composite of 6 individuals, flesh
			M5-Mytilus02	35	composite of 6 individuals, flesh
			M5-Mytilus03	34	composite of 6 individuals, flesh
			M5-Mytilus04	40	composite of 6 individuals, flesh
A1	Lennards Island	S37.01682° E149.94790°	A1-Haliotis01	127	1 individual, flesh
			A1-Haliotis02	112	1 individual, flesh
			A1-Haliotis03	125	1 individual, flesh
			A1-Haliotis04	140	1 individual, flesh
A2	Haycock Point	S36.94771° E149.93810°	A2-Haliotis01	122	1 individual, flesh
			A2-Haliotis02	133	1 individual, flesh
			A2-Haliotis03	120	1 individual, flesh
			A2-Haliotis04	103	1 individual, flesh
A3	Long Point	S36.90295° E149.93644°	A3-Haliotis01	98	1 individual, flesh
			A3-Haliotis02	96	1 individual, flesh
		S36.90306° E149.93273°	A3-Haliotis03	101	1 individual, flesh
			A3-Haliotis04	118	1 individual, flesh
A4	Tura Head	S36.84799° E149.93966°	A4-Haliotis01	112	1 individual, flesh
			A4-Haliotis02	125	1 individual, flesh
		S36.85748° E149.94900°	A4-Haliotis03	120	1 individual, flesh
			A4-Haliotis04	118	1 individual, flesh

Mussel samples from location M4 – Tura Head



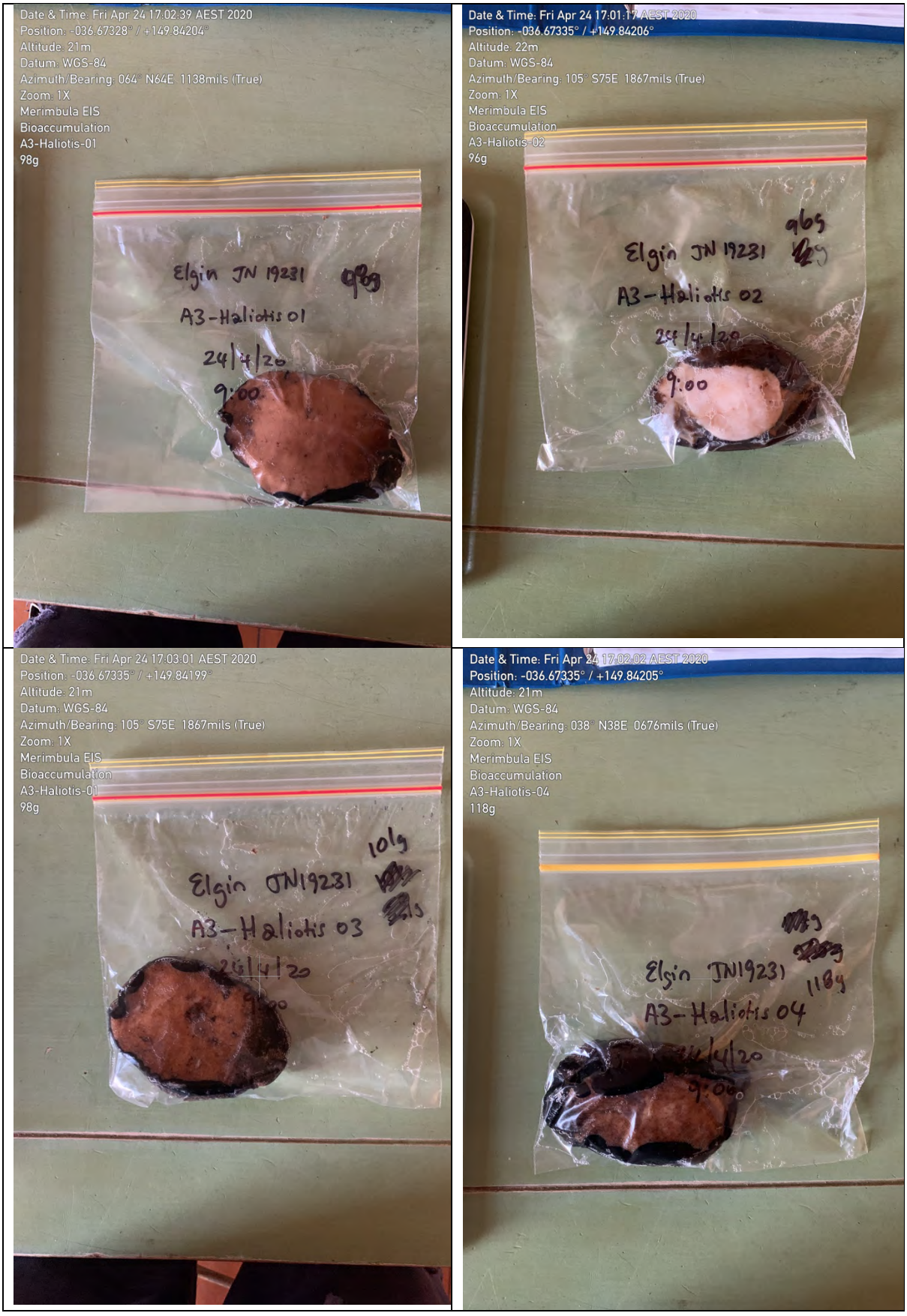
Mussel samples from location M1 – Hunter Reef

Mussel samples from location M2 – Haycock Point

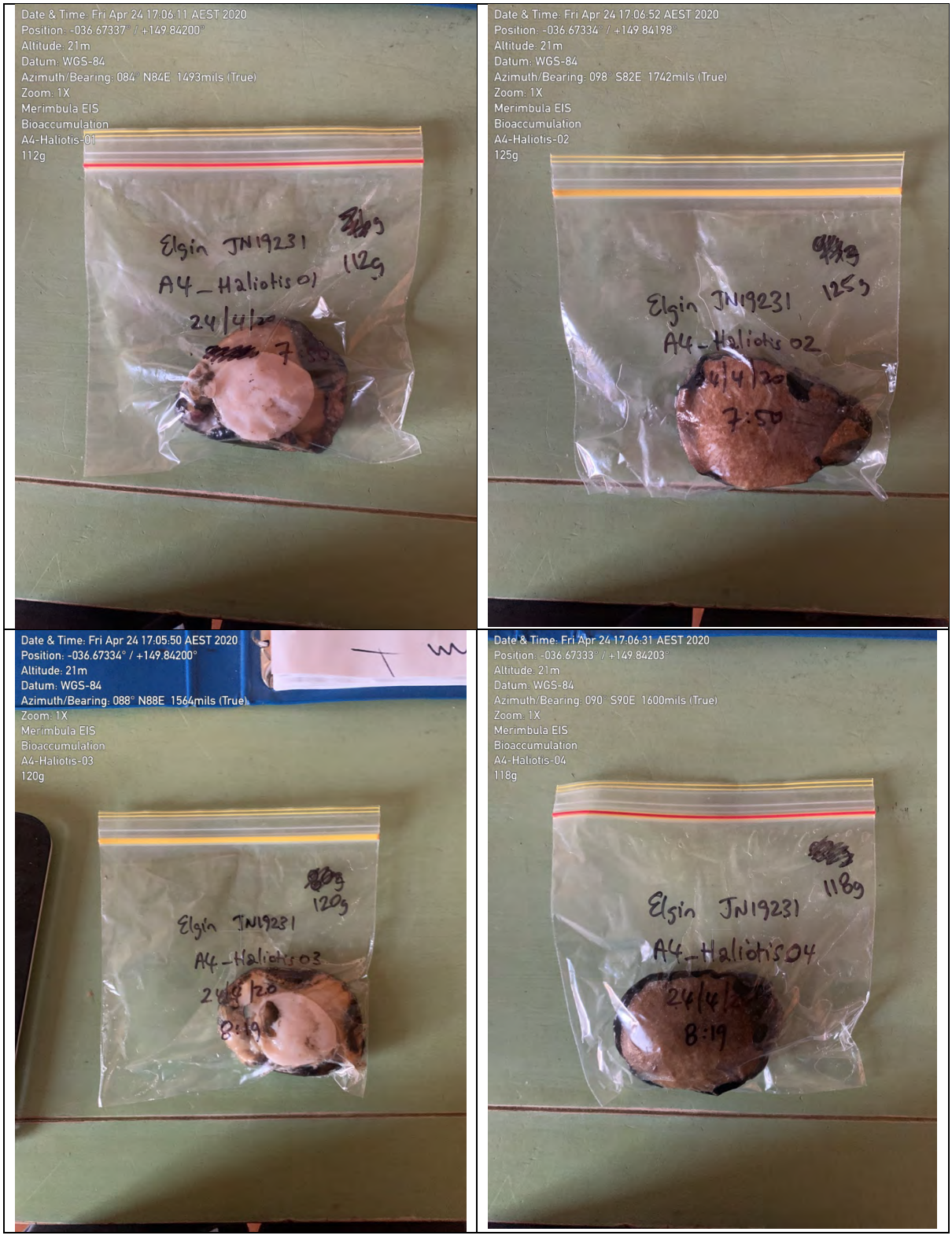
Mussel samples from location M3 – Long Point

Mussel samples from location M5 – Lennards Island

Abalone samples from location A1 – Lennards Island



Abalone samples from location A3 – Long Point



Abalone samples from location A4 – Tura Head

Abalone samples from location A2 – Haycock Point

Biota Sampling Sheet

elgin associates

Project Name	Merimbula EIS Stage 2	**Date**	29/9/19
Sampling Personnel	ARMY	**Time**	1030 - 1130.
Waterway	Merimbula Bay	**Zone**	OAR.
Sample ID	F2 - platyc01	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	144	**Length (cm)**	29cm
Angling Species (Y/N)	Yes	**Angling Legal Size (Y/N)**	N
Catch Location:	Merimbula OAR		
GPS Coordinates/Waypoint(s)	36° 54.811 ; 149° 56.133		
Catch Method	Line		
Laboratory Analysis:	metals	**QAQC**	SOP
Sample Bagging:	Lab Bag	**Sample Labelling:**	Bag.
Sign-Off		**Name**	

Sample ID	F2 - Platyc02	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	150g	**Length (cm)**	29cm
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	N
Catch Location:	Merimbula OAR		
GPS Coordinates/Waypoint(s)	36° 54.811 ; 149° 56.133		
Catch Method	Line		
Laboratory Analysis:	metals	**QAQC**	SOP
Sample Bagging:	Lab - Bag	**Sample Labelling:**	Bag
Sign-Off		**Name**	

Sample ID example: HI_20180508_PLASPP_01

Biota Sampling Sheet

elgin associates

Project Name	Merimbula EIS Stage 2	**Date**	29/9/19
Sampling Personnel	NM, AR	**Time**	1445
Waterway	Merimbula Bay	**Zone**	OAR
Sample ID	F2-Platyc 03	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead.	**(Latin)**	
Field Mass (g)	168g	**Length (cm)**	~ 31cm
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	N.
Catch Location:	OAR		
GPS Coordinates/Waypoint(s)	36°54.811 ; 149° 56.133.		
Catch Method	Line		
Laboratory Analysis:	Metals	**QAQC**	SOP
Sample Bagging:	Lab Bag	**Sample Labelling:**	Bag
Sign-Off		**Name**	
Sample ID	F2-Platyc 04	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	98g	**Length (cm)**	27cm
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	N
Catch Location:	OAR		
GPS Coordinates/Waypoint(s)	36°54.811 ; 149° 56.133		
Catch Method	Line		
Laboratory Analysis:	Metals	**QAQC**	SOP
Sample Bagging:	Lab Bag	**Sample Labelling:**	Bag
Sign-Off		**Name**	

Sample ID example: HI_20180508_PLASPP_01

Biota Sampling Sheet

elgin associates

Project Name	Merimbula EIS Stage 2	Date	21/10/19
Sampling Personnel	NM, AR	Time	830 - 1030
Waterway	Tura Head	Zone	Merimbula Bay - north.

Sample ID: F4 - PlatycO1	Photograph (Y/N): Y
Biota Species (Common): Flathead	(Latin):
Field Mass (g): 197	Length (cm): 31
Angling Species (Y/N): Y	Angling Legal Size (Y/N): N
Catch Location: Tura Head 30	
GPS Coordinates/Waypoint(s): Tura B1 36° 52.533 ; 149° 57.030	
Catch Method: Line	
Laboratory Analysis: Metals	QAQC: SOP
Sample Bagging: Lab Bag	Sample Labelling: Bag
Sign-Off	Name

Sample ID: F4 - Platyc02	Photograph (Y/N): Y
Biota Species (Common): Flathead	(Latin):
Field Mass (g): 259	Length (cm): 34
Angling Species (Y/N): Y	Angling Legal Size (Y/N): Y
Catch Location: Tura Head	
GPS Coordinates/Waypoint(s): Tura B1 36° 52.533 ; 149° 57° 030	
Catch Method: Line	
Laboratory Analysis: Metals	QAQC: SOP
Sample Bagging: Lab Bag	Sample Labelling: Bag
Sign-Off	Name

Sample ID example: HI_20180508_PLASPP_01

Biota Sampling Sheet

elgin associates

Project Name	Merimbula EIS Stage 2	**Date**	21/10/19
Sampling Personnel	MH, AR	**Time**	830-1030
Waterway	Merimbula Bay - North	**Zone**	Tura Head
Sample ID	F4-Platyc03	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	254g	**Length (cm)**	34cm
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	
Catch Location:	Tura Head		
GPS Coordinates/Waypoint(s)	Tura B1 36°52.533; 149°57.030		
Catch Method	line		
Laboratory Analysis:	Metals	**QAQC**	SOP.
Sample Bagging:	Lab Bag	**Sample Labelling:**	Bag
Sign-Off		**Name**	
Sample ID	F4-Platyc04	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	154	**Length (cm)**	29
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	N
Catch Location:	Tura Head		
GPS Coordinates/Waypoint(s)	Tura B1 36°32.533; 149°57.030		
Catch Method	line		
Laboratory Analysis:	Metals	**QAQC**	SOP
Sample Bagging:	Lab Bag	**Sample Labelling:**	Bag
Sign-Off		**Name**	

Sample ID example: HI_20180508_PLASPP_01

Biota Sampling Sheet

elgin associates

Project Name	Merimbula EIS Stage 2	**Date**	21/10/19
Sampling Personnel	NM, AR	**Time**	1100 - 1145
Waterway	Quandolo	**Zone**	Merimbula Bay - South
Sample ID	F3 ~ Platyc 01	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	311	**Length (cm)**	37
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	Y
Catch Location:	Quandolo		
GPS Coordinates/Waypoint(s)	Quan B1 - 36°58.600; 149°56.666		
Catch Method	Line		
Laboratory Analysis:	Metals	**QAQC**	SOP
Sample Bagging:	Lab Bag	**Sample Labelling:**	Bag
Sign-Off		**Name**	
Sample ID	F3 - Platyc 02	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	197	**Length (cm)**	32
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	N
Catch Location:	Quandolo		
GPS Coordinates/Waypoint(s)	Quan B1		
Catch Method	Line		
Laboratory Analysis:	Metals	**QAQC**	SOP
Sample Bagging:	Lab Bag	**Sample Labelling:**	Bag
Sign-Off		**Name**	

Sample ID example: HI_20180508_PLASPP_01

Biota Sampling Sheet

elgin associates

Project Name	Merimbula EIS Stage 2	Date	2/10/19
Sampling Personnel	AR, MY.	Time	1100-1145
Waterway	Quandolo	Zone	Merimbula Bay South

Sample ID: F3- Platyc 03	Photograph (Y/N): Y
Biota Species (Common): Flathead	(Latin):
Field Mass (g): 169	Length (cm): 31
Angling Species (Y/N): Y	Angling Legal Size (Y/N): N
Catch Location: Quandolo	
GPS Coordinates/Waypoint(s): Quan B1	
Catch Method: Line	
Laboratory Analysis: Metals	QAQC: SOP
Sample Bagging: Lab Bag	Sample Labelling: Lab
Sign-Off	Name

Sample ID: F3- Platyc 04	Photograph (Y/N): Y
Biota Species (Common): Flathead	(Latin):
Field Mass (g): 302	Length (cm): 35
Angling Species (Y/N): Y	Angling Legal Size (Y/N): Y
Catch Location: Quandolo	
GPS Coordinates/Waypoint(s): Quan-B1	
Catch Method: Line	
Laboratory Analysis: Metals	QAQC: SOP
Sample Bagging: Lab Bag	Sample Labelling: Bag
Sign-Off	Name

Sample ID example: HI_20180508_PLASPP_01

Biota Sampling Sheet

elgin associates

Project Name	Merimbula EIS Stage 2	**Date**	2/10/19
Sampling Personnel	AR, NY.	**Time**	1200 - 1245
Waterway	Merimbula Bay	**Zone**	North - Long/Short - Mid
Sample ID	F1 - Platyc 01	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	289	**Length (cm)**	38
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	Y
Catch Location:	North Alignment - Long/Short midpoint.		
GPS Coordinates/Waypoint(s)	NLS Mid	36° 55.516; 149° 56.614	
Catch Method	Line		
Laboratory Analysis:	Metals	**QAQC**	SOP
Sample Bagging:	Lab	**Sample Labelling:**	Bag
Sign-Off		**Name**	
Sample ID	F1 - Platyc 02	**Photograph (Y/N)**	Y
Biota Species (Common)	Flathead	**(Latin)**	
Field Mass (g)	324	**Length (cm)**	37
Angling Species (Y/N)	Y	**Angling Legal Size (Y/N)**	Y
Catch Location:	NTH Alignment - Long/Short Midpoint		
GPS Coordinates/Waypoint(s)	NLS - Mid	36° 55.516; 144° 56.614	
Catch Method	Line		
Laboratory Analysis:	Metals	**QAQC**	SOP
Sample Bagging:	Lab Bag	**Sample Labelling:**	Bag
Sign-Off		**Name**	

Sample ID example: HI_20180508_PLASPP_01

Biota Sampling Sheet

elgin associates

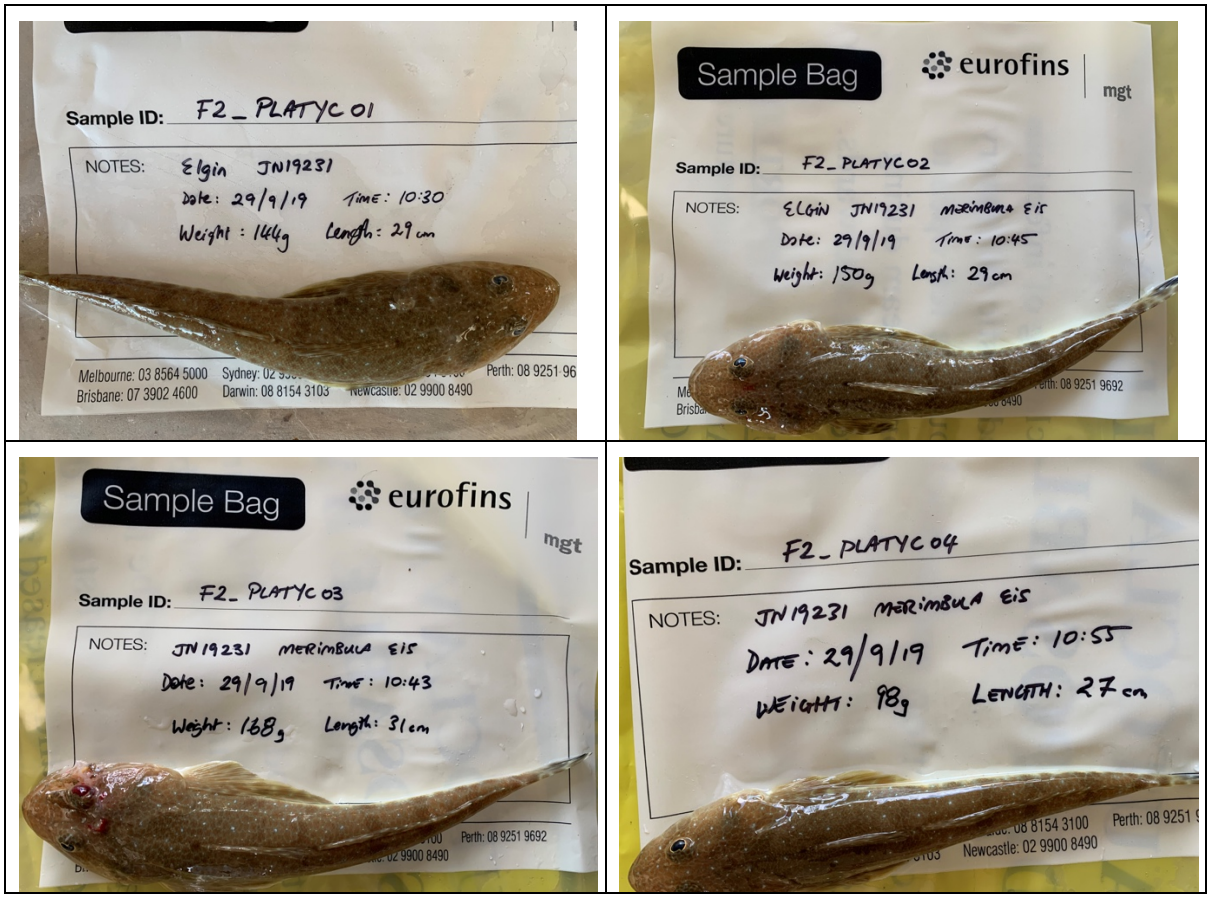
Project Name	Merimbula EIS Stage 2	Date	2/10/19
Sampling Personnel	NM, AR	Time	1200-1245
Waterway	Merimbula Bay	Zone	North - Lay/Shat (mid)

Sample ID: FI-Platyc 03	Photograph (Y/N): Y
Biota Species (Common): Flathead	(Latin):
Field Mass (g): 319	Length (cm): 39
Angling Species (Y/N): Y	Angling Legal Size (Y/N): Y
Catch Location: North Alignment - bay/Shat mid point	
GPS Coordinates/Waypoint(s): NLS-Mid 36°55.516', 144°80.614	
Catch Method: Line	
Laboratory Analysis: Metals	QAQC: SOP
Sample Bagging: Lab Bag	Sample Labelling: Bag
Sign-Off	Name

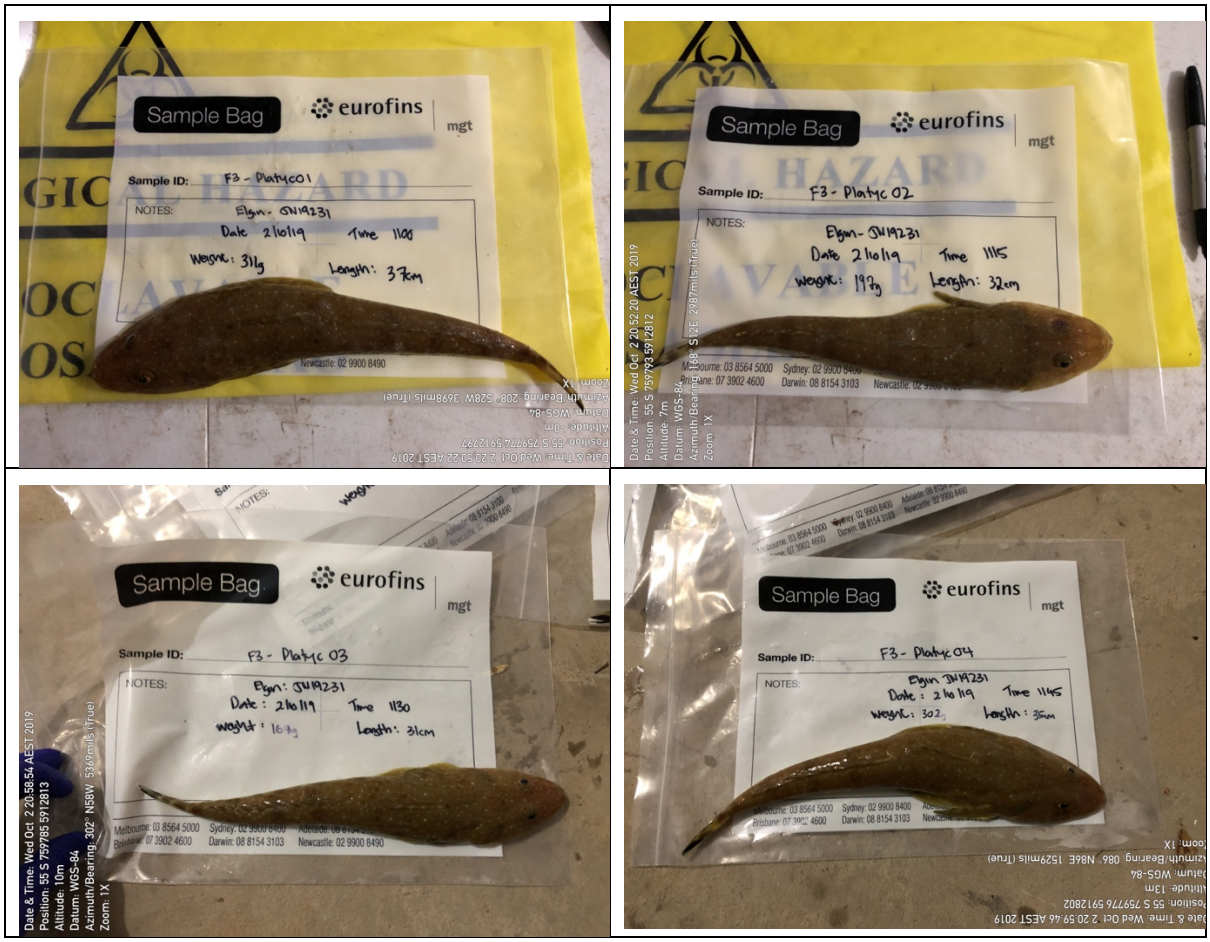
Sample ID: FI-Platyc 04	Photograph (Y/N): Y
Biota Species (Common): Flathead	(Latin):
Field Mass (g): 225	Length (cm): 34
Angling Species (Y/N): Y	Angling Legal Size (Y/N): Y
Catch Location: North Alignment - bay/Shat mid-point	
GPS Coordinates/Waypoint(s): NLS-Mid.	
Catch Method: Line	
Laboratory Analysis: Metals	QAQC: SOP
Sample Bagging: Lab Bag	Sample Labelling: Bag
Sign-Off	Name

Sample ID example: HI_20180508_PLASPP_01

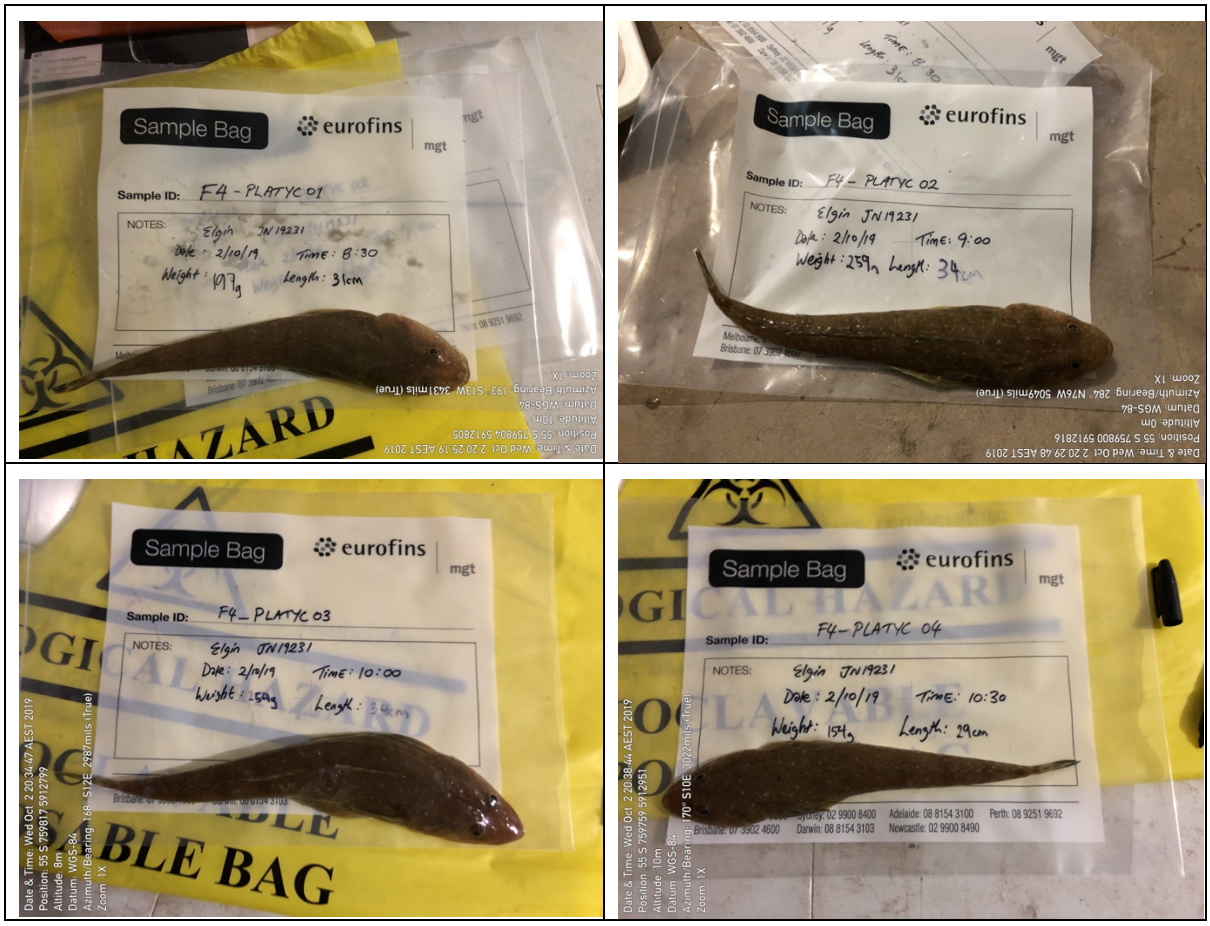
Flathead samples from location F1 – Merimbula Bay within 500 m radius buffer of 'North-Short' diffuser location, and north of Hunter Reef



Flathead samples from location F2 – Merimbula Bay close to Merimbula Offshore Artificial Reef, 1,000m north of 'North-Short' diffuser location.



Flathead samples from location F3 – Quondolo Point, outside of Merimbula Bay, southern reference location.



Flathead samples from location F4 – Tura Beach, outside of Merimbula Bay, northern reference location.

Flathead liver tissue samples (composite from four individuals) from each location F1 to F4.

APPENDIX D-2

Laboratory Analytical Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1932847**	Page	: 1 of 6
Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Contact	: Peter Ravlic
Address	: PO BOX 829 BEGA NSW, AUSTRALIA 2550	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 8003 4590	Telephone	: +6138549 9645
Project	: JN19231	Date Samples Received	: 17-Oct-2019 08:50
Order number	: JN19231	Date Analysis Commenced	: 05-Nov-2019
C-O-C number	: ----	Issue Date	: 07-Nov-2019 15:55
Sampler	: ----		
Site	: Merimbula EIS Stage 2		
Quote number	: ME/755/18		
No. of samples received	: 20		
No. of samples analysed	: 20		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Biota samples analysed and reported as received.

Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	F2-Platyc01	F2-Platyc02	F2-Platyc03	F2-Platyc04	F2-Platyc04Comp
				Client sampling date / time	29-Sep-2019 10:30	29-Sep-2019 10:40	29-Sep-2019 10:50	29-Sep-2019 11:00	29-Sep-2019 00:00
Compound	CAS Number	LOR	Unit		ES1932847-001	ES1932847-002	ES1932847-003	ES1932847-004	ES1932847-005
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**5**	**18**	**20**	**5**	**44**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	F4-Platyc01	F4-Platyc02	F4-Platyc03	F4-Platyc04	F4-Platyc04Comp
				Client sampling date / time	02-Oct-2019 08:30	02-Oct-2019 09:00	02-Oct-2019 10:00	02-Oct-2019 10:30	02-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		ES1932847-006	ES1932847-007	ES1932847-008	ES1932847-009	ES1932847-010
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**17**	**6**	**17**	**5**	**36**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	F3-Platyc01	F3-Platyc02	F3-Platyc03	F3-Platyc04	F3-Platyc04Comp
				Client sampling date / time	02-Oct-2019 11:00	02-Oct-2019 11:15	02-Oct-2019 11:30	02-Oct-2019 11:45	02-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		ES1932847-011	ES1932847-012	ES1932847-013	ES1932847-014	ES1932847-015
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**6**	**5**	**5**	<5	**40**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	F1-Platyc01	F1-Platyc02	F1-Platyc03	F1-Platyc04	F1-Platyc04Comp
				Client sampling date / time	02-Oct-2019 12:00	02-Oct-2019 12:15	02-Oct-2019 12:30	02-Oct-2019 12:45	02-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		ES1932847-016	ES1932847-017	ES1932847-018	ES1932847-019	ES1932847-020
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**6**	<5	**5**	**6**	**44**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1932847**	Page	: 1 of 3
Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Contact	: Peter Ravlic
Address	: PO BOX 829 BEGA NSW, AUSTRALIA 2550	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 8003 4590	Telephone	: +6138549 9645
Project	: JN19231	Date Samples Received	: 17-Oct-2019
Order number	: JN19231	Date Analysis Commenced	: 05-Nov-2019
C-O-C number	: ----	Issue Date	: 07-Nov-2019
Sampler	: ----		
Site	: Merimbula EIS Stage 2		
Quote number	: ME/755/18		
No. of samples received	: 20		
No. of samples analysed	: 20		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **BIOTA**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 2682654)									
ES1932847-001	F2-Platyc01	EG005-B: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005-B: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Silver	7440-22-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Zinc	7440-66-6	5	mg/kg	5	17	102	No Limit
ES1932847-010	F4-Platyc04Comp	EG005-B: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005-B: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Silver	7440-22-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Zinc	7440-66-6	5	mg/kg	36	41	14.7	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2682655)									
ES1932847-001	F2-Platyc01	EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
ES1932847-010	F4-Platyc04Comp	EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **BIOTA**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 2682654)								
EG005-B: Cadmium	7440-43-9	1	mg/kg	<1	0.306 mg/kg	84.7	70.0	130
EG005-B: Chromium	7440-47-3	2	mg/kg	<2	1.87 mg/kg	84.6	70.0	130
EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	----	----	----	----
EG005-B: Copper	7440-50-8	5	mg/kg	<5	15.9 mg/kg	95.2	70.0	130
EG005-B: Lead	7439-92-1	5	mg/kg	<5	----	----	----	----
EG005-B: Nickel	7440-02-0	2	mg/kg	<2	1.36 mg/kg	87.0	70.0	130
EG005-B: Selenium	7782-49-2	5	mg/kg	<5	3.56 mg/kg	97.2	70.0	130
EG005-B: Silver	7440-22-4	2	mg/kg	<2	----	----	----	----
EG005-B: Zinc	7440-66-6	5	mg/kg	<5	52.2 mg/kg	99.2	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2682655)								
EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.41 mg/kg	76.9	70.0	130

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **BIOTA**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 2682654)							
ES1932847-001	F2-Platyc01	EG005-B: Cadmium	7440-43-9	6.25 mg/kg	95.0	70.0	130
		EG005-B: Chromium	7440-47-3	25 mg/kg	95.6	70.0	130
		EG005-B: Cobalt	7440-48-4	25 mg/kg	95.0	70.0	130
		EG005-B: Copper	7440-50-8	25 mg/kg	94.2	70.0	130
		EG005-B: Lead	7439-92-1	25 mg/kg	92.2	70.0	130
		EG005-B: Nickel	7440-02-0	25 mg/kg	94.1	70.0	130
		EG005-B: Zinc	7440-66-6	25 mg/kg	130	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2682655)							
ES1932847-001	F2-Platyc01	EG035-B: Mercury	7439-97-6	5 mg/kg	84.0	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1932847**	Page	: 1 of 4
Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Telephone	: +6138549 9645
Project	: JN19231	Date Samples Received	: 17-Oct-2019
Site	: Merimbula EIS Stage 2	Issue Date	: 07-Nov-2019
Sampler	: ----	No. of samples received	: 20
Order number	: JN19231	No. of samples analysed	: 20

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **BIOTA**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG005(ED093)T: Total Metals by ICP-AES							
Frozen Sample (EG005-B)							
F4-Platyc01, F4-Platyc02, F4-Platyc03, F4-Platyc04, F4-Platyc04Comp, F3-Platyc01, F3-Platyc02, F3-Platyc03, F3-Platyc04, F3-Platyc04Comp, F1-Platyc01, F1-Platyc02, F1-Platyc03, F1-Platyc04, F1-Platyc04Comp	**02-Oct-2019**	**05-Nov-2019**	30-Mar-2020	✓	**05-Nov-2019**	30-Mar-2020	✓
Frozen Sample (EG005-B)							
F2-Platyc01, F2-Platyc02, F2-Platyc03, F2-Platyc04, F2-Platyc04Comp	**29-Sep-2019**	**05-Nov-2019**	27-Mar-2020	✓	**05-Nov-2019**	27-Mar-2020	✓
EG035T: Total Recoverable Mercury by FIMS							
Frozen Sample (EG035-B)							
F4-Platyc01, F4-Platyc02, F4-Platyc03, F4-Platyc04, F4-Platyc04Comp, F3-Platyc01, F3-Platyc02, F3-Platyc03, F3-Platyc04, F3-Platyc04Comp, F1-Platyc01, F1-Platyc02, F1-Platyc03, F1-Platyc04, F1-Platyc04Comp	**02-Oct-2019**	**05-Nov-2019**	30-Mar-2020	✓	**06-Nov-2019**	30-Mar-2020	✓
Frozen Sample (EG035-B)							
F2-Platyc01, F2-Platyc02, F2-Platyc03, F2-Platyc04, F2-Platyc04Comp	**29-Sep-2019**	**05-Nov-2019**	27-Mar-2020	✓	**06-Nov-2019**	27-Mar-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **BIOTA**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Metals in Biota by ICP-AES	EG005-B	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035-B	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Metals in Biota by ICP-AES	EG005-B	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035-B	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Metals in Biota by ICP-AES	EG005-B	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035-B	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Metals in Biota by ICP-AES	EG005-B	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035-B	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Metals in Biota by ICP-AES	EG005-B	BIOTA	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the material. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards.
Total Mercury by FIMS	EG035-B	BIOTA	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve.

Preparation Methods	Method	Matrix	Method Descriptions
Hot Block Digest for metals in biota	EN69	BIOTA	In house: Referenced to USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils.

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES1932847**

Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Contact	: Peter Ravlic
Address	: PO BOX 829 BEGA NSW, AUSTRALIA 2550	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: nick.yee@elgin.com.au	E-mail	: peter.ravlic@alsglobal.com
Telephone	: +61 02 8003 4590	Telephone	: +6138549 9645
Facsimile	: +61 03 8648 6336	Facsimile	: +61-2-8784 8500
Project	: JN19231	Page	: 1 of 2
Order number	: JN19231	Quote number	: EM2018ELGASS0015 (ME/755/18)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: Merimbula EIS Stage 2		
Sampler	:		

Dates

Date Samples Received	: 17-Oct-2019 08:50	Issue Date	: 17-Oct-2019
Client Requested Due Date	: 07-Nov-2019	Scheduled Reporting Date	: **07-Nov-2019**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: 1.6 - Ice Bricks present
Receipt Detail	:	No. of samples received / analysed	: 20 / 20

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **BIOTA**

Laboratory sample ID	Client sampling date / time	Client sample ID	BIOTA - EG005/EG035-B Metals in Biota (inc. mercury)
ES1932847-001	29-Sep-2019 10:30	F2-Platyc01	✓
ES1932847-002	29-Sep-2019 10:40	F2-Platyc02	✓
ES1932847-003	29-Sep-2019 10:50	F2-Platyc03	✓
ES1932847-004	29-Sep-2019 11:00	F2-Platyc04	✓
ES1932847-005	29-Sep-2019 00:00	F2-Platyc04Comp	✓
ES1932847-006	02-Oct-2019 08:30	F4-Platyc01	✓
ES1932847-007	02-Oct-2019 09:00	F4-Platyc02	✓
ES1932847-008	02-Oct-2019 10:00	F4-Platyc03	✓
ES1932847-009	02-Oct-2019 10:30	F4-Platyc04	✓
ES1932847-010	02-Oct-2019 00:00	F4-Platyc04Comp	✓
ES1932847-011	02-Oct-2019 11:00	F3-Platyc01	✓
ES1932847-012	02-Oct-2019 11:15	F3-Platyc02	✓
ES1932847-013	02-Oct-2019 11:30	F3-Platyc03	✓
ES1932847-014	02-Oct-2019 11:45	F3-Platyc04	✓
ES1932847-015	02-Oct-2019 00:00	F3-Platyc04Comp	✓
ES1932847-016	02-Oct-2019 12:00	F1-Platyc01	✓
ES1932847-017	02-Oct-2019 12:15	F1-Platyc02	✓
ES1932847-018	02-Oct-2019 12:30	F1-Platyc03	✓
ES1932847-019	02-Oct-2019 12:45	F1-Platyc04	✓
ES1932847-020	02-Oct-2019 00:00	F1-Platyc04Comp	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

LUKE FINLEY

- A4 - AU Tax Invoice (INV)	Email	luke.finley@elgin.com.au

NICK YEE

- *AU Certificate of Analysis - NATA (COA)	Email	nick.yee@elgin.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	nick.yee@elgin.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	nick.yee@elgin.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	nick.yee@elgin.com.au
- A4 - AU Tax Invoice (INV)	Email	nick.yee@elgin.com.au
- Chain of Custody (CoC) (COC)	Email	nick.yee@elgin.com.au
- EDI Format - ENMRG (ENMRG)	Email	nick.yee@elgin.com.au
- EDI Format - ESDAT (ESDAT)	Email	nick.yee@elgin.com.au

CHAIN OF CUSTODY DOCUMENTATION

CLIENT: Elgin Associates Pty Ltd		SAMPLER: Nick Yee / Andrew Roberts	ALS Environmental Pty Ltd, 277-289 Woodpark Rd, Smithfield, NSW, 2164, ph: 02 8784 8555
ADDRESS / OFFICE: First Floor, 45-47 Church St, Bega, NSW, 2550		MOBILE: 0400 965234 / 0420 981 345	
PROJECT MANAGER (PM): Nick Yee		PHONE	
PROJECT ID: JN19231		EMAIL REPORT TO: nick.yee@elgin.com.au	
SITE: Merimbula EIS Stage 2	P.O. No.: JN19231	EMAIL INVOICE TO: (if different to report)	
RESULTS REQUIRED (Date): Standard TAT	QUOTE NO.: ME/755/18 V2	ANALYSIS REQUIRED	

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No (N/A)
SAMPLE TEMPERATURE 5.2
CHILLED: Yes No

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

Please keep all samples in extended storage for possible additional analysis at later time

ALS to underake dissection of organs for analysis (flesh or liver), including compositing if indicated on COC

LAB ID	SAMPLE ID	MATRIX	DATE	Time	CONTAINER INFORMATION Type / Code	Total bottles	Metals - Cd, Cr, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Zn	HOLD	Compositing Instructions if applicable	Biota Organ for Analysis
1	F2 - Platyc Φ1	B	29/9/19	1030	Bag	1	✓			Flesh
2	F2 - Platyc Φ2	B	29/9/19	1040	Bag	1	✓			Flesh
3	F2 - Platyc Φ3	B	29/9/19	1050	Bag	1	✓			Flesh
4	F2 - Platyc Φ4	B	29/9/19	1100	Bag	1	✓			Flesh
5	F2 - Platyc Φ1-Φ4 Comp	B	29/9/19	1030-1100	Composite	1	✓	(1)	Composite livers from F2 Φ1-Φ4 above	Liver
6	F4 - Platyc Φ1	B	2/10/19	830	Bag	1	✓			Flesh
7	F4 - Platyc Φ2	B	2/10/19	0900	Bag	1	✓			Flesh
8	F4 - Platyc 03	B	2/10/19	1000	Bag	1	✓			Flesh
9	F4 - Platyc 04	B	2/10/19	1030	Bag	1	✓			Flesh
10	F4 - Platyc 01-04 Comp	B	2/10/19	830-1030	Composite	1	✓	(2)	Composite liver from F4 - 01 -04 above	Liver

RELINQUISHED BY:			RECEIVED BY		METHOD OF SHIPMENT
Name: NICHOLAS YEE	Date: 8/10/19		Name: [illegible]	9/10/19	Con' Note No:
Of: Elgin Associates	Time: 14:30		Of: [illegible]		
Name:	Date:		Name: Shakila	17/10/2019	Transport Co:
Of:	Time:		Of: [illegible]		

Environmental Division
Sydney
Work Order Reference
ES1932847

Telephone : +61-2-8784 8555

CHAIN OF CUSTODY DOCUMENTATION

CLIENT: Elgin Associates Pty Ltd
ADDRESS / OFFICE: First Floor, 45-47 Church St, Bega, NSW, 2550
PROJECT MANAGER (PM): Nick Yee
PROJECT ID: JN9231
SITE: Merimbula EIS Stage 2 — P.O. No.: JN9231
RESULTS REQUIRED (Date): Standard TAT — QUOTE NO.: ME/755/18 V2

SAMPLER: Nick Yee / Andrew Roberts
MOBILE: 0400 385 234 / 0420 981 345
PHONE
EMAIL REPORT TO: nick.yee@elgin.com.au
EMAIL INVOICE TO: (if different to report)

ALS Environmental Pty Ltd, 277-289 Woodpark Rd, Smithfield, NSW, 2164, ph: 02 8784 8555

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No (N/A)
SAMPLE TEMPERATURE: 5.2°C
CHILLED: (Yes) No

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:
Please keep all samples in extended storage for possible additional analysis at later time
ALS to underake dissection of organs for analysis (flesh or liver), including compositing if indicated on COC

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	Time	CONTAINER INFORMATION Type / Code	Total bottles	Metals - Cd, Cr, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Zn	HOLD	Compositing Instructions if applicable	Biota Organ for Analysis
11	F3- Platyc01	B	2/10/19	1100	Bag	1	✓			Flesh
12	F3- Platyc02	B	2/10/19	1115	Bag	1	✓			Flesh
13	F3- Platyc03	B	2/10/19	1130	Bag	1	✓			Flesh
14	F3- Platyc04	B	2/10/19	1145	Bag	1	✓			Flesh
15	F3-Platyc01-04 Comp	B	2/10/19	1100-1145	Bag	1	✓		Composite livers from F3/01-04 above	Liver
16	F1- Platyc01	B	2/10/19	1200	Bag	1	✓			Flesh
17	F1- Platyc02	B	2/10/19	1215	Bag	1	✓			Flesh
18	F1- Platyc03	B	2/10/19	1230	Bag	1	✓			Flesh
19	F1- Platyc04	B	2/10/19	1245	Bag	1	✓			Flesh
20	F1-Platyc01-04 Comp	B	2/10/19	1200-1245	Bag	1	✓		Composite livers from F1/01-04 above	Liver

RELINQUISHED BY:

Name:	Date:
Of: Elgin Associates	Time:
Name:	Date:
Of:	Time:

RECEIVED BY

Name:	Fiona Shakeela	9/10/19 or 17/10/2019 08:10AM
Of:		
Name:		
Of:		

METHOD OF SHIPMENT
Con' Note No:
Transport Co:

COC Page 2 of 2

Telephone : +

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2014199**	Page	: 1 of 10
Amendment	: **1**		
Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Contact	: Peter Ravlic
Address	: PO BOX 829 BEGA NSW, AUSTRALIA 2550	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 8003 4590	Telephone	: +6138549 9645
Project	: Bioaccumulation Study	Date Samples Received	: 27-Apr-2020 09:00
Order number	: JN19231	Date Analysis Commenced	: 18-May-2020
C-O-C number	: ----	Issue Date	: 21-May-2020 20:24
Sampler	: NICK YEE		
Site	: Merimbula EIS Stage 2		
Quote number	: ME/755/18		
No. of samples received	: 36		
No. of samples analysed	: 36		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Biota samples analysed and reported as received.

Analytical Results

Sub-Matrix: **BIOTA** (Matrix: **BIOTA**)

Compound	CAS Number	LOR	Unit	Client sample ID	M1 - Mytilus 01	M1 - Mytilus 02	M1 - Mytilus 03	M1 - Mytilus 04	M2 - Mytilus 01
				Client sampling date / time	24-Apr-2020 09:20	24-Apr-2020 09:20	24-Apr-2020 09:20	24-Apr-2020 09:20	24-Apr-2020 09:45
					ES2014199-001	ES2014199-002	ES2014199-003	ES2014199-004	ES2014199-005
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		**2**	**2**	**2**	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**14**	**21**	**12**	**11**	**12**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **BIOTA** (Matrix: **BIOTA**)

Compound	CAS Number	LOR	Unit	Client sample ID	M2 - Mytilus 02	M2 - Mytilus 03	M2 - Mytilus 04	M3 - Mytilus 01	M3 - Mytilus 02
				Client sampling date / time	24-Apr-2020 09:45	24-Apr-2020 09:45	24-Apr-2020 09:45	24-Apr-2020 09:00	24-Apr-2020 09:00
					ES2014199-006	ES2014199-007	ES2014199-008	ES2014199-009	ES2014199-010
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	**1**	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**9**	**15**	**18**	**7**	**17**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **BIOTA** (Matrix: **BIOTA**)

Compound	CAS Number	LOR	Unit	Client sample ID	M3 - Mytilus 03	M3 - Mytilus 04	M4 - Mytilus 01	M4 - Mytilus 02	M4 - Mytilus 03
				Client sampling date / time	24-Apr-2020 09:00	24-Apr-2020 09:00	24-Apr-2020 08:19	24-Apr-2020 08:19	24-Apr-2020 08:19
					ES2014199-011	ES2014199-012	ES2014199-013	ES2014199-014	ES2014199-015
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	**1**
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**8**	**32**	**6**	**12**	**10**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **BIOTA** (Matrix: **BIOTA**)

Compound	CAS Number	LOR	Unit	Client sample ID	M4 - Mytilus 04	M5 - Mytilus 01	M5 - Mytilus 02	M5 - Mytilus 03	M5 - Mytilus 04
				Client sampling date / time	24-Apr-2020 08:19	24-Apr-2020 10:30	24-Apr-2020 10:30	24-Apr-2020 10:30	24-Apr-2020 10:30
					ES2014199-016	ES2014199-017	ES2014199-018	ES2014199-019	ES2014199-020
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	**1**	**1**	<1	**1**
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**5**	**25**	**20**	**13**	**25**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	A1 - Haliotis 01	A1 - Haliotis 02	A1 - Haliotis 03	A1 - Haliotis 04	A2 - Haliotis 01
				Client sampling date / time	24-Apr-2020 10:30	24-Apr-2020 10:30	24-Apr-2020 10:30	24-Apr-2020 09:45	24-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		ES2014199-021	ES2014199-022	ES2014199-023	ES2014199-024	ES2014199-025
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**14**	**14**	**17**	**15**	**14**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	A2 - Haliotis 02	A2 - Haliotis 03	A2 - Haliotis 04	A3 - Haliotis 01	A3 - Haliotis 02
				Client sampling date / time	24-Apr-2020 09:45	24-Apr-2020 09:45	24-Apr-2020 09:45	24-Apr-2020 09:00	24-Apr-2020 09:00
Compound	CAS Number	LOR	Unit		ES2014199-026	ES2014199-027	ES2014199-028	ES2014199-029	ES2014199-030
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**14**	**11**	**11**	**13**	**12**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **BIOTA** (Matrix: **BIOTA**)

Compound	CAS Number	LOR	Unit	Client sample ID	A3 - Haliotis 03	A3 - Haliotis 04	A4 - Haliotis 01	A4 - Haliotis 02	A4 - Haliotis 03
				Client sampling date / time	24-Apr-2020 09:00	24-Apr-2020 09:00	24-Apr-2020 07:50	24-Apr-2020 07:50	24-Apr-2020 08:19
					ES2014199-031	ES2014199-032	ES2014199-033	ES2014199-034	ES2014199-035
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Cobalt	7440-48-4	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg		**12**	**15**	**9**	**17**	**11**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **BIOTA** (Matrix: **BIOTA**)				Client sample ID	**A4 - Haliotis 04**	**----**	**----**	**----**	**----**
				Client sampling date / time	24-Apr-2020 08:19	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**ES2014199-036**	**--------**	**--------**	**--------**	**--------**
					Result	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Cadmium	7440-43-9	1	mg/kg		<1	**----**	**----**	**----**	**----**
Chromium	7440-47-3	2	mg/kg		<2	**----**	**----**	**----**	**----**
Cobalt	7440-48-4	2	mg/kg		<2	**----**	**----**	**----**	**----**
Copper	7440-50-8	5	mg/kg		<5	**----**	**----**	**----**	**----**
Lead	7439-92-1	5	mg/kg		<5	**----**	**----**	**----**	**----**
Nickel	7440-02-0	2	mg/kg		<2	**----**	**----**	**----**	**----**
Selenium	7782-49-2	5	mg/kg		<5	**----**	**----**	**----**	**----**
Silver	7440-22-4	2	mg/kg		<2	**----**	**----**	**----**	**----**
Zinc	7440-66-6	5	mg/kg		**9**	**----**	**----**	**----**	**----**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	**----**	**----**	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES2014199**	Page	: 1 of 5
Amendment	: **1**		
Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Contact	: Peter Ravlic
Address	: PO BOX 829 BEGA NSW, AUSTRALIA 2550	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 8003 4590	Telephone	: +6138549 9645
Project	: Bioaccumulation Study	Date Samples Received	: 27-Apr-2020
Order number	: JN19231	Date Analysis Commenced	: 18-May-2020
C-O-C number	: ----	Issue Date	: 21-May-2020
Sampler	: NICK YEE		
Site	: Merimbula EIS Stage 2		
Quote number	: ME/755/18		
No. of samples received	: 36		
No. of samples analysed	: 36		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **BIOTA**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 3026272)									
ES2014199-001	M1 - Mytilus 01	EG005-B: Cadmium	7440-43-9	1	mg/kg	2	2	0.00	No Limit
		EG005-B: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Silver	7440-22-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Zinc	7440-66-6	5	mg/kg	14	17	19.7	No Limit
ES2014199-010	M3 - Mytilus 02	EG005-B: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005-B: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Silver	7440-22-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Zinc	7440-66-6	5	mg/kg	17	16	9.32	No Limit
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 3026275)									
ES2014199-021	A1 - Haliotis 01	EG005-B: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005-B: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Silver	7440-22-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit

Sub-Matrix: **BIOTA**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 3026275) - continued									
ES2014199-021	A1 - Haliotis 01	EG005-B: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Zinc	7440-66-6	5	mg/kg	14	14	0.00	No Limit
ES2014199-030	A3 - Haliotis 02	EG005-B: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005-B: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Silver	7440-22-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005-B: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005-B: Zinc	7440-66-6	5	mg/kg	12	12	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3026273)									
ES2014199-001	M1 - Mytilus 01	EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
ES2014199-010	M3 - Mytilus 02	EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3026274)									
ES2014199-021	A1 - Haliotis 01	EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
ES2014199-030	A3 - Haliotis 02	EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **BIOTA**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3026272)								
EG005-B: Cadmium	7440-43-9	1	mg/kg	<1	0.306 mg/kg	90.3	70.0	130
EG005-B: Chromium	7440-47-3	2	mg/kg	<2	1.87 mg/kg	85.2	70.0	130
EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	----	----	----	----
EG005-B: Copper	7440-50-8	5	mg/kg	<5	15.9 mg/kg	95.3	70.0	130
EG005-B: Lead	7439-92-1	5	mg/kg	<5	----	----	----	----
EG005-B: Nickel	7440-02-0	2	mg/kg	<2	1.36 mg/kg	94.8	70.0	130
EG005-B: Selenium	7782-49-2	5	mg/kg	<5	3.56 mg/kg	75.6	70.0	130
EG005-B: Silver	7440-22-4	2	mg/kg	<2	----	----	----	----
EG005-B: Zinc	7440-66-6	5	mg/kg	<5	52.2 mg/kg	91.0	70.0	130
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3026275)								
EG005-B: Cadmium	7440-43-9	1	mg/kg	<1	0.306 mg/kg	91.7	70.0	130
EG005-B: Chromium	7440-47-3	2	mg/kg	<2	1.87 mg/kg	102	70.0	130
EG005-B: Cobalt	7440-48-4	2	mg/kg	<2	----	----	----	----
EG005-B: Copper	7440-50-8	5	mg/kg	<5	15.9 mg/kg	94.0	70.0	130
EG005-B: Lead	7439-92-1	5	mg/kg	<5	----	----	----	----
EG005-B: Nickel	7440-02-0	2	mg/kg	<2	1.36 mg/kg	122	70.0	130
EG005-B: Selenium	7782-49-2	5	mg/kg	<5	3.56 mg/kg	83.2	70.0	130
EG005-B: Silver	7440-22-4	2	mg/kg	<2	----	----	----	----
EG005-B: Zinc	7440-66-6	5	mg/kg	<5	52.2 mg/kg	90.5	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3026273)								
EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.41 mg/kg	71.9	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3026274)								
EG035-B: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.41 mg/kg	75.6	70.0	130

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **BIOTA**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3026272)							
ES2014199-001	M1 - Mytilus 01	EG005-B: Cadmium	7440-43-9	6.25 mg/kg	127	70.0	130
		EG005-B: Zinc	7440-66-6	25 mg/kg	125	70.0	130

Sub-Matrix: **BIOTA**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3026275)							
ES2014199-021	A1 - Haliotis 01	EG005-B: Zinc	7440-66-6	25 mg/kg	123	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3026273)							
ES2014199-001	M1 - Mytilus 01	EG035-B: Mercury	7439-97-6	5 mg/kg	88.7	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3026274)							
ES2014199-021	A1 - Haliotis 01	EG035-B: Mercury	7439-97-6	5 mg/kg	95.7	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES2014199**	Page	: 1 of 5
Amendment	: **1**		
Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Telephone	: +6138549 9645
Project	: Bioaccumulation Study	Date Samples Received	: 27-Apr-2020
Site	: Merimbula EIS Stage 2	Issue Date	: 21-May-2020
Sampler	: NICK YEE	No. of samples received	: 36
Order number	: JN19231	No. of samples analysed	: 36

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **BIOTA**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG005(ED093)T: Total Metals by ICP-AES								
Frozen Sample (EG005-B)								
M1 - Mytilus 01,	M1 - Mytilus 02,	**24-Apr-2020**	**18-May-2020**	21-Oct-2020	✓	**18-May-2020**	21-Oct-2020	✓
M1 - Mytilus 03,	M1 - Mytilus 04,							
M2 - Mytilus 01,	M2 - Mytilus 02,							
M2 - Mytilus 03,	M2 - Mytilus 04,							
M3 - Mytilus 01,	M3 - Mytilus 02,							
M3 - Mytilus 03,	M3 - Mytilus 04,							
M4 - Mytilus 01,	M4 - Mytilus 02,							
M4 - Mytilus 03,	M4 - Mytilus 04,							
M5 - Mytilus 01,	M5 - Mytilus 02,							
M5 - Mytilus 03,	M5 - Mytilus 04,							
A1 - Haliotis 01,	A1 - Haliotis 02,							
A1 - Haliotis 03,	A1 - Haliotis 04,							
A2 - Haliotis 01,	A2 - Haliotis 02,							
A2 - Haliotis 03,	A2 - Haliotis 04,							
A3 - Haliotis 01,	A3 - Haliotis 02,							
A3 - Haliotis 03,	A3 - Haliotis 04,							
A4 - Haliotis 01,	A4 - Haliotis 02,							
A4 - Haliotis 03,	A4 - Haliotis 04							

Matrix: **BIOTA**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS							
Frozen Sample (EG035-B)							
M1 - Mytilus 01, M1 - Mytilus 02, M1 - Mytilus 03, M1 - Mytilus 04, M2 - Mytilus 01, M2 - Mytilus 02, M2 - Mytilus 03, M2 - Mytilus 04, M3 - Mytilus 01, M3 - Mytilus 02, M3 - Mytilus 03, M3 - Mytilus 04, M4 - Mytilus 01, M4 - Mytilus 02, M4 - Mytilus 03, M4 - Mytilus 04, M5 - Mytilus 01, M5 - Mytilus 02, M5 - Mytilus 03, M5 - Mytilus 04, A1 - Haliotis 01, A1 - Haliotis 02, A1 - Haliotis 03, A1 - Haliotis 04, A2 - Haliotis 01, A2 - Haliotis 02, A2 - Haliotis 03, A2 - Haliotis 04, A3 - Haliotis 01, A3 - Haliotis 02, A3 - Haliotis 03, A3 - Haliotis 04, A4 - Haliotis 01, A4 - Haliotis 02, A4 - Haliotis 03, A4 - Haliotis 04	**24-Apr-2020**	**18-May-2020**	21-Oct-2020	✓	**19-May-2020**	21-Oct-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **BIOTA**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Metals in Biota by ICP-AES	EG005-B	4	36	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035-B	4	36	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Metals in Biota by ICP-AES	EG005-B	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035-B	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Metals in Biota by ICP-AES	EG005-B	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035-B	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Metals in Biota by ICP-AES	EG005-B	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035-B	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Metals in Biota by ICP-AES	EG005-B	BIOTA	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the material. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards.
Total Mercury by FIMS	EG035-B	BIOTA	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve.

Preparation Methods	Method	Matrix	Method Descriptions
Hot Block Digest for metals in biota	EN69	BIOTA	In house: Referenced to USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils.

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES2014199**

Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Contact	: Peter Ravlic
Address	: PO BOX 829 BEGA NSW, AUSTRALIA 2550	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: nick.yee@elgin.com.au	E-mail	: peter.ravlic@alsglobal.com
Telephone	: +61 02 8003 4590	Telephone	: +6138549 9645
Facsimile	: +61 03 8648 6336	Facsimile	: +61-2-8784 8500
Project	: Bioaccumulation Study	Page	: 1 of 3
Order number	: JN19231	Quote number	: EM2018ELGASS0015 (ME/755/18)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: Merimbula EIS Stage 2		
Sampler	: NICK YEE		

Dates

Date Samples Received	: 27-Apr-2020 09:00	Issue Date	: 28-Apr-2020
Client Requested Due Date	: 19-May-2020	Scheduled Reporting Date	: **19-May-2020**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: 6.4'C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 36 / 36

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **BIOTA**

Laboratory sample ID	Client sampling date / time	Client sample ID	BIOTA - EG005/EG035-B Metals in Biota (inc. mercury)
ES2014199-001	24-Apr-2020 09:20	M1 - Mytilus 01	✓
ES2014199-002	24-Apr-2020 09:20	M1 - Mytilus 02	✓
ES2014199-003	24-Apr-2020 09:20	M1 - Mytilus 03	✓
ES2014199-004	24-Apr-2020 09:20	M1 - Mytilus 04	✓
ES2014199-005	24-Apr-2020 09:45	M2 - Mytilus 01	✓
ES2014199-006	24-Apr-2020 09:45	M2 - Mytilus 02	✓
ES2014199-007	24-Apr-2020 09:45	M2 - Mytilus 03	✓
ES2014199-008	24-Apr-2020 09:45	M2 - Mytilus 04	✓
ES2014199-009	24-Apr-2020 09:00	M3 - Mytilus 01	✓
ES2014199-010	24-Apr-2020 09:00	M3 - Mytilus 02	✓
ES2014199-011	24-Apr-2020 09:00	M3 - Mytilus 03	✓
ES2014199-012	24-Apr-2020 09:00	M3 - Mytilus 04	✓
ES2014199-013	24-Apr-2020 08:19	M4 - Mytilus 01	✓
ES2014199-014	24-Apr-2020 08:19	M4 - Mytilus 02	✓
ES2014199-015	24-Apr-2020 08:19	M4 - Mytilus 03	✓
ES2014199-016	24-Apr-2020 08:19	M4 - Mytilus 04	✓
ES2014199-017	24-Apr-2020 10:30	M5 - Mytilus 01	✓
ES2014199-018	24-Apr-2020 10:30	M5 - Mytilus 02	✓
ES2014199-019	24-Apr-2020 10:30	M5 - Mytilus 03	✓
ES2014199-020	24-Apr-2020 10:30	M5 - Mytilus 04	✓
ES2014199-021	24-Apr-2020 10:30	A1 - Haliotis 01	✓
ES2014199-022	24-Apr-2020 10:30	A1 - Haliotis 02	✓
ES2014199-023	24-Apr-2020 10:30	A1 - Haliotis 03	✓
ES2014199-024	24-Apr-2020 09:45	A1 - Haliotis 04	✓
ES2014199-025	24-Apr-2020 00:00	A2 - Haliotis 01	✓
ES2014199-026	24-Apr-2020 09:45	A2 - Haliotis 02	✓
ES2014199-027	24-Apr-2020 09:45	A2 - Haliotis 03	✓
ES2014199-028	24-Apr-2020 09:45	A2 - Haliotis 04	✓
ES2014199-029	24-Apr-2020 09:00	A3 - Haliotis 01	✓
ES2014199-030	24-Apr-2020 09:00	A3 - Haliotis 02	✓
ES2014199-031	24-Apr-2020 09:00	A3 - Haliotis 03	✓
ES2014199-032	24-Apr-2020 09:00	A3 - Haliotis 04	✓
ES2014199-033	24-Apr-2020 07:50	A4 - Haliotis 01	✓
ES2014199-034	24-Apr-2020 07:50	A4 - Haliotis 02	✓
ES2014199-035	24-Apr-2020 08:19	A4 - Haliotis 03	✓

			BIOTA - EG005/EG035-B Metals in Biota (inc. mercury)
ES2014199-036	24-Apr-2020 08:19	A4 - Haliotis 04	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ANDREW ROBERTS

- *AU Certificate of Analysis - NATA (COA)	Email	andrew.roberts@elgin.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	andrew.roberts@elgin.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	andrew.roberts@elgin.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	andrew.roberts@elgin.com.au
- Chain of Custody (CoC) (COC)	Email	andrew.roberts@elgin.com.au
- EDI Format - ESDAT (ESDAT)	Email	andrew.roberts@elgin.com.au
- EDI Format - XTab (XTAB)	Email	andrew.roberts@elgin.com.au

LUKE FINLEY

- A4 - AU Tax Invoice (INV)	Email	luke.finley@elgin.com.au

NICK YEE

- *AU Certificate of Analysis - NATA (COA)	Email	nick.yee@elgin.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	nick.yee@elgin.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	nick.yee@elgin.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	nick.yee@elgin.com.au
- A4 - AU Tax Invoice (INV)	Email	nick.yee@elgin.com.au
- Chain of Custody (CoC) (COC)	Email	nick.yee@elgin.com.au
- EDI Format - ESDAT (ESDAT)	Email	nick.yee@elgin.com.au
- EDI Format - XTab (XTAB)	Email	nick.yee@elgin.com.au

CHAIN OF CUSTODY DOCUMENTATION

Environmental Division Sydney
Work Order Reference
ES2014199

Telephone : + 61-2-8784 8555

CLIENT: Elgin Associates Pty Ltd		SAMPLER: NICHOLAS YEE	
ADDRESS / OFFICE: First Floor, 45-47 Church St, Bega, NSW, 2550		MOBILE: 0400 365 234	
PROJECT MANAGER (PM): Nick Yee		PHONE	
PROJECT ID: JN19231 BIOACCUMULATION STUDY		EMAIL REPORT TO: nick.yee@elgin.com.au andrew.roberts@elgin.com.au	
SITE: Merimbula EIS Stage 2	P.O. No.: JN19231	EMAIL INVOICE TO: (if different to report) nick.yee@elgin.com.au luke.finley@elgin.com.au	
RESULTS REQUIRED (Date): Standard TAT	QUOTE NO.: ME/755/18 V2	ANALYSIS REQUIRED	

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No N/A
SAMPLE TEMPERATURE:
CHILLED: Yes No

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

Please keep all samples in extended storage for possible additional analysis at later time

Zinc and Copper LOR of 0.5 mg/kg

LAB ID	SAMPLE ID	MATRIX	DATE	Time	Type / Code	Total bottles	Metals - Cd, Cr, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Zn	HOLD	Compositing Instructions if applicable	Biota Organ for Analysis	
1	M1 – Mytilus 01	B	24/4/20	9:20	BAG	1	✓		composite of 4 individuals, 60g	Flesh	Hunter Reef
2	M1 - Mytilus02	B	24/4/20	9:20	BAG	1	✓		" " 4 " , 65g	Flesh	
3	M1 – Mytilus 03	B	24/4/20	9:20	BAG	1	✓		" " 4 " , 73g	Flesh	
4	M1 – Mytilus 04	B	24/4/20	9:20	BAG	1	✓		" " 4 " , 66g	Flesh	
5	M2 – Mytilus01	B	24/4/20	9:45	BAG	1	✓		" " 4 " , 60g	Flesh	Haycock Pt
6	M2 - Mytilus 02	B	24/4/20	9:45	BAG	1	✓		" " 4 " , 70g	Flesh	
7	M2 – Mytilus03	B	24/4/20	9:45	BAG	1	✓		" " 4 " , 72g	Flesh	
8	M2 – Mytilus 04	B	24/4/20	9:45	BAG	1	✓		" " 4 " , 56g	Flesh	
9	M3 – Mytilus 01	B	24/4/20	9:00	BAG	1	✓		" " 4 " , 85g	Flesh	Long Point
10	M3 – Mytilus 02	B	24/4/20	9:00	BAG	1	✓		" " 4 " , 62g	Flesh	
11	M3 – Mytilus 03	B	24/4/20	9:00	BAG	1	✓		" " 4 " , 80g	Flesh	
12	M3 – Mytilus 04	B	24/4/20	9:00	BAG	1	✓		" " 4 " , 78g	Flesh	
13	M4 – Mytilus 01	B	24/4/20	8:19	BAG	1	✓		" " 4 " , 90g	Flesh	Tuka Head
14	M4 – Mytilus 02	B	24/4/20	8:19	BAG	1	✓		" " 4 " , 82g	Flesh	
15	M4 – Mytilus 03	B	24/4/20	8:19	BAG	1	✓		" " 4 " , 95g	Flesh	
16	M4 – Mytilus 04	B	24/4/20	8:19	BAG	1	✓		" " 4 " , 90g	Flesh	
17	M5 – Mytilus 01	B	24/4/20	10:30	BAG	1	✓		" " 6 " , 50g	Flesh	Leonards Is.
18	M5 – Mytilus 02	B	24/4/20	10:30	BAG	1	✓		" " 6 " , 35g	Flesh	
19	M5 – Mytilus 03	B	24/4/20	10:30	BAG	1	✓		" " 6 " , 34g	Flesh	
20	M5 – Mytilus 04	B	24/4/20	10:30	BAG	1	✓		" " 6 " , 40g	Flesh	
					TOTAL	20					

RELINQUISHED BY:		RECEIVED BY:		METHOD OF SHIPMENT
Name: NICHOLAS YEE	Date: 27/4/20	Name:	28/4/20	Con' Note No:
Of: Elgin Associates	Time: 14:00	Of:		
Name:	Date:	Name:		Transport Co:
Of:	Time:	Of:		

CHAIN OF CUSTODY DOCUMENTATION

CLIENT: Elgin Associates Pty Ltd		SAMPLER: NICHOLAS YEE	ALS Environmental Pty Ltd, 277-289 Woodpark Rd, Smithfield, NSW, 2164, ph: 02 8784 8555
ADDRESS / OFFICE: First Floor, 45-47 Church St, Bega, NSW, 2550		MOBILE: 0400 365 234	
PROJECT MANAGER (PM): Nick Yee		PHONE	
PROJECT ID: JN19231 BIOACCUMULATION STUDY		EMAIL REPORT TO: nick.yee@elgin.com.au andrew.roberts@elgin.com.au	
SITE: Merimbula EIS Stage 2	P.O. No.: JN19231	EMAIL INVOICE TO: (if different to report) nick.yee@elgin.com.au luke.finley@elgin.com.au	
RESULTS REQUIRED (Date): Standard TAT	QUOTE NO.: ME/755/18 V2	ANALYSIS REQUIRED	

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No N/A
SAMPLE TEMPERATURE
CHILLED: Yes No

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

Please keep all samples in extended storage for possible additional analysis at later time

Zinc and Copper LOR of 0.5 mg/kg

LAB ID	SAMPLE ID	MATRIX	DATE	Time	CONTAINER INFORMATION Type / Code	Total bottles	Metals - Cd, Cr, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Zn	HOLD	Compositing Instructions if applicable	Biota Organ for Analysis	
21	A1 - Haliotis 01	B	24/4/20	10:30	BAG	1	✓		x1 individual, 127 g	FLESH	Lennards Is.
22	A1 - Haliotis 02	B	24/4/20	10:30	BAG	1	✓		" " , 112 g	FLESH	
23	A1 - Haliotis 03	B	24/4/20	10:30	BAG	1	✓		" " , 125 g	FLESH	
24	A1 - Haliotis 04	B	24/4/20	10:30	BAG	1	✓		" " , 140 g	FLESH	
25	A2 - Haliotis 01	B	24/4/20	9:45	BAG	1	✓		" " , 122 g	Flesh	Haycock Point
26	A2 - Haliotis 02	B	24/4/20	9:45	BAG	1	✓		" " , 133 g	Flesh	
27	A2 - Haliotis 03	B	24/4/20	9:45	BAG	1	✓		" " , 120 g	Flesh	
28	A2 - Haliotis 04	B	24/4/20	9:45	BAG	1	✓		" " , 103 g	Flesh	
29	A3 - Haliotis 01	B	24/4/20	9:00	BAG	1	✓		" " , 98 g	Flesh	Long Point
30	A3 - Haliotis 02	B	24/4/20	9:00	BAG	1	✓		" " , 96 g	Flesh	
31	A3 - Haliotis 03	B	24/4/20	9:00	BAG	1	✓		" " , 101 g	Flesh	
32	A3 - Haliotis 04	B	24/4/20	9:00	BAG	1	✓		" " , 118 g	Flesh	
33	A4 - Haliotis 01	B	24/4/20	7:50	BAG	1	✓		" " , 112 g	Flesh	TURA Head
34	A4 - Haliotis 02	B	24/4/20	7:50	BAG	1	✓		" " , 125 g	Flesh	
35	A4 - Haliotis 03	B	24/4/20	8:19	BAG	1	✓		" " , 120 g	Flesh	
36	A4 - Haliotis 04	B	24/4/20	8:19	BAG	1	✓		" " , 118 g	Flesh	
					TOTAL	16					

RELINQUISHED BY:		RECEIVED BY		METHOD OF SHIPMENT
Name: NICHOLAS YEE	Date: 27/4/20	Name:		Con' Note No:
Of: Elgin Associates	Time: 14:00	Of:		
Name:	Date:	Name:		Transport Co:
Of:	Time:	Of:		

APPENDIX E

Stage 1 Pilot Study

Soft Sediment Infauna and Epifauna Community

APPENDIX E

Table E1. Summary of soft sediment infauna sample site coordinates.

Site Code	Distance (m)	Location	Depth (m)	Latitude	Longitude
SIS01	0	Haycock Point	30	-36.94971032	149.955045
SIS02	50	Haycock Point	30	-36.94926281	149.9555379
SIS03	200	Haycock Point	30	-36.94807744	149.9560322
SIS04	400	Haycock Point	30	-36.94661379	149.9575139
SIS05	0	Merimbula Bay	30	-36.92636185	149.9408416
SIS06	50	Merimbula Bay	30	-36.92627074	149.940171
SIS07	200	Merimbula Bay	30	-36.9257177	149.9386415
SIS08	400	Merimbula Bay	30	-36.9251562	149.9362847

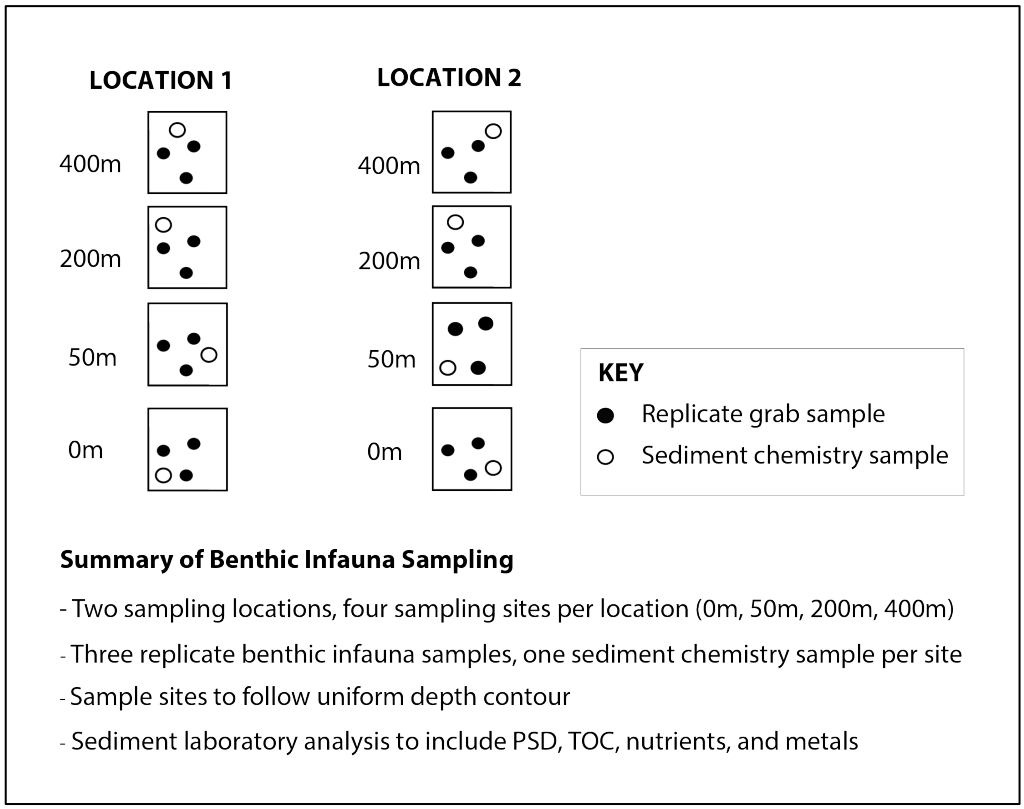


Figure E1. Assessment of soft sediment infauna community - sampling design.

Sample collection and Processing

Sediment sampling was undertaken in accordance with guidelines provided in the CSIRO *Handbook for Sediment Quality Assessment* (CSIRO 2005) and Commonwealth of Australia *National Assessment Guidelines for Dredging* 2009 (NAGD 2009).

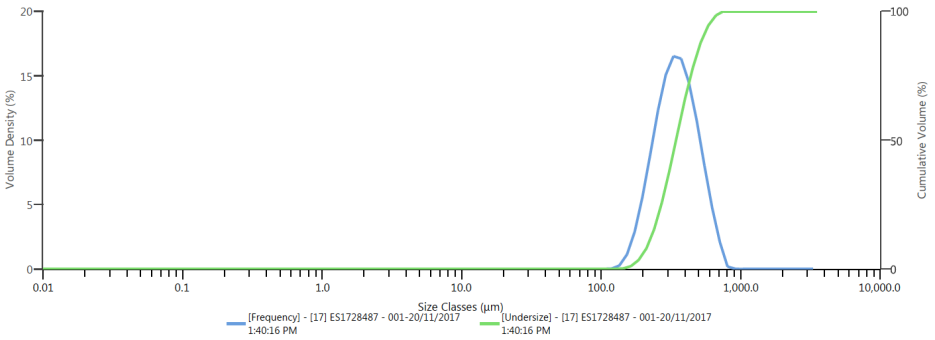
A Van-Veen grab sampler with capacity to sample 0.1m^2 area and 0.005m^3 of sediment was deployed from the work vessel to collect surficial sediments at each site. Upon retrieval, the each sample was emptied into clean plastic tub for field measurement of pH and redox using a field chemistry kit.

Photos of each sediment sample were recorded along with notes describing sediment characteristics such as colour, presence of odours, and grain particle size. A subsample of sediments for chemistry

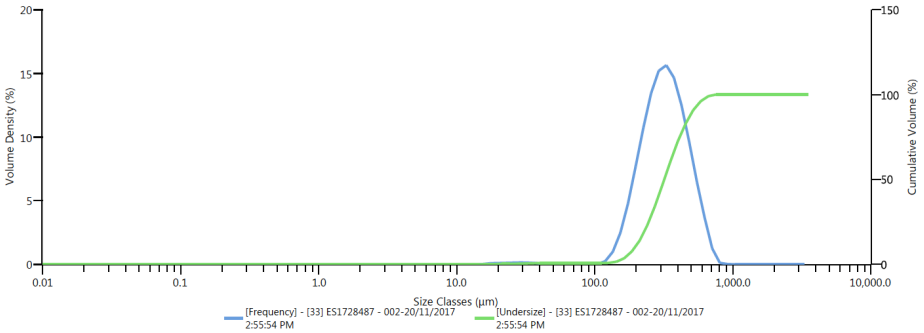
analysis were transferred into clean laboratory-supplied bags for laboratory analysis and placed in a chilled esky under chain of custody documentation.

Remaining sediments were sieved through 1.0mm mesh, with the retained sediment fraction bagged for taxonomic analysis of infauna. Infauna samples were initially fixed in 10% seawater formalin-bierbrich scarlet stain solution and afterwards preserved in 70% ethanol with collection details logged.

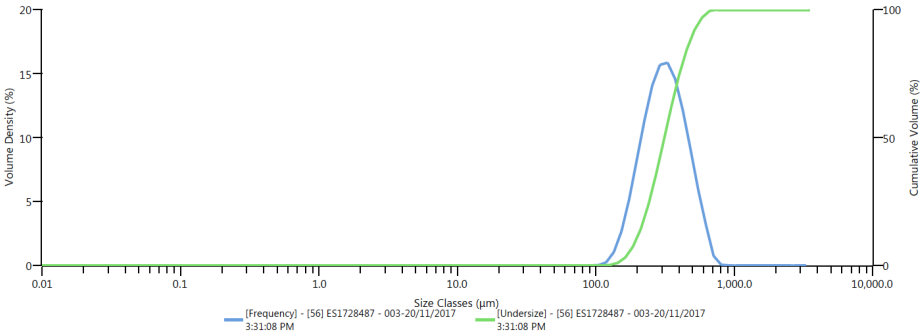
Sediment particle size distribution graphs for benthic infauna sites at Haycock Point, 30m depth.



SIS01_9/11/17 (phi mean = 363 µm, 0.04% >2mm)

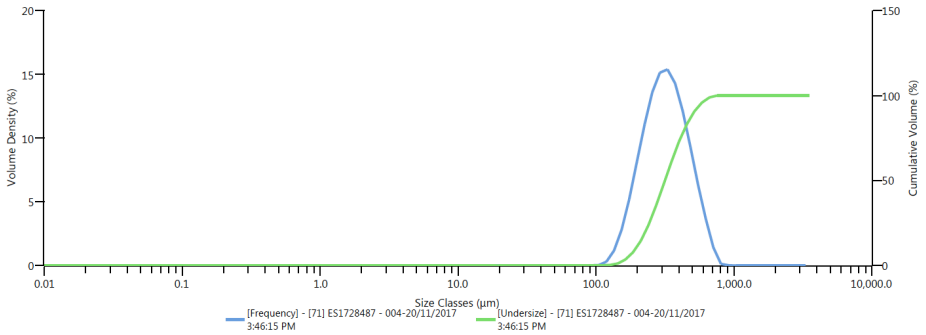


SIS02_10/11/17 (phi mean = 337 µm, 0.1% >2mm)



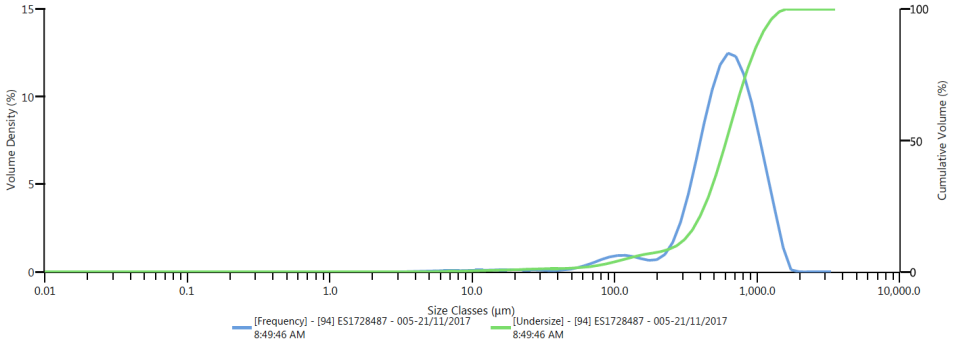
SIS03_10/11/17 (phi mean = 332 µm, 0.03% >2mm)

APPENDIX E

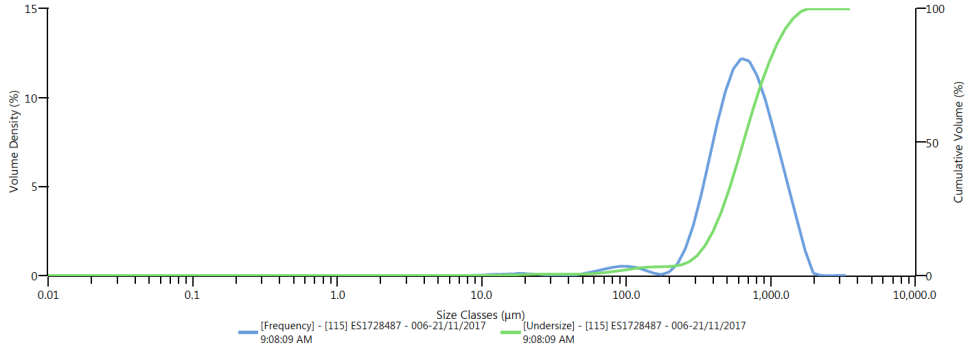


SIS04_10/11/17 (phi mean = 336 µm, 0.13% >2mm)

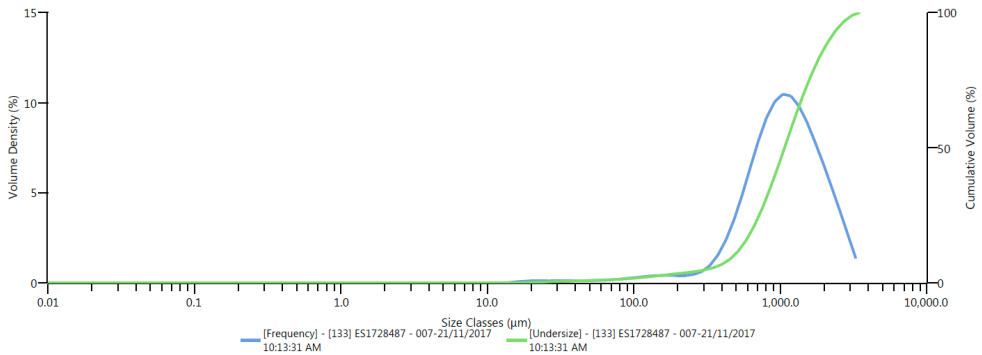
Sediment particle size distribution graphs for benthic infauna sites at Merimbula Bay, 30m depth.



SIS05_10/11/17 (phi mean = 642 µm, 0.72% >2mm)

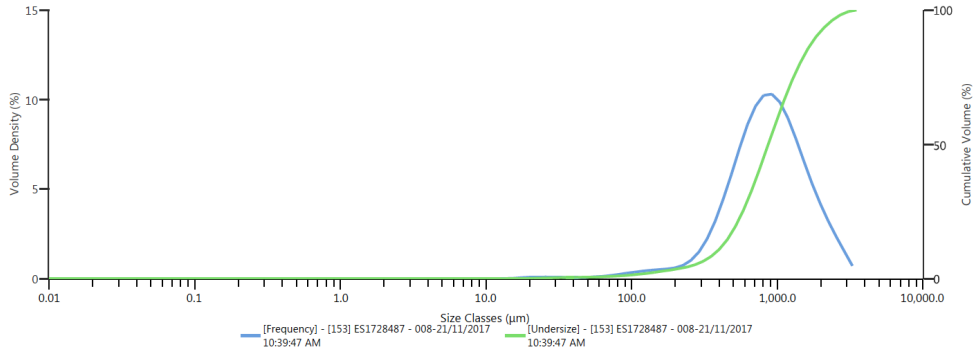


SIS06_10/11/17 (phi mean = 707 µm, 1.11% >2mm)



APPENDIX E

SIS07_10/11/17 (phi mean = 1200 µm, 2.62% >2mm)



SIS08_10/11/17 (phi mean = 1010 µm, 2.65% >2mm)

APPENDIX E1. List of soft sediment infauna taxa recorded at 30m depth at Haycock Point and Merimbula Bay.

					Haycock Point, 30m depth											
Phylum / Subphylum	**Class**	**Order**	**Infraorder / Suborder**	**Family / Taxon**	**SIS01-1**	**SIS01-2**	**SIS01-3**	**SIS02-1**	**SIS02-2**	**SIS02-3**	**SIS03-1**	**SIS03-2**	**SIS03-3**	**SIS04-1**	**SIS04-2**	**SIS04-3**
Crustacea	Hexanauplia			Copepoda												1
	Malacostraca	Amphipoda	Lysianassida	Amaryllididae	10		6	4	1	4	6		3	8	4	1
				Urohaustoriidae												
			Corophiida	Ischyroceridae				2			1	1	1			
				Caprellidae											1	
		Cumacea		Cumacea	1		1	7	2	7	3		2	2	2	4
		Decapoda	Brachyura	Grapsidae								2	1			
				Majidae												
			Anomura	Diogenidae - *Paguristes tuberculatus*												
			Caridea	Processidae - *Processa australiensis*				1	1						1	1
		Isopoda	Cymothoida	Anthuridae		2	4	2	1				2	6	1	1
				Cirolanidae												
				Gnathiidae			2	1		1						1
			Sphaeromatidea	Serolidae												
				Sphaeromatidae				1					2			
			Valvifera	Antarcturidae						1	3	1	4			1
		Tanaidacea		Tanaidacea	2		1		1	3	1	1		1	5	2
	Ostrocoda			Ostrocoda			1	1			1		1	3		1
Mollusca	Bivalvia	Venerida		Veneridae 1	12	12	14	5	13	28	8	9	2	4	4	4
		Venerida		Veneridae 2			1	1		1	1		1	4	2	2
		Venerida		Veneridae 3			1									
		Cardiida		Tellinidae		2	1			1					2	
		Anomalodesmata		Myochamidae		1						2		3	2	
		Imparidentia		Mactridae												
		Arcida		Arcidae												
		Pectinida		Pectinidae												
	Gastropoda			Cylichnidae		1				1	1	1	2	1		
				Pyramidellidae						3			2			
				Scaphandridae							1			1		
				Acteonidae		1	1									
				Solariellidae												
				Calyptraeidae												
				Marginellidae												
	Scaphopoda			Scaphopoda	2	3	2				4		3			1

APPENDIX E1. List of soft sediment infauna taxa recorded at 30m depth at Haycock Point and Merimbula Bay.

					Haycock Point, 30m depth											
Phylum / Subphylum	**Class**	**Order**	**Infraorder / Suborder**	**Family / Taxon**	**SIS01-1**	**SIS01-2**	**SIS01-3**	**SIS02-1**	**SIS02-2**	**SIS02-3**	**SIS03-1**	**SIS03-2**	**SIS03-3**	**SIS04-1**	**SIS04-2**	**SIS04-3**
Annelida	Polychaeta	Amphinomida		Amphinomidae												
		Eunicida		Dorvilleidae					1							
				Eunicidae												
				Lumbrineridae	1	1										2
				Onuphidae	11	9	13	21	9	25	56	18	7	29	24	12
		Phyllodocida		Glyceridae								1				
				Nephtyidae		1										
				Nereididae		1	2									
				Phyllodocidae			4	1	4	1	3			1	3	6
				Sigalionidae										2		
				Syllidae												
		Sabellida		Sabellidae	10	2	16	6	6	20	32	6	16	39	20	9
		Spionida		Spionidae (sp. 1)		2	5	2								
		Terrebellidae		Ampharetidae										3		
				Cirratulidae 1	3	2	2	3	4	1	4			6	2	1
				Cirratulidae 2	1											
				Trichobranchidae												
				Magelonidae												
		Infraclass Scolecida		Maldanidae	37	5	25	50	64	102	207	42	51	128	38	44
				Opheliidae												
				Orbiniidae												
				Paraonidae												
Chelicerata	Pycnogonida			Pycnogonida												1
Nemertea				Nemertea					4		3	1			1	2
Echinodermata	Ophiuroidea			Ophiuroidea			1		1			15	1	3	1	
	Echinoidea			*Fibulariella acuta*									1	1		
	Holothuroidea			Holothuroidea			1									2
Chordata	Actinopterygii	Perciformes	Trachinoidei	Creediidae - *Creedia haswelli*							1					
Chordata	Leptocardii	Amphioxiformes		Lancelet												
Bryozoa				Bryozoa					1		2	3	1		2	1
Foraminifera				Foraminifera							2			5		
Nematoda				Nematoda										2		
				Total Abundance	90	45	104	108	113	199	340	103	103	252	115	99
				Richness	11	15	21	16	15	15	20	14	19	21	18	21

Note

Taxonomy follows currently accpeted nomenclature from:

WoRMS Editorial Board (2017). World Register of Marine Species. Available from URL: http://www.marinespecies.org

Samples collected by Van Veen grab sampler and sieved through 1.0 mm mesh.

APPENDIX E1. List of soft sediment infauna taxa recorded at 30m depth at Haycock Point and Merimbula B

					Merimbula Bay											
Phylum / Subphylum	**Class**	**Order**	**Infraorder / Suborder**	**Family / Taxon**	**SIS05-1**	**SIS05-2**	**SIS05-3**	**SIS06-1**	**SIS06-2**	**SIS06-3**	**SIS07-1**	**SIS07-2**	**SIS07-3**	**SIS08-1**	**SIS08-2**	**SIS08-3**
Crustacea	Hexanauplia			Copepoda							2					
	Malacostraca	Amphipoda	Lysianassida	Amaryllididae	21	17	24	5	33	1	4	14	14	16	4	3
				Urohaustoriidae			1		4	1			4	1		1
			Corophiida	Ischyroceridae	3	1	2		9			1		2		
				Caprellidae					1	1						
		Cumacea		Cumacea	4	9	2	2	8	3	4	5	5	10	2	4
		Decapoda	Brachyura	Grapsidae												
				Majidae							2					
			Anomura	Diogenidae - *Paguristes tuberculatus*	1	1	1	1	15	1	2	2	2			3
			Caridea	Processidae - *Processa australiensis*						1						
		Isopoda	Cymothoida	Anthuridae	3	2	2	2	2	2	4	2	1	4	4	3
				Cirolanidae								2				
				Gnathiidae	1					1	1					
			Sphaeromatidea	Serolidae			1				1		4			1
				Sphaeromatidae					2	1	1	41	1	1	1	13
			Valvifera	Antarcturidae												1
		Tanaidacea		Tanaidacea	13	16	11	2	18	11	19	38	22	27	5	13
	Ostrocoda			Ostrocoda	84	33	91	26	41	19	12	2	14	1	3	3
Mollusca	Bivalvia	Venerida		Veneridae 1	8	10	5		3	1	7	2	4			2
		Venerida		Veneridae 2												
		Venerida		Veneridae 3						1	1	1	1			
		Cardiida		Tellinidae	1		1	1			1	1		2		1
		Anomalodesmata		Myochamidae							1					
		Imparidentia		Mactridae				3								
		Arcida		Arcidae						2				1		
		Pectinida		Pectinidae							1		1			
	Gastropoda			Cylichnidae				1						1		
				Pyramidellidae							1					
				Scaphandridae												
				Acteonidae												
				Solariellidae	1		1			2	2	1		2		
				Calyptraeidae	1						3	16	2	2		27
				Marginellidae										1		
	Scaphopoda			Scaphopoda												

APPENDIX E1. List of soft sediment infauna taxa recorded at 30m depth at Haycock Point and Merimbula B

					Merimbula Bay											
Phylum / Subphylum	**Class**	**Order**	**Infraorder / Suborder**	**Family / Taxon**	**SIS05-1**	**SIS05-2**	**SIS05-3**	**SIS06-1**	**SIS06-2**	**SIS06-3**	**SIS07-1**	**SIS07-2**	**SIS07-3**	**SIS08-1**	**SIS08-2**	**SIS08-3**
Annelida	Polychaeta	Amphinomida		Amphinomidae						9	22	154	44	11		
		Eunicida		Dorvilleidae												
				Eunicidae	1											
				Lumbrineridae	5	1	5	5	10	13	13	8	22	12	8	8
				Onuphidae	11	10	9	4	37	18	10	49	12	87	9	14
		Phyllodocida		Glyceridae		4	2		3		1	3	1	4		2
				Nephtyidae												
				Nereididae		1				1	3	19		1		3
				Phyllodocidae	5	2	8	7	2	7	2	8	30	9	1	2
				Sigalionidae		1		1		2					1	
				Syllidae		2	3	4		8	2	8	18	48	5	1
		Sabellida		Sabellidae				1		1						
		Spionida		Spionidae (sp. 1)	1	3			2		1					
		Terrebellidae		Ampharetidae				2		2		2	3			
				Cirratulidae 1		1		3				1				
				Cirratulidae 2	1						1		2			
				Trichobranchidae	2	3			2	2		1	2	2	1	2
				Magelonidae										1		
		Infraclass Scolecida		Maldanidae	1		1	2		3		2	2			
				Opheliidae	1											
				Orbiniidae	2	1		1	2			3				7
				Paraonidae	3	10	4	8	2			3	7	15		
Chelicerata	Pycnogonida			Pycnogonida												
Nemertea				Nemertea		1	3		1	4			5	5	1	
Echinodermata	Ophiuroidea			Ophiuroidea	2	3	3		2	1	1	1	1	10	1	2
	Echinoidea			*Fibulariella acuta*												
	Holothuroidea			Holothuroidea		1			2				1		1	
Chordata	Actinopterygii	Perciformes	Trachinoidei	Creediidae - *Creedia haswelli*												
Chordata	Leptocardii	Amphioxiformes		Lancelet			1		1							
Bryozoa				Bryozoa								1			1	
Foraminifera				Foraminifera											3	
Nematoda				Nematoda		12	1				12	1	6	55	44	
				Total Abundance	176	145	182	81	202	119	135	392	231	331	95	116
				Richness	24	24	23	20	23	28	29	30	28	27	18	22

Note

Taxonomy follows currently accpeted nomenclature from:

WoRMS Editorial Board (2017). World Register of Marine Species. Available from URL: http://www.marinespecies.org

Samples collected by Van Veen grab sampler and sieved through 1.0 mm mesh.

Appendix E2. Sediment Analytical Results

Sample ID	Sample Type	Sample Date	Sample Time	FIELD PARAMETERS[2]		LABORATORY PARAMETERS[3]												
				pH	Redox	phi mean	Ammonia as N	Nitrite as N	Nitrate as N	NOx (Nitrite + Nitrate) as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Reactive Phosphorus as P	Total Organic Carbon	Aluminium (Al)	Beryllium (Be)	Arsenic (As)
				pH unit	mV		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg		mg/kg
	Limit of Reporting (LOR)			-	-		20	0.1	0.1	0.1	20	20	2	0.1	0.02	50		1
	ISQG-Low[1]			-	-		-	-	-	-		-	-	-	-	-	-	20
	ISQG-High[1]			-	-		-	-	-	-		-	-	-	-	-	-	70
	Other Background Data - Benthic Sediments Wonthaggi, Vic (Bass Strait) - Wonthaggi Desal Plant EES 2008						<20	<0.1	<0.1-0.546	<0.1-0.546		100-280		0.177-0.922	0.06-0.09			4.4-15
SIS01_9/11/17	SEDIMENT	9-Nov-17	-	7.3	215	363	<20	<0.1	<0.1	<0.1	80	80	91	3.2	0.08	150	-	1.52
SIS02_10/11/17	SEDIMENT	10-Nov-17	-	7.5	200	337	<20	<0.1	0.7	0.7	150	150	154	2.6	0.07	200	-	1.92
SIS03_10/11/17	SEDIMENT	10-Nov-17	-	7.4	116	332	<20	<0.1	<0.1	<0.1	90	90	106	3.1	0.06	190	-	1.53
SIS04_10/11/17	SEDIMENT	10-Nov-17	-	7.8	145	336	<20	<0.1	<0.1	<0.1	130	130	102	2.9	0.05	180	-	1.52
SIS05_10/11/17	SEDIMENT	10-Nov-17	-	7.9	164	642	<20	<0.1	<0.1	<0.1	100	100	274	1.4	0.07	560	-	10.5
SIS06_10/11/17	SEDIMENT	10-Nov-17	-	7.8	174	707	<20	<0.1	<0.1	<0.1	50	50	250	1	0.05	470	-	8.51
SIS07_10/11/17	SEDIMENT	10-Nov-17	-	8	171	1200	<20	<0.1	0.2	0.2	140	140	278	1.5	0.06	500	-	12.9
SIS08_10/11/17	SEDIMENT	10-Nov-17	-	7.8	160	1010	<20	<0.1	0.5	0.5	90	90	249	1.2	0.06	510	-	14.4

Note

[1] Interim Sediment Quality Guidelines (ANZECC/ARMCANZ 2000, CSIRO 2005)

[3] Field parameters measured *insitu* using field-chem kit

[4] Laboratory parameters reported by ALS Sydney

Shaded cells with bold text indicate guideline value has been exceeded.

Appendix E2. Sediment Analytical Results

Sample ID	Sample Type	Sample Date	Sample Time	Iron (Fe)	Chromium (Cr)	Manganese (Mn)	Copper (Cu)	Zinc (Zn)	Nickel (Ni)	Selenium (Se)	Vanadium (V)	Antimony (Sb)	Barium (Ba)	Boron (B)	Cadmium (Cd)	Cobalt (Co)	Lead (Pb)	Molybdenum (Mo)	Silver (Ag)	Tin (Sn)
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			mg/kg	mg/kg	mg/kg		mg/kg	
	Limit of Reporting (LOR)			50	1	10	1	1	1	0.1	2	0.5			0.1	0.5	1		0.1	
	ISQG-Low[1]			-	80	-	65	200	21	-	-	2	-	-	1.5	-	50	-	1	-
	ISQG-High[1]			-	370	-	270	410	52	-	-	25	-	-	10	-	220	-	3.7	-
	Other Background Data - Benthic Sediments Wonthaggi, Vic (Bass Strait) - Wonthaggi Desal Plant EES 2008				<1-3.8		4.8-5.5	9.6-11.4	<1-1.3						<0.1		<1.0-1.3			
SIS01_9/11/17	SEDIMENT	9-Nov-17	-	800	2.5	<10	<1.0	<1.0	<1.0	<0.1	2.3	<0.50	-	-	<0.1	<0.5	<1.0	-	<0.1	-
SIS02_10/11/17	SEDIMENT	10-Nov-17	-	980	2.7	<10	<1.0	<1.0	<1.0	0.1	3.2	<0.50	-	-	<0.1	<0.5	<1.0	-	<0.1	-
SIS03_10/11/17	SEDIMENT	10-Nov-17	-	900	2.4	<10	<1.0	<1.0	<1.0	<0.1	2.6	<0.50	-	-	<0.1	<0.5	<1.0	-	<0.1	-
SIS04_10/11/17	SEDIMENT	10-Nov-17	-	960	2.4	<10	<1.0	<1.0	<1.0	<0.1	2.5	<0.50	-	-	<0.1	<0.5	<1.0	-	<0.1	-
SIS05_10/11/17	SEDIMENT	10-Nov-17	-	4720	5.8	<10	<1.0	2	<1.0	<0.1	12.5	<0.50	-	-	<0.1	<0.5	1.3	-	<0.1	-
SIS06_10/11/17	SEDIMENT	10-Nov-17	-	4030	5	<10	<1.0	1.4	<1.0	<0.1	11	<0.50	-	-	<0.1	<0.5	<1.0	-	<0.1	-
SIS07_10/11/17	SEDIMENT	10-Nov-17	-	4650	4.7	<10	<1.0	6.7	<1.0	<0.1	14.1	<0.50	-	-	<0.1	<0.5	<1.0	-	<0.1	-
SIS08_10/11/17	SEDIMENT	10-Nov-17	-	4960	5	<10	<1.0	1.7	<1.0	<0.1	14.4	0.88	-	-	<0.1	<0.5	1.1	-	0.6	-

Note

[1] Interim Sediment Quality Guidelines (ANZECC/ARMCANZ 2000, CSIRO 2005)

[3] Field parameters measured *insitu* using field-chem kit

[4] Laboratory parameters reported by ALS Sydney

Shaded cells with bold text indicate guideline value has been exceeded.

Appendix E2. Sediment Analytical Results

Sample ID	Sample Type	Sample Date	Sample Time	Mercury (Hg)	OBSERVATIONS
				mg/kg	
	Limit of Reporting (LOR)			0.01	
	ISQG-Low[1]			0.15	
	ISQG-High[1]			1	
	Other Background Data - Benthic Sediments Wonthaggi, Vic (Bass Strait) - Wonthaggi Desal Plant EES 2008			<0.01-0.01	
SIS01_9/11/17	SEDIMENT	9-Nov-17	-	<0.01	SAND, light brown, fine to medium grained and uniform size.
SIS02_10/11/17	SEDIMENT	10-Nov-17	-	<0.01	SAND, brown, fine to medium grained, uniform size, sulphide odour, with lumps of black clay-sand
SIS03_10/11/17	SEDIMENT	10-Nov-17	-	<0.01	SAND, brown, fine to medium grained and uniform size, lumps of black clay-sand, no odour.
SIS04_10/11/17	SEDIMENT	10-Nov-17	-	<0.01	SAND, light brown with green tinge, fine to medium grained, uniform size, slight sulphide odour.
SIS05_10/11/17	SEDIMENT	10-Nov-17	-	<0.01	SAND, brown, medium to coarse grained, shell grit, slight odour.
SIS06_10/11/17	SEDIMENT	10-Nov-17	-	<0.01	SAND, brown, medium to coarse grained, shell grit, some pebble, slight sulphide odour.
SIS07_10/11/17	SEDIMENT	10-Nov-17	-	<0.01	SAND, brown, medium to coarse grained, shell grit, lumps of black clay-fine sand.
SIS08_10/11/17	SEDIMENT	10-Nov-17	-	<0.01	SAND, brown, medium to coarse grained, shell grit, lumps of black clay-fine sand.

Note

[1] Interim Sediment Quality Guidelines (ANZECC/ARMCANZ 2000, CSIRO 2005)

[3] Field parameters measured *insitu* using field-chem kit

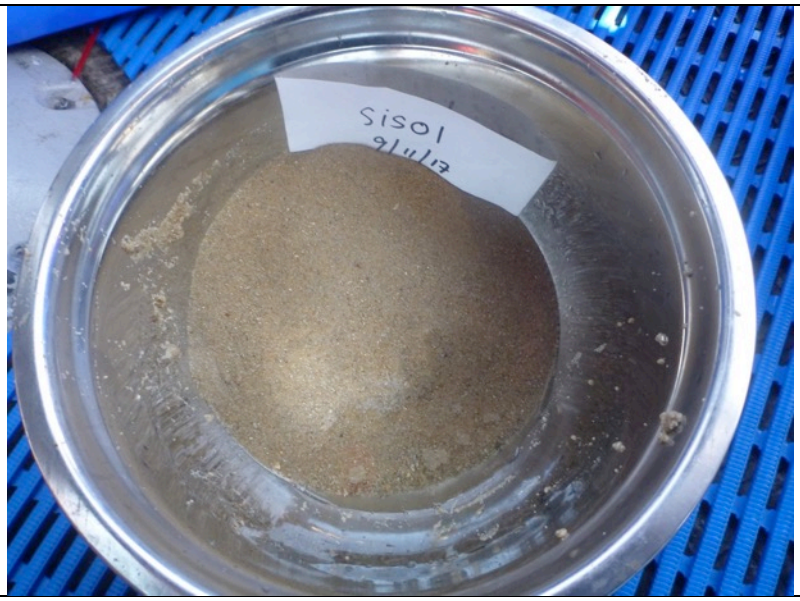
[4] Laboratory parameters reported by ALS Sydney

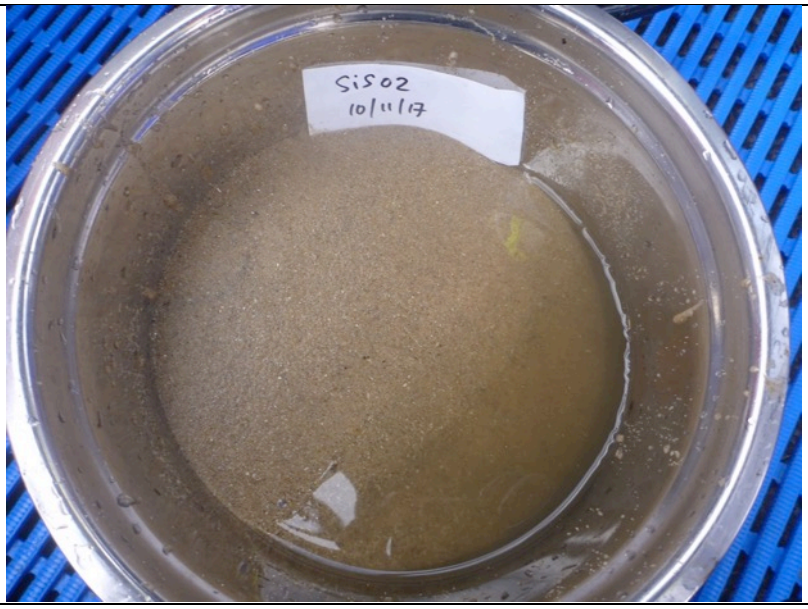
Shaded cells with bold text indicate guideline value has been exceeded.

APPENDIX E3

SEDIMENT CHARACTERISTICS

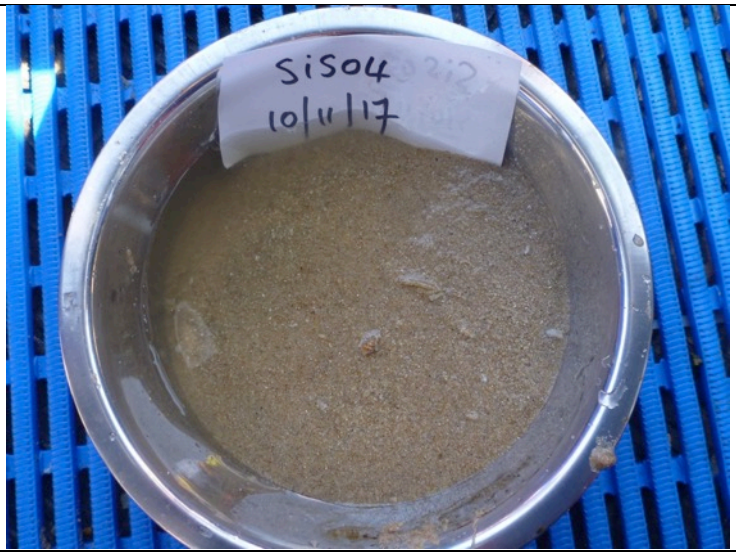
APPENDIX E3

Sediment Sample	**SIS01**
Location Coordinates:	-36.94971032 149.955045
Lithology:	SAND, light brown, fine to medium grained and uniform size.
pH	7.3
Redox	215 mV
Photo	

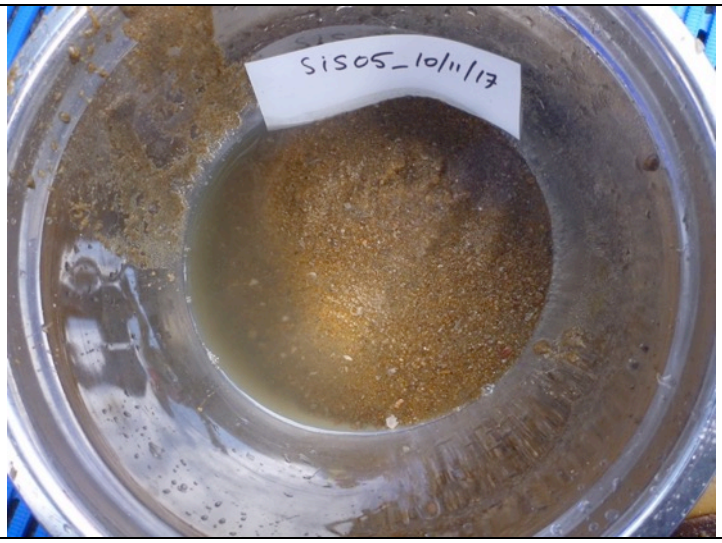
Sediment Sample	**SIS02**
Location Coordinates:	-36.94926281 149.9555379
Lithology:	SAND, brown, fine to medium grained, uniform size, sulphide odour, with lumps of black clay-sand
pH	7.5
Redox	200 mV
Photo	

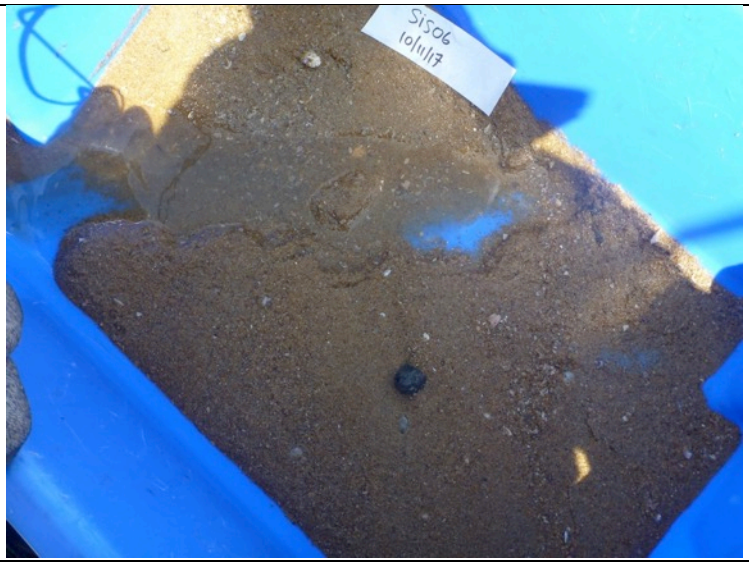
APPENDIX E3

Sediment Sample	**SIS03**
Location Coordinates:	-36.94807744 149.9560322
Lithology:	SAND, brown, fine to medium grained and uniform size, lumps of black clay-sand, no odour.
pH	7.4
Redox	116 mV
Photo	

Sediment Sample	**SIS04**
Location Coordinates:	-36.94661379 149.9575139
Lithology:	SAND, light brown with green tinge, fine to medium grained, uniform size, slight sulphide odour.
pH	7.8
Redox	145 mV
Photo	

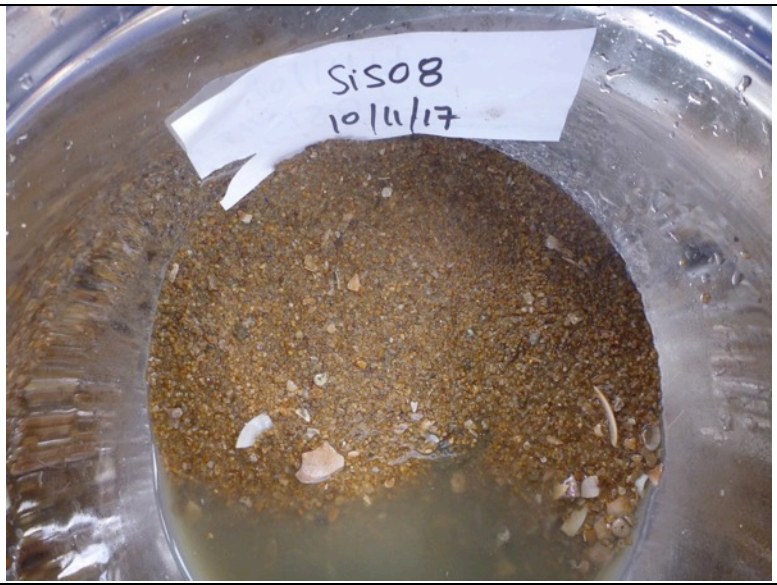
APPENDIX E3

Sediment Sample	**SIS05**
Location Coordinates:	-36.92636185 149.9408416
Lithology:	SAND, brown, medium to coarse grained, shell grit, slight odour.
pH	7.9
Redox	164 mV
Photo	

Sediment Sample	**SIS06**
Location Coordinates:	-36.92627074 149.940171
Lithology:	SAND, brown, medium to coarse grained, shell grit, some pebble, slight sulphide odour.
pH	7.8
Redox	174 mV
Photo	

APPENDIX E3

Sediment Sample	**SIS07**
Location Coordinates:	-36.9257177 149.9386415
Lithology:	SAND, brown, medium to coarse grained, shell grit, lumps of black clay-fine sand.
pH	8
Redox	171 mV
Photo	

Sediment Sample	**SIS08**
Location Coordinates:	-36.9251562 149.9362847
Lithology:	SAND, brown, medium to coarse grained, shell grit, lumps of black clay-fine sand.
pH	7.8
Redox	160 mV
Photo	

APPENDIX E4

LABORATORY CERTIFICATES

- **CERTIFICATE OF ANALYSIS**
- **SAMPLE RECEIPT NOTIFICATION**
- **CHAIN OF CUSTODY**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1728487**	Page	: 1 of 6
Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Contact	: Peter Ravlic
Address	: PO BOX 829 BEGA NSW, AUSTRALIA 2550	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 8003 4590	Telephone	: +61-2-8784 8555
Project	: JN17169 MERIMBULA DEEP OCEAN OUTFALL - BENTHIC FAUNA	Date Samples Received	: 14-Nov-2017 08:30
Order number	: ----	Date Analysis Commenced	: 16-Nov-2017
C-O-C number	: ----	Issue Date	: 21-Nov-2017 17:09
Sampler	: ----		
Site	: ----		
Quote number	: ME/222/17		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA153: ALS does not hold NATA accreditation for Laser Particle Sizing.

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	SIS01_9/11/17	SIS02_10/11/17	SIS03_10/11/17	SIS04_10/11/17	SIS05_10/11/17
				Client sampling date / time	09-Nov-2017 00:00	10-Nov-2017 00:00	10-Nov-2017 00:00	10-Nov-2017 00:00	10-Nov-2017 00:00
Compound	CAS Number	LOR	Unit		ES1728487-001	ES1728487-002	ES1728487-003	ES1728487-004	ES1728487-005
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		31.8	38.2	30.2	31.2	30.0
EG005-SD: Total Metals in Sediments by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		150	200	190	180	560
Iron	7439-89-6	50	mg/kg		800	980	900	960	4720
EG020-SD: Total Metals in Sediments by ICPMS									
Antimony	7440-36-0	0.50	mg/kg		<0.50	<0.50	<0.50	<0.50	<0.50
Arsenic	7440-38-2	1.00	mg/kg		1.52	1.92	1.53	1.52	10.5
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	1.0	mg/kg		2.5	2.7	2.4	2.4	5.8
Copper	7440-50-8	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	<1.0
Cobalt	7440-48-4	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Lead	7439-92-1	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	1.3
Manganese	7439-96-5	10	mg/kg		<10	<10	<10	<10	<10
Nickel	7440-02-0	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	<1.0
Selenium	7782-49-2	0.1	mg/kg		<0.1	0.1	<0.1	<0.1	<0.1
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	2.0	mg/kg		2.3	3.2	2.6	2.5	12.5
Zinc	7440-66-6	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	2.0
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		<0.1	0.7	<0.1	<0.1	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		<0.1	0.7	<0.1	<0.1	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		80	150	90	130	100
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		80	150	90	130	100
EK067G: Total Phosphorus as P by Discrete Analyser									

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	SIS01_9/11/17	SIS02_10/11/17	SIS03_10/11/17	SIS04_10/11/17	SIS05_10/11/17
				Client sampling date / time	09-Nov-2017 00:00	10-Nov-2017 00:00	10-Nov-2017 00:00	10-Nov-2017 00:00	10-Nov-2017 00:00
Compound	CAS Number	LOR	Unit		ES1728487-001	ES1728487-002	ES1728487-003	ES1728487-004	ES1728487-005
					Result	Result	Result	Result	Result
EK067G: Total Phosphorus as P by Discrete Analyser - Continued									
Total Phosphorus as P	----	2	mg/kg		**91**	**154**	**106**	**102**	**274**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		**3.2**	**2.6**	**3.1**	**2.9**	**1.4**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.08**	**0.07**	**0.06**	**0.05**	**0.07**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	SIS06_10/11/17	SIS07_10/11/17	SIS08_10/11/17	----	----
			Client sampling date / time	10-Nov-2017 00:00	10-Nov-2017 00:00	10-Nov-2017 00:00	----	----
Compound	CAS Number	LOR	Unit	ES1728487-006	ES1728487-007	ES1728487-008	--------	--------
				Result	Result	Result	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**16.7**	**21.4**	**22.4**	----	----
EG005-SD: Total Metals in Sediments by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**470**	**500**	**510**	----	----
Iron	7439-89-6	50	mg/kg	**4030**	**4650**	**4960**	----	----
EG020-SD: Total Metals in Sediments by ICPMS								
Antimony	7440-36-0	0.50	mg/kg	<0.50	<0.50	**0.88**	----	----
Arsenic	7440-38-2	1.00	mg/kg	**8.51**	**12.9**	**14.4**	----	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Chromium	7440-47-3	1.0	mg/kg	**5.0**	**4.7**	**5.0**	----	----
Copper	7440-50-8	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
Cobalt	7440-48-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Lead	7439-92-1	1.0	mg/kg	<1.0	<1.0	**1.1**	----	----
Manganese	7439-96-5	10	mg/kg	<10	<10	<10	----	----
Nickel	7440-02-0	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	**0.6**	----	----
Vanadium	7440-62-2	2.0	mg/kg	**11.0**	**14.1**	**14.4**	----	----
Zinc	7440-66-6	1.0	mg/kg	**1.4**	**6.7**	**1.7**	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	<0.1	**0.2**	**0.5**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	**0.2**	**0.5**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**50**	**140**	**90**	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**50**	**140**	**90**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	SIS06_10/11/17	SIS07_10/11/17	SIS08_10/11/17	----	----
				Client sampling date / time	10-Nov-2017 00:00	10-Nov-2017 00:00	10-Nov-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		ES1728487-006	ES1728487-007	ES1728487-008	--------	--------
					Result	Result	Result	----	----
EK067G: Total Phosphorus as P by Discrete Analyser - Continued									
Total Phosphorus as P	----	2	mg/kg		**250**	**278**	**249**	**----**	**----**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		**1.0**	**1.5**	**1.2**	**----**	**----**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.05**	**0.06**	**0.06**	**----**	**----**

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

Work Order:	ES1728487
Client:	ELGIN ASSOCIATES PTY LTD
Address:	PO BOX 829 BEGA NSW, AUSTRALIA 2550
Contact:	MR NICK YEE
Project:	JN17169 MERIMBULA DEEP OCEAN OUTFALL - BENTHIC FAUNA
Report Date:	21/11/2017
Samples Submitted:	14/11/2017

Report:

The particle size distribution of these samples was determined by Light-Scattering using a Mastersizer 3000 instrument.
This report contains data only for the fraction below 2mm. Any particles greater than 2mm were removed prior to analysis and are reported as a percentage of total mass in the table below.

Lab ID	Client ID	+ 2mm %
ES1728487 - 001	SIS01_9/11/17	0.04
ES1728487 - 002	SIS02_10/11/17	0.1
ES1728487 - 003	SIS03_10/11/17	0.03
ES1728487 - 004	SIS04_10/11/17	0.13
ES1728487 - 005	SIS05_10/11/17	0.72
ES1728487 - 006	SIS06_10/11/17	1.11
ES1728487 - 007	SIS07_10/11/17	2.62
ES1728487 - 008	SIS08_10/11/17	2.65

A detailed report for each sample is attached.
Sampled by ELGIN ASSOCIATES PTY LTD; analysed as received.

Michael Mercer
Laboratory Analyst
Soils and Sizings.

Analysis

Malvern Instruments

Malvern

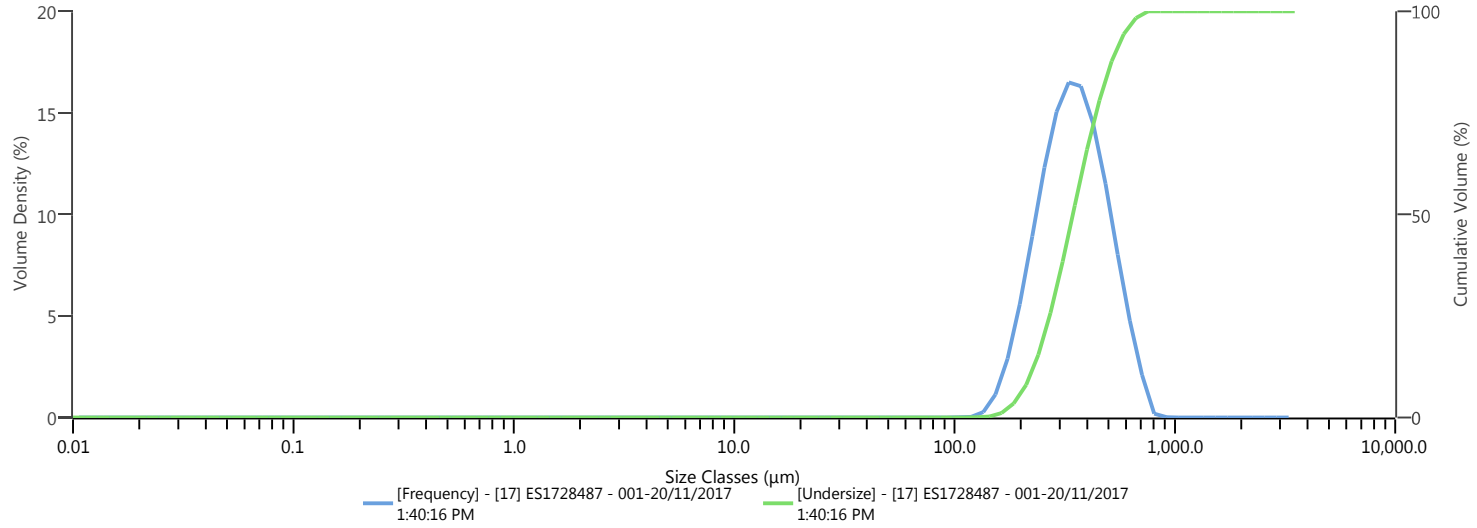
Measurement Details	
Operator Name	michael.mercer
Sample Name	ES1728487 - 001
SOP File Name	HydroLV.cfg

Measurement Details	
Analysis Date Time	20/11/2017 1:40:16 PM
Measurement Date Time	20/11/2017 1:40:16 PM
Result Source	Averaged

Analysis	
Particle Name	ALS
Particle Refractive Index	1.550
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.57 %
Laser Obscuration	10.59 %

Result	
Span	0.930
Uniformity	0.285
Specific Surface Area	18.50 m^2/kg
D [3,2]	324 µm
D [4,3]	363 µm
Dv (10)	218 µm
Dv (50)	345 µm
Dv (90)	539 µm

Frequency (compatible) and Undersize



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0552	0.00	0.305	0.00	1.68	0.00	9.30	0.00	51.4	0.00	284	29.73	1570	100.00
0.0113	0.00	0.0624	0.00	0.345	0.00	1.90	0.00	10.5	0.00	58.0	0.00	321	42.15	1770	100.00
0.0128	0.00	0.0705	0.00	0.389	0.00	2.15	0.00	11.9	0.00	65.6	0.00	362	55.37	2000	100.00
0.0144	0.00	0.0796	0.00	0.440	0.00	2.43	0.00	13.4	0.00	74.1	0.00	409	68.19		
0.0163	0.00	0.0900	0.00	0.497	0.00	2.74	0.00	15.2	0.00	83.7	0.00	462	79.45		
0.0184	0.00	0.102	0.00	0.561	0.00	3.10	0.00	17.1	0.00	94.6	0.00	522	88.36		
0.0208	0.00	0.115	0.00	0.634	0.00	3.50	0.00	19.3	0.00	107	0.00	590	94.58		
0.0235	0.00	0.130	0.00	0.717	0.00	3.96	0.00	21.9	0.00	121	0.00	667	98.31		
0.0266	0.00	0.147	0.00	0.810	0.00	4.47	0.00	24.7	0.00	136	0.10	753	99.93		
0.0300	0.00	0.166	0.00	0.915	0.00	5.05	0.00	27.9	0.00	154	0.65	851	100.00		
0.0339	0.00	0.187	0.00	1.03	0.00	5.71	0.00	31.5	0.00	174	2.21	962	100.00		
0.0383	0.00	0.211	0.00	1.17	0.00	6.45	0.00	35.6	0.00	197	5.46	1090	100.00		
0.0433	0.00	0.239	0.00	1.32	0.00	7.29	0.00	40.2	0.00	222	11.01	1230	100.00		
0.0489	0.00	0.270	0.00	1.49	0.00	8.23	0.00	45.5	0.00	251	19.14	1390	100.00		

Measurement Details

Operator Name	michael.mercer
Sample Name	ES1728487 - 002
SOP File Name	HydroLV.cfg

Measurement Details

Analysis Date Time	20/11/2017 2:55:54 PM
Measurement Date Time	20/11/2017 2:55:54 PM
Result Source	Averaged

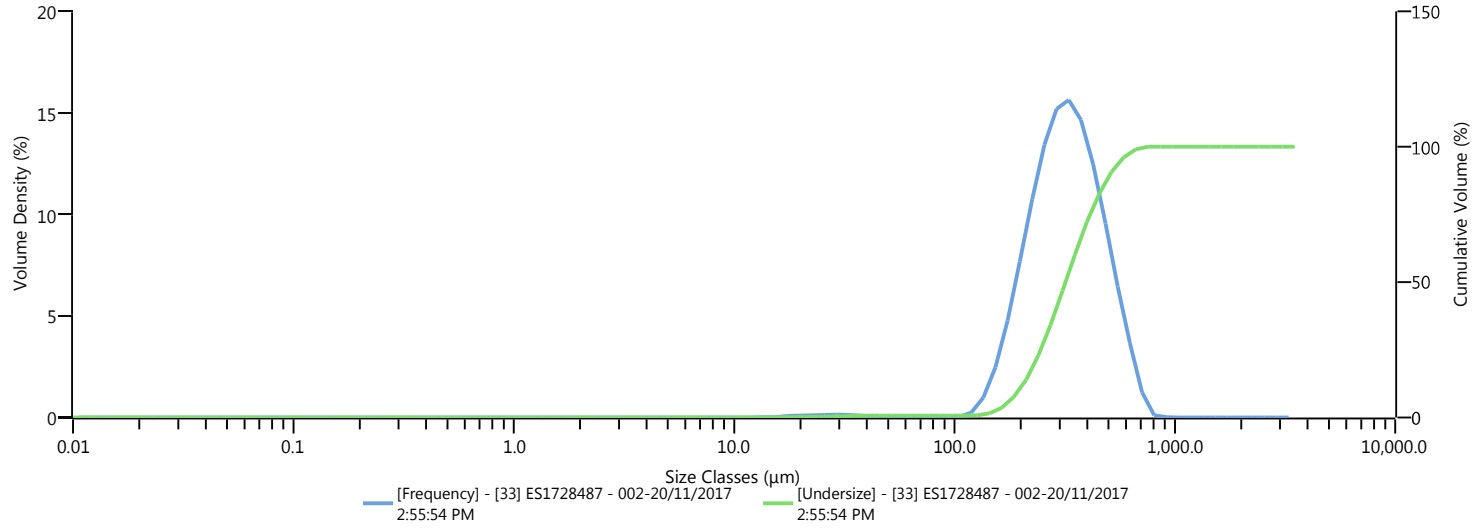
Analysis

Particle Name	ALS
Particle Refractive Index	1.550
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.66 %
Laser Obscuration	13.78 %

Result

Span	0.986
Uniformity	0.305
Specific Surface Area	21.39 m^2/kg
D [3,2]	280 µm
D [4,3]	337 µm
Dv (10)	195 µm
Dv (50)	319 µm
Dv (90)	510 µm

Frequency (compatible) and Undersize



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0552	0.00	0.305	0.00	1.68	0.00	9.30	0.00	51.4	0.62	284	38.14	1570	100.00
0.0113	0.00	0.0624	0.00	0.345	0.00	1.90	0.00	10.5	0.00	58.0	0.62	321	50.43	1770	100.00
0.0128	0.00	0.0705	0.00	0.389	0.00	2.15	0.00	11.9	0.00	65.6	0.62	362	62.80	2000	100.00
0.0144	0.00	0.0796	0.00	0.440	0.00	2.43	0.00	13.4	0.00	74.1	0.62	409	74.22		
0.0163	0.00	0.0900	0.00	0.497	0.00	2.74	0.00	15.2	0.00	83.7	0.62	462	83.86		
0.0184	0.00	0.102	0.00	0.561	0.00	3.10	0.00	17.1	0.02	94.6	0.62	522	91.21		
0.0208	0.00	0.115	0.00	0.634	0.00	3.50	0.00	19.3	0.08	107	0.63	590	96.19		
0.0235	0.00	0.130	0.00	0.717	0.00	3.96	0.00	21.9	0.16	121	0.72	667	99.07		
0.0266	0.00	0.147	0.00	0.810	0.00	4.47	0.00	24.7	0.25	136	1.21	753	99.97		
0.0300	0.00	0.166	0.00	0.915	0.00	5.05	0.00	27.9	0.35	154	2.60	851	100.00		
0.0339	0.00	0.187	0.00	1.03	0.00	5.71	0.00	31.5	0.45	174	5.46	962	100.00		
0.0383	0.00	0.211	0.00	1.17	0.00	6.45	0.00	35.6	0.55	197	10.32	1090	100.00		
0.0433	0.00	0.239	0.00	1.32	0.00	7.29	0.00	40.2	0.62	222	17.48	1230	100.00		
0.0489	0.00	0.270	0.00	1.49	0.00	8.23	0.00	45.5	0.62	251	26.89	1390	100.00		

Analysis

Malvern Instruments

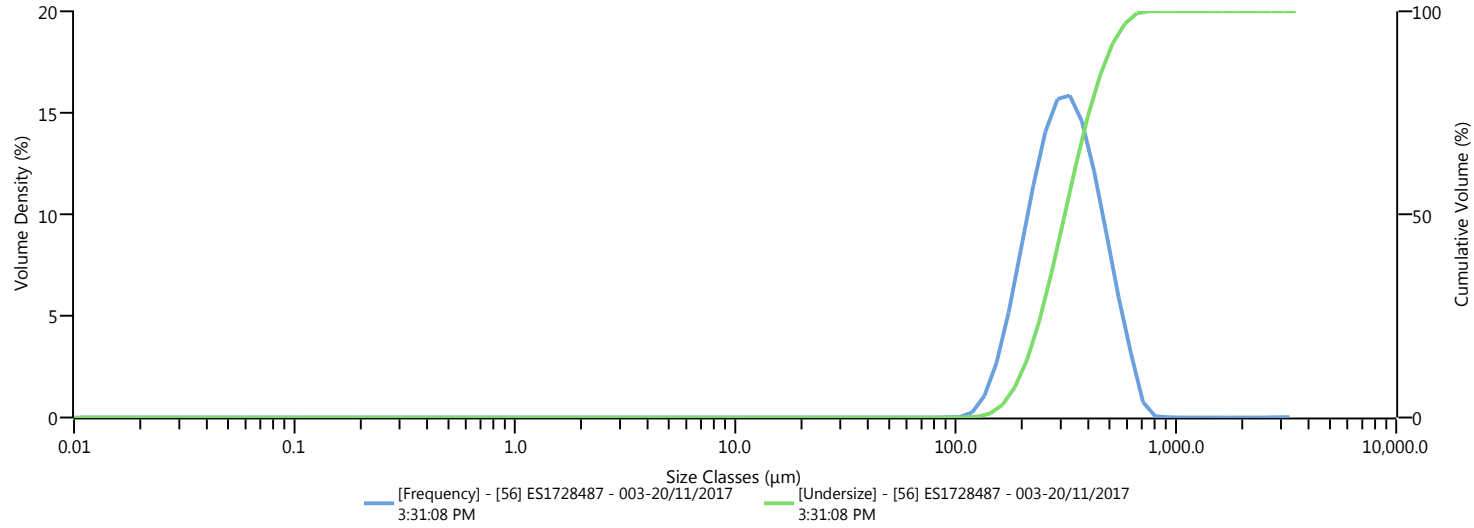
Measurement Details	
Operator Name	michael.mercer
Sample Name	ES1728487 - 003
SOP File Name	HydroLV.cfg

Measurement Details	
Analysis Date Time	20/11/2017 3:31:08 PM
Measurement Date Time	20/11/2017 3:31:08 PM
Result Source	Averaged

Analysis	
Particle Name	ALS
Particle Refractive Index	1.550
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.62 %
Laser Obscuration	18.32 %

Result	
Span	0.969
Uniformity	0.297
Specific Surface Area	20.44 m^2/kg
D [3,2]	294 µm
D [4,3]	332 µm
Dv (10)	195 µm
Dv (50)	313 µm
Dv (90)	499 µm

Frequency (compatible) and Undersize



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0552	0.00	0.305	0.00	1.68	0.00	9.30	0.00	51.4	0.00	284	39.78	1570	100.00
0.0113	0.00	0.0624	0.00	0.345	0.00	1.90	0.00	10.5	0.00	58.0	0.00	321	52.41	1770	100.00
0.0128	0.00	0.0705	0.00	0.389	0.00	2.15	0.00	11.9	0.00	65.6	0.00	362	64.90	2000	100.00
0.0144	0.00	0.0796	0.00	0.440	0.00	2.43	0.00	13.4	0.00	74.1	0.00	409	76.21		
0.0163	0.00	0.0900	0.00	0.497	0.00	2.74	0.00	15.2	0.00	83.7	0.00	462	85.55		
0.0184	0.00	0.102	0.00	0.561	0.00	3.10	0.00	17.1	0.00	94.6	0.00	522	92.49		
0.0208	0.00	0.115	0.00	0.634	0.00	3.50	0.00	19.3	0.00	107	0.00	590	97.03		
0.0235	0.00	0.130	0.00	0.717	0.00	3.96	0.00	21.9	0.00	121	0.10	667	99.52		
0.0266	0.00	0.147	0.00	0.810	0.00	4.47	0.00	24.7	0.00	136	0.63	753	99.98		
0.0300	0.00	0.166	0.00	0.915	0.00	5.05	0.00	27.9	0.00	154	2.14	851	100.00		
0.0339	0.00	0.187	0.00	1.03	0.00	5.71	0.00	31.5	0.00	174	5.24	962	100.00		
0.0383	0.00	0.211	0.00	1.17	0.00	6.45	0.00	35.6	0.00	197	10.48	1090	100.00		
0.0433	0.00	0.239	0.00	1.32	0.00	7.29	0.00	40.2	0.00	222	18.12	1230	100.00		
0.0489	0.00	0.270	0.00	1.49	0.00	8.23	0.00	45.5	0.00	251	28.06	1390	100.00		

Measurement Details

Operator Name	michael.mercer
Sample Name	ES1728487 - 004
SOP File Name	HydroLV.cfg

Measurement Details

Analysis Date Time	20/11/2017 3:46:15 PM
Measurement Date Time	20/11/2017 3:46:15 PM
Result Source	Averaged

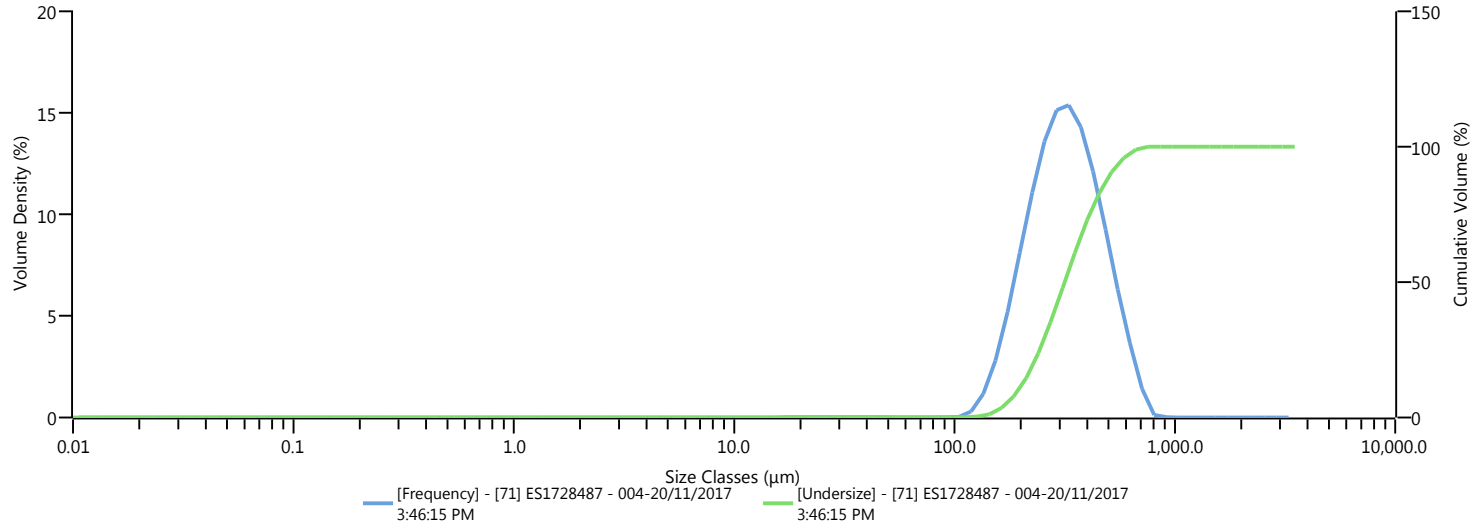
Analysis

Particle Name	ALS
Particle Refractive Index	1.550
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.63 %
Laser Obscuration	23.48 %

Result

Span	1.001
Uniformity	0.308
Specific Surface Area	20.38 m^2/kg
D [3,2]	294 µm
D [4,3]	336 µm
Dv (10)	194 µm
Dv (50)	316 µm
Dv (90)	510 µm

Frequency (compatible) and Undersize



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0552	0.00	0.305	0.00	1.68	0.00	9.30	0.00	51.4	0.03	284	39.18	1570	100.00
0.0113	0.00	0.0624	0.00	0.345	0.00	1.90	0.00	10.5	0.00	58.0	0.03	321	51.38	1770	100.00
0.0128	0.00	0.0705	0.00	0.389	0.00	2.15	0.00	11.9	0.00	65.6	0.03	362	63.51	2000	100.00
0.0144	0.00	0.0796	0.00	0.440	0.00	2.43	0.00	13.4	0.00	74.1	0.03	409	74.64		
0.0163	0.00	0.0900	0.00	0.497	0.00	2.74	0.00	15.2	0.00	83.7	0.03	462	84.00		
0.0184	0.00	0.102	0.00	0.561	0.00	3.10	0.00	17.1	0.00	94.6	0.03	522	91.14		
0.0208	0.00	0.115	0.00	0.634	0.00	3.50	0.00	19.3	0.00	107	0.04	590	96.02		
0.0235	0.00	0.130	0.00	0.717	0.00	3.96	0.00	21.9	0.00	121	0.17	667	98.90		
0.0266	0.00	0.147	0.00	0.810	0.00	4.47	0.00	24.7	0.01	136	0.77	753	99.96		
0.0300	0.00	0.166	0.00	0.915	0.00	5.05	0.00	27.9	0.01	154	2.38	851	100.00		
0.0339	0.00	0.187	0.00	1.03	0.00	5.71	0.00	31.5	0.02	174	5.56	962	100.00		
0.0383	0.00	0.211	0.00	1.17	0.00	6.45	0.00	35.6	0.03	197	10.77	1090	100.00		
0.0433	0.00	0.239	0.00	1.32	0.00	7.29	0.00	40.2	0.03	222	18.25	1230	100.00		
0.0489	0.00	0.270	0.00	1.49	0.00	8.23	0.00	45.5	0.03	251	27.87	1390	100.00		

Measurement Details

Operator Name	michael.mercer
Sample Name	ES1728487 - 005
SOP File Name	HydroLV.cfg

Measurement Details

Analysis Date Time	21/11/2017 8:49:46 AM
Measurement Date Time	21/11/2017 8:49:46 AM
Result Source	Averaged

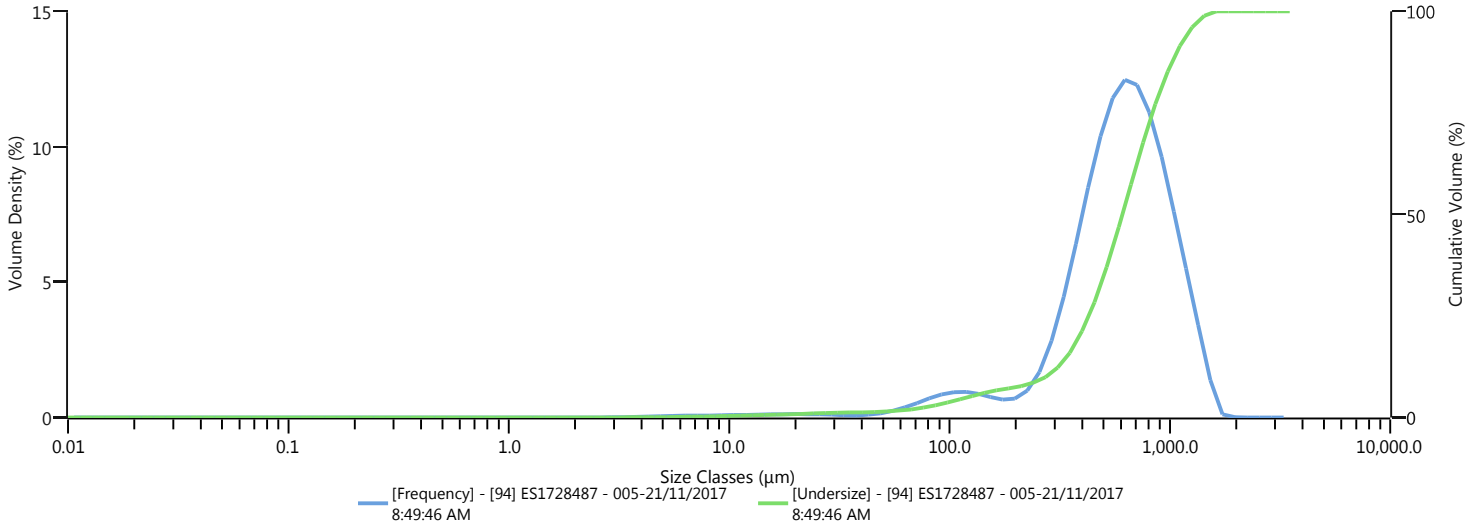
Analysis

Particle Name	ALS
Particle Refractive Index	1.550
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.98 %
Laser Obscuration	27.25 %

Result

Span	1.319
Uniformity	0.406
Specific Surface Area	19.60 m^2/kg
D [3,2]	306 µm
D [4,3]	642 µm
Dv (10)	274 µm
Dv (50)	609 µm
Dv (90)	1080 µm

Frequency (compatible) and Undersize



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0552	0.00	0.305	0.00	1.68	0.00	9.30	0.31	51.4	1.45	284	10.63	1570	99.67
0.0113	0.00	0.0624	0.00	0.345	0.00	1.90	0.00	10.5	0.38	58.0	1.63	321	13.23	1770	100.00
0.0128	0.00	0.0705	0.00	0.389	0.00	2.15	0.00	11.9	0.45	65.6	1.91	362	17.13	2000	100.00
0.0144	0.00	0.0796	0.00	0.440	0.00	2.43	0.00	13.4	0.53	74.1	2.32	409	22.55		
0.0163	0.00	0.0900	0.00	0.497	0.00	2.74	0.00	15.2	0.61	83.7	2.85	462	29.55		
0.0184	0.00	0.102	0.00	0.561	0.00	3.10	0.00	17.1	0.70	94.6	3.49	522	37.98		
0.0208	0.00	0.115	0.00	0.634	0.00	3.50	0.00	19.3	0.79	107	4.22	590	47.46		
0.0235	0.00	0.130	0.00	0.717	0.00	3.96	0.01	21.9	0.89	121	4.97	667	57.46		
0.0266	0.00	0.147	0.00	0.810	0.00	4.47	0.03	24.7	0.98	136	5.70	753	67.31		
0.0300	0.00	0.166	0.00	0.915	0.00	5.05	0.06	27.9	1.07	154	6.34	851	76.36		
0.0339	0.00	0.187	0.00	1.03	0.00	5.71	0.10	31.5	1.14	174	6.89	962	84.16		
0.0383	0.00	0.211	0.00	1.17	0.00	6.45	0.15	35.6	1.21	197	7.42	1090	90.42		
0.0433	0.00	0.239	0.00	1.32	0.00	7.29	0.20	40.2	1.26	222	8.05	1230	95.10		
0.0489	0.00	0.270	0.00	1.49	0.00	8.23	0.26	45.5	1.33	251	9.02	1390	98.18		

Measurement Details

Operator Name	michael.mercer
Sample Name	ES1728487 - 006
SOP File Name	HydroLV.cfg

Measurement Details

Analysis Date Time	21/11/2017 9:08:09 AM
Measurement Date Time	21/11/2017 9:08:09 AM
Result Source	Averaged

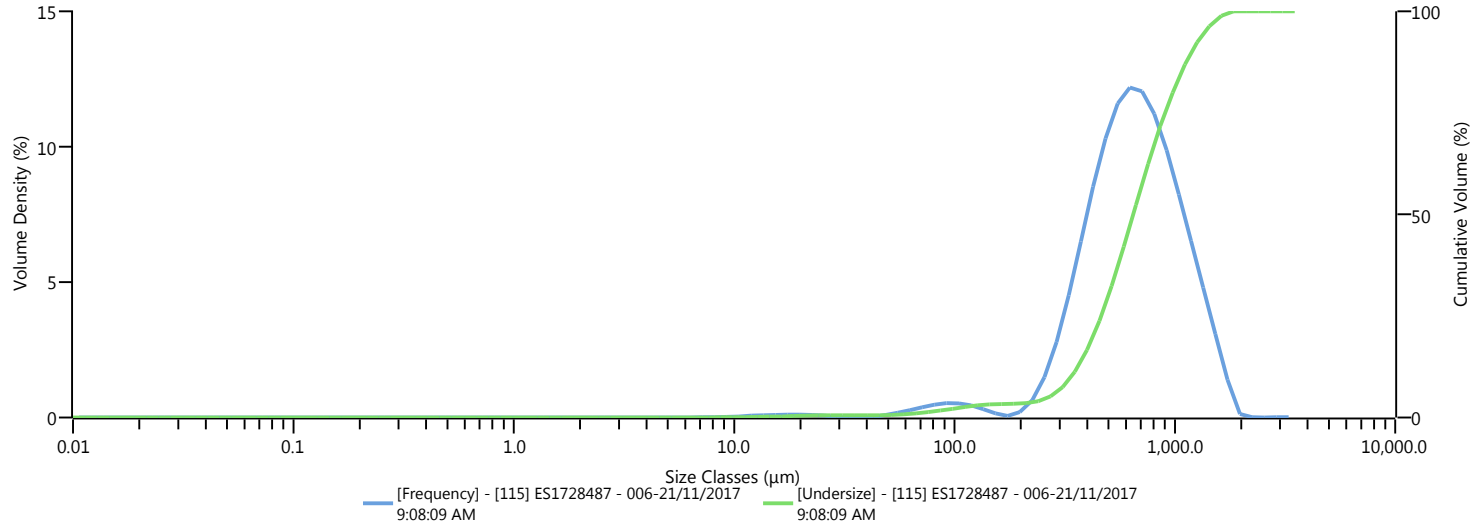
Analysis

Particle Name	ALS
Particle Refractive Index	1.550
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.94 %
Laser Obscuration	20.99 %

Result

Span	1.324
Uniformity	0.410
Specific Surface Area	13.56 m^2/kg
D [3,2]	442 µm
D [4,3]	707 µm
Dv (10)	337 µm
Dv (50)	647 µm
Dv (90)	1190 µm

Frequency (compatible) and Undersize



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0552	0.00	0.305	0.00	1.68	0.00	9.30	0.01	51.4	0.62	284	5.91	1570	98.10
0.0113	0.00	0.0624	0.00	0.345	0.00	1.90	0.00	10.5	0.02	58.0	0.75	321	8.50	1770	99.61
0.0128	0.00	0.0705	0.00	0.389	0.00	2.15	0.00	11.9	0.06	65.6	0.95	362	12.46	2000	100.00
0.0144	0.00	0.0796	0.00	0.440	0.00	2.43	0.00	13.4	0.12	74.1	1.22	409	17.95		
0.0163	0.00	0.0900	0.00	0.497	0.00	2.74	0.00	15.2	0.19	83.7	1.58	462	24.97		
0.0184	0.00	0.102	0.00	0.561	0.00	3.10	0.00	17.1	0.26	94.6	1.99	522	33.33		
0.0208	0.00	0.115	0.00	0.634	0.00	3.50	0.00	19.3	0.34	107	2.41	590	42.64		
0.0235	0.00	0.130	0.00	0.717	0.00	3.96	0.00	21.9	0.42	121	2.78	667	52.40		
0.0266	0.00	0.147	0.00	0.810	0.00	4.47	0.00	24.7	0.50	136	3.07	753	62.04		
0.0300	0.00	0.166	0.00	0.915	0.00	5.05	0.00	27.9	0.55	154	3.24	851	71.03		
0.0339	0.00	0.187	0.00	1.03	0.00	5.71	0.00	31.5	0.55	174	3.31	962	79.00		
0.0383	0.00	0.211	0.00	1.17	0.00	6.45	0.00	35.6	0.55	197	3.39	1090	85.74		
0.0433	0.00	0.239	0.00	1.32	0.00	7.29	0.00	40.2	0.55	222	3.68	1230	91.17		
0.0489	0.00	0.270	0.00	1.49	0.00	8.23	0.00	45.5	0.55	251	4.41	1390	95.29		

Analysis

Malvern Instruments

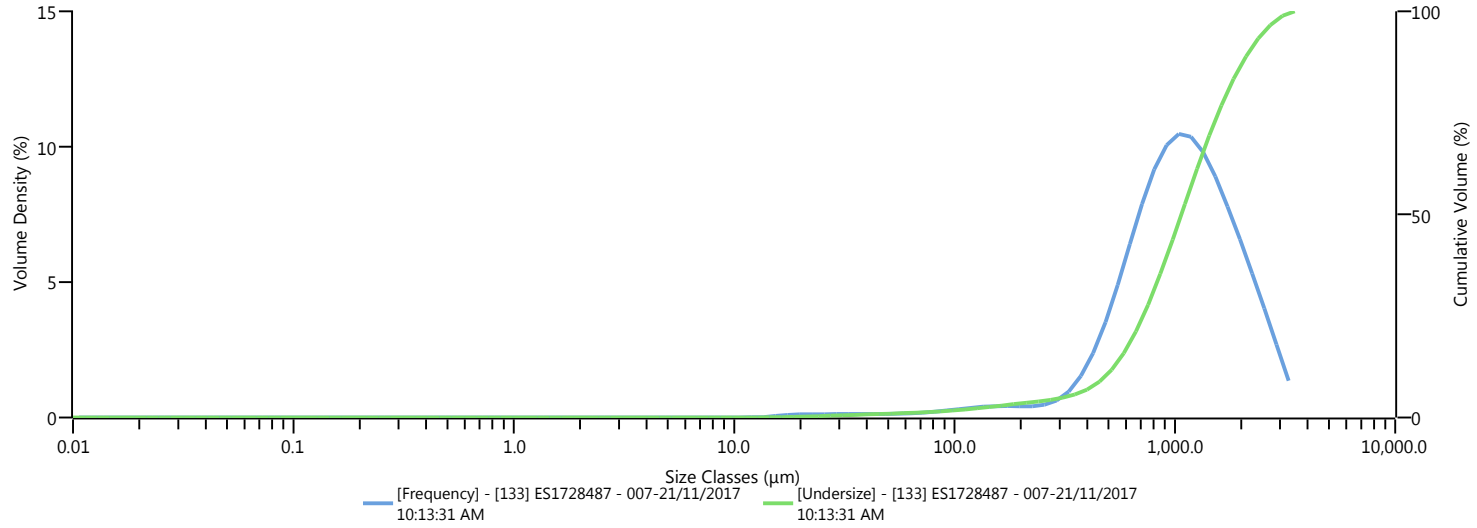
Measurement Details	
Operator Name	michael.mercer
Sample Name	ES1728487 - 007
SOP File Name	HydroLV.cfg

Measurement Details	
Analysis Date Time	21/11/2017 10:13:31 AM
Measurement Date Time	21/11/2017 10:13:31 AM
Result Source	Averaged

Analysis	
Particle Name	ALS
Particle Refractive Index	1.550
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	1.48 %
Laser Obscuration	28.56 %

Result	
Span	1.585
Uniformity	0.486
Specific Surface Area	9.615 m^2/kg
D [3,2]	624 µm
D [4,3]	1200 µm
Dv (10)	478 µm
Dv (50)	1070 µm
Dv (90)	2170 µm

Frequency (compatible) and Undersize



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0552	0.00	0.305	0.00	1.68	0.00	9.30	0.00	51.4	0.92	284	4.47	1570	74.65
0.0113	0.00	0.0624	0.00	0.345	0.00	1.90	0.00	10.5	0.00	58.0	1.03	321	5.03	1770	81.14
0.0128	0.00	0.0705	0.00	0.389	0.00	2.15	0.00	11.9	0.00	65.6	1.14	362	5.89	2000	86.73
0.0144	0.00	0.0796	0.00	0.440	0.00	2.43	0.00	13.4	0.00	74.1	1.28	409	7.21		
0.0163	0.00	0.0900	0.00	0.497	0.00	2.74	0.00	15.2	0.02	83.7	1.44	462	9.22		
0.0184	0.00	0.102	0.00	0.561	0.00	3.10	0.00	17.1	0.07	94.6	1.63	522	12.12		
0.0208	0.00	0.115	0.00	0.634	0.00	3.50	0.00	19.3	0.15	107	1.86	590	16.08		
0.0235	0.00	0.130	0.00	0.717	0.00	3.96	0.00	21.9	0.23	121	2.13	667	21.20		
0.0266	0.00	0.147	0.00	0.810	0.00	4.47	0.00	24.7	0.33	136	2.43	753	27.49		
0.0300	0.00	0.166	0.00	0.915	0.00	5.05	0.00	27.9	0.42	154	2.75	851	34.79		
0.0339	0.00	0.187	0.00	1.03	0.00	5.71	0.00	31.5	0.52	174	3.08	962	42.78		
0.0383	0.00	0.211	0.00	1.17	0.00	6.45	0.00	35.6	0.62	197	3.41	1090	51.12		
0.0433	0.00	0.239	0.00	1.32	0.00	7.29	0.00	40.2	0.72	222	3.73	1230	59.42		
0.0489	0.00	0.270	0.00	1.49	0.00	8.23	0.00	45.5	0.82	251	4.07	1390	67.35		

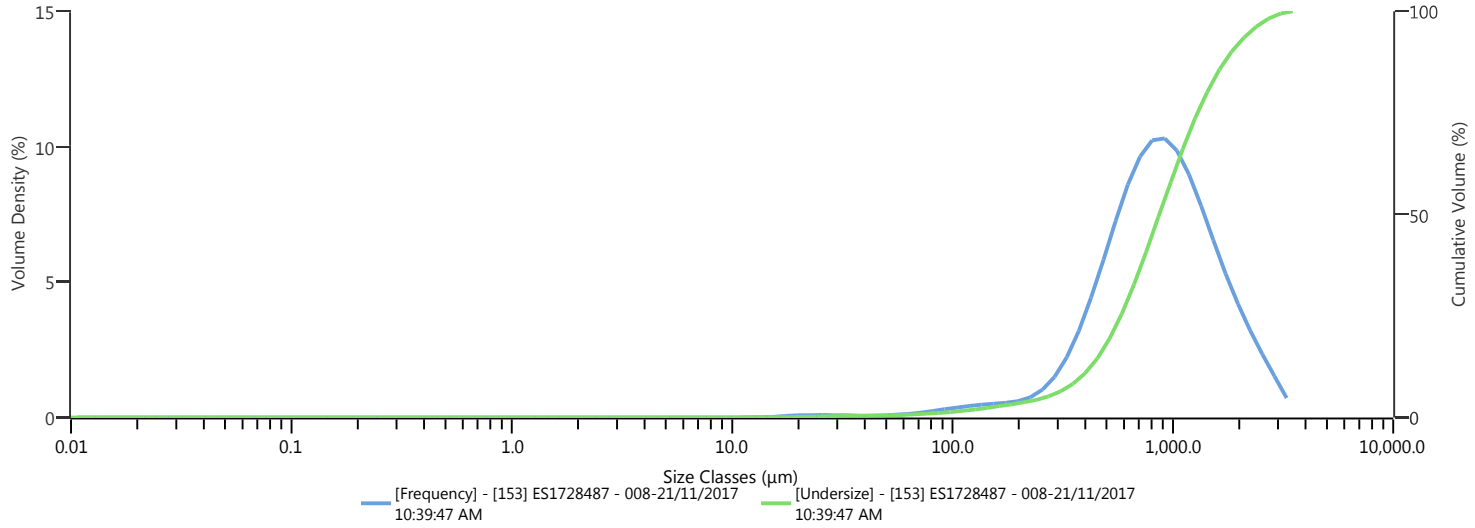
Measurement Details	
Operator Name	michael.mercer
Sample Name	ES1728487 - 008
SOP File Name	HydroLV.cfg

Measurement Details	
Analysis Date Time	21/11/2017 10:39:47 AM
Measurement Date Time	21/11/2017 10:39:47 AM
Result Source	Averaged

Analysis	
Particle Name	ALS
Particle Refractive Index	1.550
Particle Absorption Index	0.100
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	1.13 %
Laser Obscuration	28.08 %

Result	
Span	1.685
Uniformity	0.520
Specific Surface Area	10.33 m^2/kg
D [3,2]	581 µm
D [4,3]	1010 µm
Dv (10)	383 µm
Dv (50)	869 µm
Dv (90)	1850 µm

Frequency (compatible) and Undersize



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0552	0.00	0.305	0.00	1.68	0.00	9.30	0.00	51.4	0.54	284	5.56	1570	84.00
0.0113	0.00	0.0624	0.00	0.345	0.00	1.90	0.00	10.5	0.00	58.0	0.61	321	6.90	1770	88.53
0.0128	0.00	0.0705	0.00	0.389	0.00	2.15	0.00	11.9	0.00	65.6	0.71	362	8.83	2000	92.18
0.0144	0.00	0.0796	0.00	0.440	0.00	2.43	0.00	13.4	0.00	74.1	0.84	409	11.56		
0.0163	0.00	0.0900	0.00	0.497	0.00	2.74	0.00	15.2	0.01	83.7	1.01	462	15.24		
0.0184	0.00	0.102	0.00	0.561	0.00	3.10	0.00	17.1	0.03	94.6	1.24	522	20.00		
0.0208	0.00	0.115	0.00	0.634	0.00	3.50	0.00	19.3	0.08	107	1.51	590	25.86		
0.0235	0.00	0.130	0.00	0.717	0.00	3.96	0.00	21.9	0.15	121	1.83	667	32.74		
0.0266	0.00	0.147	0.00	0.810	0.00	4.47	0.00	24.7	0.21	136	2.19	753	40.45		
0.0300	0.00	0.166	0.00	0.915	0.00	5.05	0.00	27.9	0.28	154	2.58	851	48.62		
0.0339	0.00	0.187	0.00	1.03	0.00	5.71	0.00	31.5	0.34	174	3.00	962	56.86		
0.0383	0.00	0.211	0.00	1.17	0.00	6.45	0.00	35.6	0.40	197	3.44	1090	64.78		
0.0433	0.00	0.239	0.00	1.32	0.00	7.29	0.00	40.2	0.45	222	3.97	1230	72.07		
0.0489	0.00	0.270	0.00	1.49	0.00	8.23	0.00	45.5	0.49	251	4.63	1390	78.51		

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1728487**	Page	: 1 of 8
Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Telephone	: +61-2-8784 8555
Project	: JN17169 MERIMBULA DEEP OCEAN OUTFALL - BENTHIC FAUNA	Date Samples Received	: 14-Nov-2017
Site	: ----	Issue Date	: 21-Nov-2017
Sampler	: ----	No. of samples received	: 8
Order number	: ----	No. of samples analysed	: 8

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type / Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Quality Control Specification
Laboratory Control Samples (LCS)					
TKN as N By Discrete Analyser	2	15	13.33	14.29	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Total Mercury by FIMS (Low Level)	0	14	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container* / Client Sample ID(s)	*Sample Date*	*Extraction / Preparation* Date extracted	Due for extraction	Evaluation	*Analysis* Date analysed	Due for analysis	Evaluation
EA055: Moisture Content (Dried @ 105-110°C)							
Soil Glass Jar - Unpreserved (EA055) SIS01_9/11/17	**09-Nov-2017**	**----**	----	----	**16-Nov-2017**	23-Nov-2017	✓
Soil Glass Jar - Unpreserved (EA055) SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**----**	----	----	**16-Nov-2017**	24-Nov-2017	✓
EG005-SD: Total Metals in Sediments by ICP-AES							
Soil Glass Jar - Unpreserved (EG005-SD) SIS01_9/11/17	**09-Nov-2017**	**16-Nov-2017**	08-May-2018	✓	**16-Nov-2017**	08-May-2018	✓
Soil Glass Jar - Unpreserved (EG005-SD) SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**16-Nov-2017**	09-May-2018	✓	**16-Nov-2017**	09-May-2018	✓
EG020-SD: Total Metals in Sediments by ICPMS							
Soil Glass Jar - Unpreserved (EG020-SD) SIS01_9/11/17	**09-Nov-2017**	**16-Nov-2017**	08-May-2018	✓	**16-Nov-2017**	08-May-2018	✓
Soil Glass Jar - Unpreserved (EG020-SD) SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**16-Nov-2017**	09-May-2018	✓	**16-Nov-2017**	09-May-2018	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS							
Soil Glass Jar - Unpreserved (EG035T-LL)							
SIS01_9/11/17	**09-Nov-2017**	**16-Nov-2017**	07-Dec-2017	✓	**17-Nov-2017**	07-Dec-2017	✓
Soil Glass Jar - Unpreserved (EG035T-LL)							
SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**16-Nov-2017**	08-Dec-2017	✓	**17-Nov-2017**	08-Dec-2017	✓
EK055: Ammonia as N							
Soil Glass Jar - Unpreserved (EK055)							
SIS01_9/11/17	**09-Nov-2017**	**----**	----	----	**21-Nov-2017**	08-May-2018	✓
Soil Glass Jar - Unpreserved (EK055)							
SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**----**	----	----	**21-Nov-2017**	09-May-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK057G)							
SIS01_9/11/17	**09-Nov-2017**	**17-Nov-2017**	08-May-2018	✓	**17-Nov-2017**	08-May-2018	✓
Soil Glass Jar - Unpreserved (EK057G)							
SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**17-Nov-2017**	09-May-2018	✓	**17-Nov-2017**	09-May-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK059G)							
SIS01_9/11/17	**09-Nov-2017**	**17-Nov-2017**	08-May-2018	✓	**17-Nov-2017**	08-May-2018	✓
Soil Glass Jar - Unpreserved (EK059G)							
SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**17-Nov-2017**	09-May-2018	✓	**17-Nov-2017**	09-May-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Soil Glass Jar - Unpreserved (EK061G)							
SIS01_9/11/17	**09-Nov-2017**	**17-Nov-2017**	08-May-2018	✓	**17-Nov-2017**	08-May-2018	✓
Soil Glass Jar - Unpreserved (EK061G)							
SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**17-Nov-2017**	09-May-2018	✓	**17-Nov-2017**	09-May-2018	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK067G)							
SIS01_9/11/17	**09-Nov-2017**	**17-Nov-2017**	08-May-2018	✓	**17-Nov-2017**	08-May-2018	✓
Soil Glass Jar - Unpreserved (EK067G)							
SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**17-Nov-2017**	09-May-2018	✓	**17-Nov-2017**	09-May-2018	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Soil Glass Jar - Unpreserved (EK071G)							
SIS01_9/11/17	**09-Nov-2017**	**17-Nov-2017**	08-May-2018	✓	**17-Nov-2017**	08-May-2018	✓
Soil Glass Jar - Unpreserved (EK071G)							
SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**17-Nov-2017**	09-May-2018	✓	**17-Nov-2017**	09-May-2018	✓
EP003: Total Organic Carbon (TOC) in Soil							
Pulp Bag (EP003)							
SIS01_9/11/17	**09-Nov-2017**	**20-Nov-2017**	07-Dec-2017	✓	**20-Nov-2017**	07-Dec-2017	✓
Pulp Bag (EP003)							
SIS02_10/11/17, SIS03_10/11/17, SIS04_10/11/17, SIS05_10/11/17, SIS06_10/11/17, SIS07_10/11/17, SIS08_10/11/17	**10-Nov-2017**	**20-Nov-2017**	08-Dec-2017	✓	**20-Nov-2017**	08-Dec-2017	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Buchi Ammonia	EK055	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	2	15	**13.33**	**9.52**	✓	NEPM 2013 B3 & ALS QC Standard
Total Fe and Al in Sediments by ICPAES	EG005-SD	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Sediments by ICPMS	EG020-SD	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Buchi Ammonia	EK055	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	2	15	**13.33**	**14.29**	×	NEPM 2013 B3 & ALS QC Standard
Total Fe and Al in Sediments by ICPAES	EG005-SD	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Sediments by ICPMS	EG020-SD	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	3	14	**21.43**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Buchi Ammonia	EK055	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	15	**6.67**	**4.76**	✓	NEPM 2013 B3 & ALS QC Standard
Total Fe and Al in Sediments by ICPAES	EG005-SD	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Sediments by ICPMS	EG020-SD	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS)							
Buchi Ammonia	EK055	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	15	**6.67**	**4.76**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	0	14	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Total Metals in Sediments by ICPMS	EG020-SD	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Total Fe and Al in Sediments by ICPAES	EG005-SD	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3). LORs per NODG
Total Metals in Sediments by ICPMS	EG020-SD	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector. Analyte list and LORs per NODG.
Total Mercury by FIMS (Low Level)	EG035T-LL	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Buchi Ammonia	EK055	SOIL	In house: Referenced to APHA 4500-NH3 B&G, H Samples are steam distilled (Buchi) prior to analysis and quantified using titration, FIA or Discrete Analyser.
Nitrite as N - Soluble by Discrete Analyser	EK057G	SOIL	In house: Referenced to APHA 4500-NO3- B. Nitrite in a water extract is determined by direct colourimetry by Discrete Analyser.
Nitrate as N - Soluble by Discrete Analyser	EK058G	SOIL	In house: Referenced to APHA 4500-NO3- F. Nitrate in the 1:5 soil:water extract is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results.
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	SOIL	In house: Thermo Scientific Method D08727 and NEMI (National Environmental Method Index) Method ID: 9171. This method covers the determination of total oxidised nitrogen (NOx-N) and nitrate (NO3-N) by calculation, Combined oxidised Nitrogen (NO2+NO3) in a water extract is determined by direct colourimetry by Discrete Analyser.
TKN as N By Discrete Analyser	EK061G	SOIL	In house: Referenced to APHA 4500-Norg-D Soil samples are digested using Kjeldahl digestion followed by determination by Discrete Analyser.
Total Nitrogen as N (TKN + NOx) By Discrete Analyser	EK062G	SOIL	In house: Referenced to APHA 4500 Norg/NO3- Total Nitrogen is determined as the sum of TKN and Oxidised Nitrrogen, each determined seperately as N.
Total Phosporus By Discrete Analyser	EK067G	SOIL	In house: Referenced to APHA 4500 P-B&F This procedure involves sulfuric acid digestion and quantification using Discrete Analyser.
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	SOIL	In house: Referenced to APHA 4500 P-F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3) (

Analytical Methods	Method	Matrix	Method Descriptions
Total Organic Carbon	EP003	SOIL	In house C-IR17. Dried and pulverised sample is reacted with acid to remove inorganic Carbonates, then combusted in a LECO furnace in the presence of strong oxidants / catalysts. The evolved (Organic) Carbon (as CO2) is automaticaly measured by infra-red detector.

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	SOIL	In house: Referenced to APHA 4500 Norg- D; APHA 4500 P - H. Macro Kjeldahl digestion.
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (2013) Schedule B(3) (Method 202)
Dry and Pulverise (up to 100g)	GEO30	SOIL	#

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES1728487**

Client	: **ELGIN ASSOCIATES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR NICK YEE	Contact	: Peter Ravlic
Address	: PO BOX 829 BEGA NSW, AUSTRALIA 2550	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: nick.yee@elgin.com.au	E-mail	: peter.ravlic@alsglobal.com
Telephone	: +61 02 8003 4590	Telephone	: +61-2-8784 8555
Facsimile	: +61 03 8648 6336	Facsimile	: +61-2-8784 8500
Project	: JN17169 MERIMBULA DEEP OCEAN OUTFALL - BENTHIC FAUNA	Page	: 1 of 2
Order number	: ----	Quote number	: EM2017ELGASS0003 (ME/222/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	:		

Dates

Date Samples Received	: 14-Nov-2017 08:30	Issue Date	: 14-Nov-2017
Client Requested Due Date	: 21-Nov-2017	Scheduled Reporting Date	: **21-Nov-2017**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 14.5'C
Receipt Detail	:	No. of samples received / analysed	: 8 / 8

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **TOC analysis will be conductd by ALS Brisbane.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **PSD analysis will be conducted by ALS Newcastle.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EA055-103 Moisture Content	SOIL - EA153 Particle Size Analysis of Soils by Laser	SOIL - EK067G (Solids) Total Phosphorus as P by Discrete Analyser	SOIL - EK071G (solids) Reactive Phosphorus as P By Discrete	SOIL - EP003 Total Organic Carbon (TOC) in Soil	SOIL - NT-8S NH3, NO2, NO3, NOX, TKN, TN, TP	SOIL - SD-03 Metals by ICPMS (15 metals + low level Hg)
ES1728487-001	09-Nov-2017 00:00	SIS01_9/11/17	✓	✓	✓	✓	✓	✓	✓
ES1728487-002	10-Nov-2017 00:00	SIS02_10/11/17	✓	✓	✓	✓	✓	✓	✓
ES1728487-003	10-Nov-2017 00:00	SIS03_10/11/17	✓	✓	✓	✓	✓	✓	✓
ES1728487-004	10-Nov-2017 00:00	SIS04_10/11/17	✓	✓	✓	✓	✓	✓	✓
ES1728487-005	10-Nov-2017 00:00	SIS05_10/11/17	✓	✓	✓	✓	✓	✓	✓
ES1728487-006	10-Nov-2017 00:00	SIS06_10/11/17	✓	✓	✓	✓	✓	✓	✓
ES1728487-007	10-Nov-2017 00:00	SIS07_10/11/17	✓	✓	✓	✓	✓	✓	✓
ES1728487-008	10-Nov-2017 00:00	SIS08_10/11/17	✓	✓	✓	✓	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

LUKE FINLEY

- A4 - AU Tax Invoice (INV)	Email	luke.finley@elgin.com.au

NICK YEE

- *AU Certificate of Analysis - NATA (COA)	Email	nick.yee@elgin.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	nick.yee@elgin.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	nick.yee@elgin.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	nick.yee@elgin.com.au
- A4 - AU Tax Invoice (INV)	Email	nick.yee@elgin.com.au
- Chain of Custody (CoC) (COC)	Email	nick.yee@elgin.com.au
- EDI Format - ENMRG (ENMRG)	Email	nick.yee@elgin.com.au
- EDI Format - ESDAT (ESDAT)	Email	nick.yee@elgin.com.au

CHAIN OF CUSTODY

SYDNEY: 277 WOODPARK ROAD, SMITHFIELD NSW 2176
Ph: 02 8784 8555 Email: samples.sydney@alsenviro.com

NEWCASTLE: 5 ROSEGUM ROAD, WARABROOK NSW 2304
Ph: 02 4968 9433 Email: samples.newcastle@alsenviro.com

BRISBANE: 32 SHAND STREET, STAFFORD QLD 4053
Ph: 07 3243 7222 Email: samples.brisbane@alsenviro.com

21/11/17

CLIENT: ELGIN ASSOCIATES	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace	FOR LABORATORY USE ONLY (Circle)
OFFICE: 1st Floor, 45-47 CHURCH ST, BEGA, NSW 2550		Custody Seal Intact? Yes No N/A
PROJECT: JN17169 Merimbula Deep Ocean Outfall - Benthic Fauna	ALS QUOTE NO.: SY/585/17	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:	COC SEQUENCE NUMBER (Circle) COC 1 2 3 4 5 7	Random Sample Temperature on Receipt: 1.4.5
PROJECT MANAGER: NICK YEE	CONTACT PH: 0400 365 234	Other comments:
SAMPLER:	SAMPLER MOBILE:	
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	
Email Reports to: nick.yee@elgin.com.au		
Email Invoice to : nick.yee@elgin.com.au		

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Elgin Assoc.			Kim
DATE/TIME: 13/11/17 12:00	DATE/TIME:	DATE/TIME:	DATE/TIME: 14-11-17 8:30am

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: MARINE SEDIMENTS

ALS USE ONLY	SAMPLE DETAILS (MATRIX: Solid(S) Water(W))			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).										Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	SD3 - TOTAL METALS (Al, Fe, Sb, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, V, Zn, Hg)	NT05 - Nutrients (TN, NO3, NO2, NOx, NH3)	EK067 Total Phosphorous	EK071 PO4	EP003 Total Organic Carbon	EA153 Grain Size Particle Distribution					
1	SiS01_9/11/17	9/11	S		3	x	x	x	x	x	x					
2	SiS02_10/11/17	10/11	S		3	x	x	x	x	x	x					
3	SiS03_10/11/17	10/11	S		3	x	x	x	x	x	x					
4	SiS04_10/11/17	10/11	S		3	x	x	x	x	x	x					
5	SiS05_10/11/17	10/11	S		3	x	x	x	x	x	x					
6	SiS06_10/11/17	10/11	S		3	x	x	x	x	x	x					
7	SiS07_10/11/17	10/11	S		3	x	x	x	x	x	x					
8	SiS08_10/11/17	10/11	S		4	x	x	x	x	x	x					QC sample
					TOTAL											

Sediment Container Codes:

Forward Lab / Sub WO Analysis:
Originated By / Date: JCC Bris
Relinquished By / Date:
Courier: PSP Nercart
WO No:
Alt PO / Internal

All samples frozen

Environmental Division Sydney
Work Order Reference
ES1728487

Telephone : + 61-2-8784 8555

APPENDIX F

Intertidal Rocky Shore Community

Appendix F-1. List of invertebrates and algae recorded on intertidal reef at Haycock Point, NSW.

Phylum	Class	Order	Family	Taxon	Shore Height		
					High	Mid	Low
INVERTEBRATES							
Mollusca	Gastropoda	Littorinimorpha	Littorinidae	*Austrolittorina unifasciata*	x	x	x
				Bembicium nanum		x	
		Neogastropoda	Muricidae	*Tenguella marginalba*		x	
				Dicathais orbita			x
		Cycloneritimorpha	Neritidae	*Nerita atramentosa*	x	x	
			Trochidae	*Austrocochlea porcata*		x	x
				Austrocochlea concamerata		x	
			Nacellidae	*Cellana tramoserica*		x	x
			Lottiidae	*Patelloida latistrigata*	x	x	x
			Lottiidae	*Patelloida alticostata*		x	x
				Patelloida mufria		x	x
			Fissurellidae	*Montfortula rugosa*		x	x
			Patellidae	*Scutellastra peronii*			x
		Siphonariida	Siphonariidae	*Siphonaria diemensis*		x	x
	Polyplacophora	Chitonida	Chitonidae	*Sypharochiton pelliserpentis*			
				Onithochiton quercinus			x
Arthropoda (subphylum Crustacea)	Maxillipoda	Sessilia	Tetraclitidae	*Tesseropora rosea*		x	x
				Tetraclitella purpurascens		x	
			Catophragmidae	*Catomerus polymerus*		x	
			Cthamalidae	*Chamaesipho tasmanica*	x	x	
				Chthamalus antennatus		x	
Cnidaria	Anthozoa	Actinaria	Actiniidae	*Actinia tenebrosa*		x	x
		Actinaria	Actiniidae	*Oulactis mucosa*			x
Chordata	Ascidiacea	Stolibranchia	Pyuridae	*Pyura stolonifera-praeputialis*			x
Echinodermata	Echinoidea (urchins	Camarodonta	Echinometridae	*Heliocidaris erythrogramma*			x
	Asteroidea	Valvatida	Asterinidae	*Meridiastra sp.*			x
Annelida	Polychaeta	Sabellida	Serpulidae	*Galeolaria caespitiosa*			x
ALGAE							
Ochrophyta	Phaeophyceae	Ralfsiales	Ralfsiaceae	*Ralfsia sp.*		x	x
		Ectocarpales	Chordariales	*Leathesia difformis*			x
		Fucales	Sargassaceae	*Sargassum sp.*			x
			Hormosiraceae	*Hormosira banksii*		x	x
			Seirococcaceae	*Phyllospora comsosa*			x
		Dictyotales	Dictyotaceae	*Padina sp.*			x
				Dictyota dichotoma			x
		Scytothamnales	Splachnidiaceae	*Splachnidium rugosum*		x	
Rhodophyta	Bangiophyceae	Bangiales	Bangiaceae	*Porphyra lucasii*	x		
Rhodophyta	Florideophyceae	Ceramiales	Rhodomelaceae	*Laurencia sp.*			x
				Chondrophycus sp.			x
		Corallinales	Corallinaceae	*Corallina officinalis*			x
				Amphiroa anceps			x
				non-geniculate encrusting coralline algae			x
		Gigartinales	Cystocloniaceae	*Hypnea* sp.			x
		Gelidales	Gelidiaceae	turfing red algae (*Gelidium/Gelidiella spp.*)			x
Chlorophyta	Ulvophyceae	Ulvales	Ulvaceae	*Ulva* spp.		x	x
		Bryopsidales	Codiaceae	*Codium lucasii*			x
		Cladophorales	Cladophoraceae	filamentous green algae (*Cladophora/Rhizoclonium/Chaetomorpha* spp.)		x	x
				TOTAL TAXA	**5**	**23**	**35**

Note
Taxa recorded during field survey conducted at low tide on 1 December 2017 and 2 January 2018.
Taxonomy follows currently accpeted nomenclature from:
WoRMS Editorial Board (2017). World Register of Marine Species. Available from URL: http://www.marinespecies.org

Appendix F-2. Low Shore Intertidal Community Data

SAMPLE	**S1T1**												
SITE and TRANSECT	S1T1Q1	S1T1Q2	S1T1Q3	S1T1Q4	S1T1Q5	S1T1Q6	S1T1Q7	S1T1Q8	S1T1Q9	S1T1Q10	S1T1Q11	S1T1Q12	S1T1Q13
Austrolittorina unifasciata													
Austrococchlea porcata													
Dicathais orbita	3				3		3				1	1	
Cellana tramoserica	5	3	5	2	8	8	1	1		5	10	13	6
Siphonaria diemenensis	1												6
Patelloida latistrigata					36	2	1	1					11
Patelloida alticostata							1				1		
Patelloida mufria												10	
Montfortula rugosa					1						2		
Scutellastra chapmani													
Scutellastra peronii	7	7	2	3	14	10	6	2	7		8	4	4
Onithochiton quercinus												2	1
Meridiastra sp	1	3	3	1			1		1				
Heliocidaris erythrogramma													
BARE ROCK	12	4	6	10	26	8	8	2	8	2	8	2	8
Saccostrea glomerata													
Actinia tenebrosa													
Oulactis mucosa													
Pyura stolonifera	56	56	58	46	24	24	28	36	42	32	38	58	52
Galeolaria	14	16	6	10	6	4	8			2	8		4
Tesseropora rosea (live)					2	2							
turfing algae (*Gelidium/Gelidiella* spp)					2			2					
Encrusting non-geniculate coralline	10	14	8	4	6	2	12	4	22		16	26	26
Corallina officinalis				2	24	16	2		4	8	10		
Foliose red												2	
Amphiroa													
Hypnea sp.													
Laurencia sp.					4			2	4				
Chondrophycus									2				
Sargassum spp	8	2	10	22	2	36	40	52	14	56	16	12	4
Splanchnidum rugosum													
Hormosira		2	6	4									
Encrusting algae (*Ralfsia*)		4	6		4	4		2					6
Padina sp.													
Dictyota dichotoma									2				
Phyllospora comosa													
Lethesia sp.													
Ulva		2				4	2				4		
green filamentous (*cladophora/chaetomorpha*)									2				
Codium lucasii				2									
Taxon richness gastropods	4	2	2	2	5	3	5	3	1	1	5	4	4
Taxon richness Invertebrates	1	1	1	1	0	0	1	0	1	0	0	1	1
Taxon richness sessile	4	7	6	7	9	8	6	6	8	4	6	4	5
Taxon richness	9	10	9	10	14	11	12	9	10	5	11	9	10
% Cover	100	100	100	100	100	100	100	100	100	100	100	100	100

Appendix F-2. Low Shore Intertidal Com

SAMPLE	**S1T2**											
SITE and TRANSECT	S1T2Q1	S1T2Q2	S1T2Q3	S1T2Q4	S1T2Q5	S1T2Q6	S1T2Q7	S1T2Q8	S1T2Q9	S1T2Q10	S1T2Q11	S1T2Q12
Austrolittorina unifasciata								1				
Austrocochlea porcata			5									
Dicathais orbita											1	
Cellana tramoserica								5	4			
Siphonaria diemenensis								1	1			
Patelloida latistrigata								6				
Patelloida alticostata												
Patelloida mufria								2				
Montfortula rugosa	1		1	2			2					
Scutellastra chapmani												
Scutellastra peronii						2		4	3	2	6	7
Onithochiton quercinus	1					1						
Meridiastra sp	4											
Heliocidaris erythrogramma				1								
BARE ROCK	2	2				2		6	10	2		
Saccostrea glomerata												
Actinia tenebrosa												
Oulactis mucosa	2											
Pyura stolonifera			4	6	6	2	16	8	50	48	32	24
Galeolaria									2			
Tesseropora rosea (live)								2				
turfing algae (*Gelidium/Gelidiella* spp)	10	6										
Encrusting non-geniculate coralline				4		2	2		2	6	2	12
Corallina officinalis	44	54	80	54	36	40	48	48				6
Foliose red												
Amphiroa	2	6		2	28	16	2					
Hypnea sp.												
Laurencia sp.					4		8	20		4		
Chondrophycus		4		2								
Sargassum spp	4	6			4	2	4	4	20	36	66	52
Splanchnidum rugosum												
Hormosira	8		2				8					
Encrusting algae (*Ralfsia*)				4			2	2	16	4		6
Padina sp.												
Dictyota dichotoma												
Phyllospora comosa					22	34		4				
Lethesia sp.	4	20	12	20			2					
Ulva	2		2	8		2	8	6				
green filamentous (*cladophora/chaetomorpha*)												
Codium lucasii	22	2										
Taxon richness gastropods	1	0	2	1	0	1	1	6	3	1	2	1
Taxon richness Invertebrates	2	0	0	1	0	1	0	0	0	0	0	0
Taxon richness sessile	9	7	5	8	6	7	10	8	5	5	3	5
Taxon richness	12	7	7	10	6	9	11	14	8	6	5	6
% Cover	100	100	100	100	100	100	100	100	100	100	100	100

Appendix F-2. Low Shore Intertidal Com

SAMPLE	**S2T1**											
SITE and TRANSECT	S2T1Q1	S2T1Q2	S2T1Q3	S2T1Q4	S2T1Q5	S2T1Q6	S2T1Q7	S2T1Q8	S2T1Q9	S2T1Q10	S2T1Q11	S2T1Q12
Austrolittorina unifasciata												
Austrococchlea porcata												
Dicathais orbita								1				
Cellana tramoserica					1			1	1			
Siphonaria diemenensis	2							1	1	2		
Patelloida latistrigata										12		
Patelloida alticostata												
Patelloida mufria							1			1		
Montfortula rugosa	5	3	1		1		1					
Scutellastra chapmani												
Scutellastra peronii	3	1										
Onithochiton quercinus	1											
Meridiastra sp						1	2		2	1		
Heliocidaris erythrogramma												
BARE ROCK	2	2				2	2	2	4		6	2
Saccostrea glomerata												
Actinia tenebrosa												
Oulactis mucosa												
Pyura stolonifera	4	4	10	8					6	4	2	22
Galeolaria										2		
Tesseropora rosea (live)												
turfing algae (*Gelidium/Gelidiella* spp)		2	4									
Encrusting non-geniculate coralline		8									2	2
Corallina officinalis	84	58	40	18	72	44	38	58	50	36	28	34
Foliose red												
Amphiroa							6	4	22	10	32	8
Hypnea sp.							2					
Laurencia sp.	2	2			6			12	4	4		
Chondrophycus		2		2	6	24	24	2	10	8	6	10
Sargassum spp		2			8	4	6	4		4	2	4
Splanchnidum rugosum												
Hormosira												
Encrusting algae (*Ralfsia*)												
Padina sp.						2	2	6				2
Dictyota dichotoma	4	8			8	14	8	6		14		8
Phyllospora comosa	4	12	46	72		4	8				20	
Lethesia sp.						6	4	4	4	2		4
Ulva								2				
green filamentous (*cladophora/chaetomorpha*)												
Codium lucasii										16	2	4
Taxon richness gastropods	3	2	1	0	2	0	2	3	2	3	0	0
Taxon richness Invertebrates	1	0	0	0	0	1	1	0	1	1	0	0
Taxon richness sessile	5	9	4	4	5	7	9	9	6	10	8	10
Taxon richness	9	11	5	4	7	8	12	12	9	14	8	10
% Cover	100	100	100	100	100	100	100	100	100	100	100	100

Appendix F-2. Low Shore Intertidal Com

SAMPLE	**S2T2**											
SITE and TRANSECT	S2T2Q1	S2T2Q2	S2T2Q3	S2T2Q4	S2T2Q5	S2T2Q6	S2T2Q7	S2T2Q8	S2T2Q9	S2T2Q10	S2T2Q11	S2T2Q12
Austrolittorina unifasciata												
Austrocochlea porcata												1
Dicathais orbita	2	1										
Cellana tramoserica	3	2										
Siphonaria diemenensis	1						1					
Patelloida latistrigata	5											
Patelloida alticostata												
Patelloida mufria												
Montfortula rugosa	2	20		2						1		8
Scutellastra chapmani												
Scutellastra peronii	2											6
Onithochiton quercinus	1		2	2								
Meridiastra sp			5	7			1					
Heliocidaris erythrogramma	2		2	3			1					
BARE ROCK	2	4		2			10				2	
Saccostrea glomerata												
Actinia tenebrosa												
Oulactis mucosa												
Pyura stolonifera	48	52	10	20	12		68	2	2	22	14	40
Galeolaria	4	2										
Tesseropora rosea (live)												
turfing algae (*Gelidium/Gelidiella* spp)												
Encrusting non-geniculate coralline	10	20	2								2	
Corallina officinalis	2	4	44	46	40	56	2	54	58	52	44	34
Foliose red												
Amphiroa	4	8	16	18	14	6		4	16	4	4	2
Hypnea sp.												
Laurencia sp.	2										2	
Chondrophycus						4		2	2			
Sargassum spp	2	4			2	4					6	2
Splanchnidum rugosum												
Hormosira											2	2
Encrusting algae (*Ralfsia*)	14					2	6				2	8
Padina sp.												
Dictyota dichotoma			12		10				2			2
Phyllospora comosa	12	6			6	26	14	30	4	10	4	2
Lethesia sp.			10	8	6	2		6	8	2	14	4
Ulva								2	2	4		
green filamentous (*cladophora/chaetomorpha*)												
Codium lucasii			6	6	10				6	6	4	4
Taxon richness gastropods	6	3	0	1	0	0	1	0	0	1	0	3
Taxon richness Invertebrates	2	0	3	3	0	0	2	0	0	0	0	0
Taxon richness sessile	9	7	7	5	8	7	4	7	9	7	11	10
Taxon richness	17	10	10	9	8	7	7	7	9	8	11	13
% Cover	100	100	100	100	100	100	100	100	100	100	100	100

APPENDIX G

PHYTOPLANKTON ASSEMBLAGE

APPENDIX G

Appendix G-1. Total phytoplankton species list from five separate studies conducted from 1965 to 2012 at a long term coastal station offshore from Sydney – Port Hacking 100m (PH_{100m}).
Note - taxa known to produce toxins in Australia are shaded in grey.

Actinocyclus spp.	*Akashiwo spp.*	*Amphidinium spp.*
Amphidinium turbo	*Amphisolenia bidentata*	*Amphisolenia globifera*
Amphisolenia sp.	*Amphora hendeyi*	*Amphora spp.*
Anthosphaera spp.	*Asterionellopsis glacialis*	*Asteromphalus heptactis*
Asteromphalus hookeri	*Asteromphalus spp.*	*Bacillaria sp.*
Bacteriastrum furcatum	*Bacteriastrum hyalinum*	*Bacteriastrum spp.*
Bacteriastrum varians	*Bellerochea spp.*	*Biddulphia chinensis*
Biddulphia mobiliensis	*Biddulphia spp.*	*Brachidinium capitatum*
Brachidinium spp.	*Cerataulina bergonii*	*Cerataulina chapmanii*
Cerataulina pelagica	*Cerataulina pentagonum*	*Cerataulina spp.*
Ceratium arietinum	*Ceratium buceros*	*Ceratium candelabrum*
Ceratium concilians	*Ceratium declinatum*	*Ceratium extensum*
Ceratium falcatum	*Ceratium furca*	*Ceratium fusus*
Ceratium gibberum	*Ceratium gravidum*	*Ceratium horridum*
Ceratium inflatum	*Ceratium karsteni*	*Ceratium kofoidii*
Ceratium lineatum	*Ceratium longissimum*	*Ceratium macroceros*
Ceratium massiliense	*Ceratium pentagonum*	*Ceratium platycorne*
Ceratium spp.	*Ceratium tenue*	*Ceratium teres*
Ceratium trichoceros	*Ceratium tripos*	*Ceratium vultur*
Ceratoneis closterium	*cf. Alexandrium sp*	*cf. Trigonium sp.*
Chaetoceros affine	*Chaetoceros atlanticus*	*Chaetoceros compressus*
Chaetoceros curvisetus	*Chaetoceros danicus*	*Chaetoceros decipiens*
Chaetoceros didymus	*Chaetoceros diversum*	*Chaetoceros eibenii*
Chaetoceros lorenzianus	*Chaetoceros peruvianus*	*Chaetoceros secundum*
Chaetoceros spp.	*Chaetoceros subtilis*	*Chaetoceros teres*
Chrysochromulina spp.	*Climacodium frauenfeldianum*	*Climacodium spp.*
Climacosphenia sp.	*Coccolithophorid spp.*	*Cocconeis spp.*
Cochlodinium sp.	*Corethron criophilum*	*Corethron pennatum*
Corethron spp.	*Corythodinium elegans/tesselatum*	*Coscinodiscus concinnis*
Coscinodiscus radiatus	*Coscinodiscus spp.*	*Coscinodiscus wailesii*
Cryptomonads spp.	*Cyclotella sp.*	*Dactyliosolen blavyanus*
Dactyliosolen fragilissimus	*Dactyliosolen mediterraneus*	*Dactyliosolen phuketensis*
Dactyliosolen spp.	*Detonula pumila*	*Dictyocha fibula*
Dictyocha octonaria	*Dictyocha spp.*	*Dinophysis acuminata*
Dinophysis acuta	*Dinophysis caudata*	*Dinophysis dens*
Dinophysis fortii	*Dinophysis miles*	*Dinophysis mitra*
Dinophysis ovum	*Dinophysis rotundata*	*Dinophysis schroederi*
Dinophysis sphaerica	*Dinophysis spp.*	*Dinophysis tripos*
Dinophysis truncata	*Diploneis fusca*	*Diploneis spp.*
Diplopsalis lenticula	*Diplopsalis sphaerica*	*Diplopsalis spp.*
Discosphaera spp.	*Dissodinium sp.*	*Ditylum brightwelli*
Ditylum sol	*Ebria tripartita*	*Emiliania huxleyi/Gephyrocapsa oceania*
Entomoneis sp.	*Eucampia cornuta*	*Eucampia spp.*
Eucampia zodiacus	*Euglena spp.*	*Eutreptiella spp.*
Fragilariopsis oceanica	*Fragilariopsis spp.*	*Fragilariopsis striatula*
Goniodoma spp.	*Gonyaulax digitale*	*Gonyaulax kofoidii*
Gonyaulax minima	*Gonyaulax pacifica*	*Gonyaulax polygramma*
Gonyaulax spp.	*Guinardia cylindrus*	*Guinardia delicatula*
Guinardia delicatula/Dactyliosolen fragillissimus	*Guinardia flaccida*	*Guinardia spp.*
Guinardia striata	*Gymnodinium flavum*	*Gymnodinium spp.*
Gyrodinium spp.	*Helicosphaera spp.*	*Helicotheca spp.*
Helicotheca tamesis	*Hemiaulus hauckii*	*Hemiaulus indicus*
Hemiaulus membranaceus	*Hemiaulus spp.*	*Heterocapsa triquetra*
Heterosigma spp.	*Histioneis hyalina*	*Histoneis tubifera*
Hyalodiscus stelliger	*Karenia spp.*	*Lauderia annulata*
Lauderia borealis	*Lauderia spp.*	*Leptocylindricus spp.*
Leptocylindrus danicus	*Leptocylindrus mediterraneus*	*Leptocylindrus minimus*
Leptocylindrus spp.	*Leptocylindrus spp./Cerataulina spp.*	*Licmophora spp.*

APPENDIX G

Licomorpha abbreviata
Melanodinium nigricans
Melosira nummuloides
Mesodinium rubrum
Miniscula spp.
Nitzschia bicapitata
Nitzschia pacifica
Odontella aurita
Ornithocercus sp.
Oxytoxum coronatum
Oxytoxum laticeps
Oxytoxum obliqum
Oxytoxum spp.
Phalacroma argus
Phalacroma rotundatum
Planktoniella spp.
Podolampas elegans
Proboscia alata
Prorocentrum compressum
Prorocentrum lima
Prorocentrum rostratum
Prorocentrum triestinum
Protoperidinium crassipes
Protoperidinium elegans
Protoperidinium minusculus
Protoperidinium orbiculare
Protoperidinium pentagonum
Protoperidinium steini
Pseudo-nitzschia spp.
Ptychodiscus sp.
Pyrocystis robusta
Rhizosolenia cf. fallax
Rhizosolenia delicatula
Rhizosolenia spp.
Rhodomonas spp.
Skeletonema spp.
Stephanopyxis spp.
Striatella unipunctata
Synedra spp.
Tetraselmis spp.
Thalassionema spp.
Thalassiosira decipiens
Thalassiosira rotula
Thalassiothrix elongata
Thalassiothrix sp./Lioloma sp.
Lioloma spp.
Melosira crenulata
Melosira polaris
Meuniera membranacea
Navicula septentrionalis
Nitzschia brightwellii
Nitzschia spp.
Odontella sp.
Oxytoxum caudatum
Oxytoxum curvatum
Oxytoxum longiceps
Oxytoxum scolopax
Oxytoxum turbo
Phalacroma doryphorum
Plagioselmis spp.
Pleurosigma sp./Gyrosigma sp.
Podolampas palmipes
Pronoctiluca sp.
Prorocentrum dentatum
Prorocentrum micans
Prorocentrum schilleri
Protoperidinium bipes
Protoperidinium decipiens
Protoperidinium excentricum
Protoperidinium monacanthum
Protoperidinium ovatum
Protoperidinium pyriforme
Protoperidinium tenuissimum
Pseudosolenia spp.
Pyramimonas spp.
Pyrophacus horologicum
Rhizosolenia cf. imbricata
Rhizosolenia robusta
Rhizosolenia stolterfothii
Scrippsiella spp.
Stauroneis spp.
Stephanopyxis turris
Strombidium spp.
Syracosphaera cf. pulchra
Thalassionema frauenfeldii
Thalassiosira cf. partheneia
Thalassiosira fragillissima
Thalassiosira spp.
Thalassiothrix frauenfeldii
Thalassiothrix spp.
Lithodesmium spp.
Melosira moniliformis
Melosira spp.
Micromonas spp.
Navicula spp.
Nitzschia longissima
Noctiluca scintillans
Ornithocercus magnificus
Oxytoxum cf. nanum
Oxytoxum gladiolus
Oxytoxum milneri
Oxytoxum sphaeoideum
Phaeocystis spp.
Phalacroma ovum
Planktoniella sol
Pleurosigma spp.
Podolampas spinifer
Pronoctiluca spinifera
Prorocentrum gracile
Prorocentrum minimum
Prorocentrum spp.
Protoperidinium breve
Protoperidinium divergens
Protoperidinium globulus
Protoperidinium oceanicum
Protoperidinium pellucidum
Protoperidinium spp.
Protoperidinium tuba
Ptychodiscus noctiluca
Pyrocystis lunula
Pyrophacus spp.
Rhizosolenia cf. styliformis
Rhizosolenia setigera
Rhizosolenia styliformis
Scrippsiella trochoidea
Stephanopyxis palmeriana
Striatella spp.
Synedra acus
Syracosphaera spp.
Thalassionema nitzschioides
Thalassiosira condensata
Thalassiosira gravida
Thalassiosira subtilis
Thalassiothrix nitzschioides
Trichodesmium erythraeum

APPENDIX G

Appendix G-2. Merimbula Lake (site 2) phytoplankton enumeration (total species counts) from two sampling periods from 12/6/2012 to 10/6/2012 and from 3/8/2014 to 9/6/2015 (Data provided by NSW Food Authority and Microalgal Services)

Taxon		**12/6/2012 to 10/6/2013**	**3/8/2014 to 9/6/2015**
Diatoms		**Max cells^{-1}**	**Max cells^{-1}**
Acanthoceras	*sp.*	0	0
Achnanthes	*sp.*	0	5000
Actinocyclus	*sp.*	0	0
Actinoptychus	*sp.*	0	0
Amphora	*sp.*	9000	10000
Anaulus	*australis*	0	0
Ardissonea	*crystallina*	0	0
Asterionellopsis	*glacialis*	0	4000
Asteromphalus	*heptactis*	0	0
Asteromphalus	*sarcophagus*	0	170000
Attheya	*sp.*	0	0
Aulacoseira	*sp.*	0	0
Auliscus	*sp.*	0	0
Bacillaria	*paxillifera*	0	7500
Bacteriastrum	*elegans*	0	55000
Bellerochea	*malleus*	0	0
Biddulphia	*sp.*	0	0
Biddulphiopsis	*sp.*	0	0
Campylodiscus	*sp.*	0	0
Cerataulina	*pelagica*	30000	14000
Ceratoneis	*closterium*	160000	245000
Chaetoceros	*spp.*	876000	2000000
Climacodium	*sp.*	0	0
Climacosphaenia	*sp.*	0	0
Cocconeis	*spp.*	24000	6000
Corethron	*criophilum*	0	0
Coscinodiscus	*spp.*	5000	10000
Cyclophora	*tenuis*	0	30000
Cyclotella	*spp.*	22000	65000
Cymbella	*sp.*	0	0
Dactyliosolen	*antarcticus*	18000	85000
Dactyliosolen	*fragilissimus*	30000	20000
Dactyliosolen	*phukutensis*	50000	0
Dactyliosolen	*sp.*	0	0
Detonula	*pumilla*	0	1500
Diploneis	*sp.*	3000	0
Ditylum	*brightwellii*	0	0
Encyonema	*sp.*	0	0
Entomoneis	*sp.*	5000	26000
Eucampia	*zodiacus*	30000	10000
Eunotia	*sp.*	0	0
Fallacia	*sp.*	0	0
Fragilaria	*sp.*	14000	10000
Fragilariopsis	*sp.*	0	0
Gomphonema	*sp.*	0	0
Grammotophora	*serpentina*	8000	0
Guinardia	*delicatula*	0	15000
Guinardia	*flaccida*	0	2000
Guinardia	*striata*	20000	42000

APPENDIX G

Gyrosigma	*spp.*	0	0
Haslea	*wawrikae*	0	500
Helicotheca	*tamesis*	0	0
Hemiaulus	*sp.*	0	2500
Hemidiscus	*sp.*	0	0
Hyalodiscus	*sp.*	0	0
Lauderia	*annulata*	0	10000
Leptocylindrus	*danicus*	55000	100000
Leptocylindrus	*mediterraneus*	0	0
Leptocylindrus	*minimus*	70000	4500000
Licmophora	*sp.*	6000	10000
Lioloma	*pacifica*	5000	30000
Lithodesmium	*sp.*	0	0
Mastogloea	*sp.*	0	0
Melosira	*sp.*	0	0
Membraneis	*sp.*	0	0
Meunieria	*membranacea*	0	0
Minidiscus	*trioculatus*	8000	41000
Minutocellus	*scriptua*	4000	25000
Naviculoid	*spp.*	25000	25000
Nitzschia	*spp.*	35000	20000
Nitzschia	*longissima*	0	0
Nitzschia	*sigmoidea*	0	0
Odontella	*sp.*	0	0
Paralia	*sulcata*	0	2000
Pinnularia	*sp.*	0	0
Plagiotropis	*sp.*	0	2000
Planktoniella	*sol*	0	0
Pleurosigma	*sp.*	2000	5000
Proboscia	*alata*	10000	10000
Pseudo-nitzschia	*spp.*	0	0
Pseudo-nitzschia	*delicatissima* group	21500	320000
Pseudo-nitzschia	*fraudulenta/australis*	1000	8500
Pseudo-nitzschia	*cf. galaxiae*	0	0
Pseudo-nitzschia	*heimii*	0	0
Pseudo-nitzschia	*multistriata*	0	24000
Pseudo-nitzschia	*pungens/multiseries*	1500	30000
Pseudo-nitzschia	*subcurvata*	0	0
Pseudo-nitzschia	*subpacifica/heimii*	1000	14000
Pseudo-nitzschia	*dolorosa/turgidula*	0	1000
Pseudosolenia	*calcar-avis*	0	0
Rhizosolenia	*spp.*	5000	4000
Rhizosolenia	*setigera*	0	30000
Rhopalodia	*sp.*	0	0
Skeletonema	*costatum*	4000000	1480000
Stauroneis	*sp.*	0	0
Stephanopyxis	*turris*	0	0
Striatella	*unipunctata*	4000	5000
Surirella	*sp.*	0	500
Synedra	*sp.*	0	0
Tabellaria	*sp.*	0	0
Thalassionema	*sp.*	20000	10000
Thalassiosira	*sp.*	12000	65000
Thalassiosira	*cf. mala*	120000	285000

Thalassiothrix	*sp.*	0	0
Triceratium	*spp.*	0	0
Trigonium	*sp.*	0	0
Urosolenia	*eriensis*	0	0
Dinoflagellates			
Akashiwo	*sanguinea*	100	0
Alexandrium	*total*	0	0
Alexandrium	*affine*	0	0
Alexandrium	*catenella/fundyense*	50	0
Alexandrium	*fraterculus*	0	0
Alexandrium	*insuetum*	100	150
Alexandrium	*margalefi*	0	100
Alexandrium	*minutum*	0	0
Alexandrium	*ostenfeldii*	0	50
Alexandrium	*pseudogonyaulax*	500	1000
Alexandrium	*tamarense*	0	0
Alexandrium	*sp.*	0	0
Amphidinium	*sp.*	15000	5000
Amphidinium	*carterae*	0	0
Amylax	*sp.*	0	0
Ceratium	*biceps*	0	0
Ceratium	*candelabrum*	0	0
Ceratium	*concillians*	0	0
Ceratium	*furca*	12000	500
Ceratium	*fusus*	0	500
Ceratium	*hirundinella*	0	0
Ceratium	*lineatum*	0	1000
Ceratium	*macroceros*	0	0
Ceratium	*pentagonum*	0	0
Ceratium	*setaceum*	0	0
Ceratium	*symmetricum*	0	0
Ceratium	*tenue*	0	500
Ceratium	*teres*	0	0
Ceratium	*tripos*	0	0
Ceratocorys	*horridum*	0	0
Coolia	*monotis*	0	0
Cochlodinium	*sp.*	0	4000
Corythodinium	*constrictum*	0	0
Corythodinium	*tesselatum*	0	0
Dinophysis	*acuminata*	100	200
Dinophysis	*acuta*	0	50
Dinophysis	*caudata*	4050	800
Dinophysis	*fortii*	0	0
Dinophysis	*hastata*	0	0
Dinophysis/Phalacroma	*mitra*	0	0
Dinophysis/Phalacroma	*rotundatum*	200	100
Dinophysis	*tripos*	0	0
Diplopsalid	*spp.*		4000
Fragilidium	*subglobosum*	0	0
Gambierdiscus	*sp.*	800	450
Goniodoma	*sp.*	0	0
Gonyaulax	*spp.*	0	10000
Gymnodinioid	*spp.*	72000	150000

Gymnodinium	*cf. impudicum*	200	0
Gyrodinium	*spp.*	20000	20000
Heterocapsa	*spp.*	0	0
Heterocapsa	*rotundata*	35000	45000
Karenia	*brevis*	0	0
Karenia	*mikimotoi*	0	0
Karenia	*papilionacea*	0	50
Karenia	*sp.*	0	1500
Karlodinium	*spp.*	500	500
Katodinium	*sp.*	6000	500
Kryptoperidinium	*foliaceum*	0	0
Lepidodinium	*chlorophorum*	0	10000
Lingulodinium	*polyedrum*	0	0
Mesoporus	*perforatus*	0	1000
Noctiluca	*scintillans*	50	100
Oblea	*sp.*	0	0
Ornithocercus	*magnificus*	0	0
Ostreopsis	*sp.*	50	250
Oxyphysis	*oxytoxoides*	0	0
Oxyrrhis	*marina*	0	0
Oxytoxum	*scolopax*	0	0
Oxytoxum	*spp.*	0	1000
Peridinium	*sp.*	12000	45000
Peridinium	*quinquecorne*	0	0
Podolampas	*sp.*	0	0
Polykrykos	*schwartzii*	500	1500
Preperidinium	*meuneri*	0	0
Pronoctiluca	*spinifera*	0	1000
Prorocentrum	*sp.*	0	0
Prorocentrum	*compressum*	0	0
Prorocentrum	*cordatum*	39000	8500
Prorocentrum	*dentatum*	0	4500
Prorocentrum	*emarginatum*	100	0
Prorocentrum	*excavatum*	0	0
Prorocentrum	*gracile*	6000	12000
Prorocentrum	*lima*	50	100
Prorocentrum	*lima var. marina*	50	0
Prorocentrum	*micans*	0	0
Prorocentrum	*rhathymum*	1200	3500
Prorocentrum	*rostratum*	0	0
Prorocentrum	*triestinum*	4000	16000
Protoceratium	*reticulatum*	0	0
Protoperidinium	*spp.*	4000	15000
Protoperidinium	*avellana*	0	0
Protoperidinium	*bipes*	0	0
Protoperidinium	*brevipes*	0	0
Protoperidinium	*claudicans*	0	0
Protoperidinium	*conicum*	0	0
Protoperidinium	*crassipes*	0	0
Protoperidinium	*depressum*	0	0
Protoperidinium	*divergens*	0	0
Protoperidinium	*elegans*	0	0
Protoperidinium	*latissimum*	0	0
Protoperidinium	*leonis*	0	0

Protoperidinium	*minutum*	0	0
Protoperidinium	*nudum*	0	0
Protoperidinium	*oceanicum*	0	0
Protoperidinium	*oblongum*	0	0
Protoperidinium	*obtusum*	0	0
Protoperidinium	*pallidum/pellucidum*	0	0
Protoperidinium	*pentagonum*	0	0
Protoperidinium	*punctulatum*	0	0
Protoperidinium	*steinii*	0	0
Protoperidinium	*subinerme*	0	0
Protoperidinium	*subpyriforme*	0	0
Protoperidinium	*thorianium*	0	0
Pyrocystis	*lunula*	0	0
Pyrophacus	*horologium*	0	0
Scrippsiella	*trochoidea*	3000	20000
Sinophysis	*microcephala*	0	0
Takayama	*pulchella*	450	1000
Thecadinium	*sp.*	0	0
Torodinium	*sp.*	0	1000
Warnowia	*sp.*	0	0
Chrysophytes			
Calycomonas	*sp.*	0	15000
Dinobryon	*sp.*	25000	15000
Meringiosphaera	*mediterranea*	4000	40000
Ochromonas	*spp.*	12000	30000
Paraphysomonas	*spp.*	0	0
Prymnesiophytes			
Acanthoica	*sp.*	0	0
Calciopappus	*caudatus*	16000	10000
Calciosolenia	*sp.*	0	0
Chrysochromulina	*spp.*	176000	114000
Corymbellus	*sp.*	0	0
Emiliania	*huxleyi*	48000	90000
Gephyrocapsa	*oceanica*	0	0
Paraphysomonas	*sp.*	0	0
Phaeocystis	*pouchetii colonies*	0	0
Phaeocystis	*pouchetii cells*	0	0
Prymnesium	*patellifera*	0	2000
Syracosphaera	*sp.*	0	2000
Unidentified	*spp.*	0	0
		0	0
Cryptophytes			
Campylomonas	*reflexa*	0	0
Chroomonas	*spp.*	0	0
Cryptomonas	*sp.*	0	0
Goniomonas	*truncata*	0	0
Hemiselmis	*sp.*	93000	120000
Leucocryptos	*marina*	8000	10000
Plagioselmis	*prolonga*	104000	95000
Rhodomonas	*salina*	0	5000
Rhodomonas	*sp.*	0	0
Storeatula	*major*	0	0

Teleaulax	*acuta*	20000	25000
Chlorophytes			
Ankistrodesmus	*sp.*	0	0
Arthrodesmus	*sp.*	0	0
Brachiomonas	*sp.*	0	0
Carteria	*sp.*	0	0
Chlamydomonas	*sp.*	0	0
Chlorella	*sp.*	0	0
Closterium	*sp.*	0	0
Crucigenia	*sp.*	0	0
Klebsormidium	*sp.*	0	0
Oltmansiellopsis	*lineata*	0	0
Oocystis	*sp.*	0	0
Pediastrum	*sp.*	0	0
Scenedesmus	*sp.*	0	0
Spirogyra	*sp.*	0	0
Staurastrum	*sp.*	0	0
Xanthidium	*sp.*	0	0
Unidentified	*filament*	0	0
Unidentified	*colonial cells*	0	0
Prasinophytes			
Micromonas	*pusilla*	0	0
Cymbomonas	*tetramitiformis*	0	10000
Halosphaera	*viridis*	25000	2000
Nephroselmis	*pyriformis*	8000	12000
Prasinopapilla	*sp.*		500
Pterosperma	*sp.*	18000	15000
Pyramimonas	*spp.*	70000	75000
Tetraselmis	*spp.*	83000	60000
Euglenophyta			
Euglena	*spp.*	0	0
Eutreptiella	*spp.*	12000	20000
Phacus	*spp.*	0	0
Trachelomonas	*spp.*	0	0
Cyanoprokaryota			
Anabena	*sp.*	0	0
Aphanothece	*sp.*	0	0
Arthrospira	*sp.*	0	0
Gloeocapsa	*sp.*	0	0
Merismopedia	*sp.*	0	0
Microcystis	*aeruginosa*	0	0
Microcystis	*sp.*	0	0
Microcystis	*viridis*	0	0
Oscillatoria	*sp.*	0	0
Phormidium	*sp.*	0	0
Planktolyngbya	*sp.*	0	0
Pseudanabaena	*sp.*	0	0
Rhabdoderma	*sp.*	0	0
Spriulina	*sp.*	0	0
Synechococcus	*sp.*	0	0

Trichodesmium	*erythraeum*	0	0
Other			
Actinomonad	*sp*	0	0
Apedinella	*spinifera*	28000	16000
Bicosoeca	*spp.*	78000	0
Chattonella	*spp.*	0	500
Diaphanoeca	*grandis*	0	0
Ebria	*tripartita*	5000	1000
Dictyocha	*fibula*	0	500
Dictyocha	*octonaria*	150	2500
Fibrocapsa	*japonica*	0	2500
Heterosigma	*akashiwo*	0	4500
Pedinella	*sp.*	0	0
Pseudochattonella	*sp.*	0	1000
Pseudopedinella	*pyriforme*	0	0
Stephanoeca	*sp.*	12000	0
Telonema	*subtilis*	0	0
Unidentified	amoeba	0	0
Unidentified	bodonids	20000	0
Unidentified	choanoflagellates	5000	5000
Unidentified	coccoid cells (5µm)	0	0
Unidentified	coccoid cells (8µm)	0	0
Unidentified	flagellates	27000	8000
Unidentified	heterotrophic flagellates	5000	0

APPENDIX G

Appendix G-3. Phytoplankton Action Limits (PALs) for harvest area closure which are used to trigger sampling of shellfish flesh (Appendix 6 in NSW Marine Biotoxin Management Plan 2015).

Phytoplankton species	Toxin	Trigger flesh sampling# (cells per litre)	Alert level – Close harvest area pending flesh testing results	Issue public health warning (cells per litre)
Alexandrium minutum#	PSP	200	500	5000
Alexandrium ostenfeldii#	PSP	200	500	5000
Alexandrium catenella#	PSP	200	500	5000
Alexandrium tamarense#	PSP	200	500	5000
Alexandrium spp#.	PSP (?)			
Gymnodinium catenatum	PSP	1000 mussels 2000 other shellfish	5000	5000
Pseudonitzschia (P.multiseries & P.australis)*	ASP	50,000	500,000	N/A
Pseudonitzschia delicatissima group - historically non-toxic in Australia	ASP (?)	500,000		N/A
Karenia cf brevis	NSP	1000		5000
Dinophysis acuminata	DSP	1000		N/A
Dinophysis acuta	DSP	500		N/A
Dinophysis caudata	DSP	500		N/A
Dinophysis fortii	DSP	500		N/A
Dinophysis hastata	DSP	500		N/A
Dinophysis mitra	DSP	500		N/A
Dinophysis rotundata	DSP	500		N/A
Dinophysis tripos	DSP	500		N/A
Total Dinophysis spp.	DSP	500		N/A
Prorocentrum lima	DSP	500		N/A

Note: For *Pseudonitzschia spp.* risk remains high for a minimum of two weeks post bloom crash.

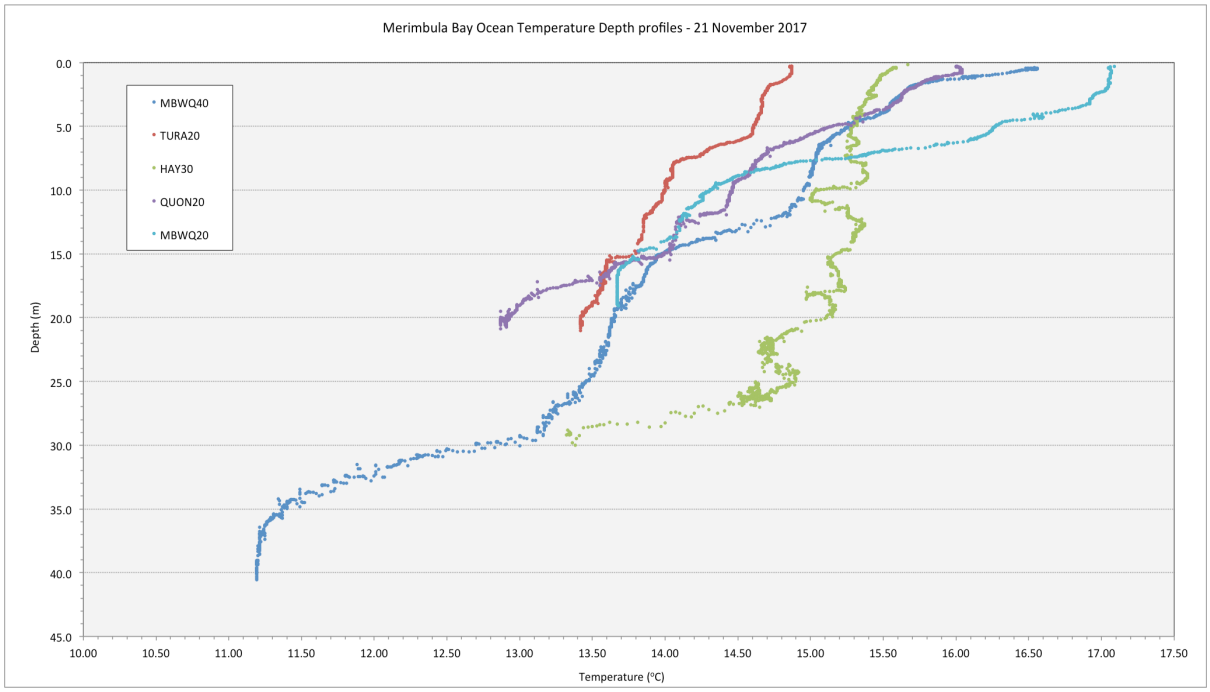
The cell levels within each toxin group are cumulative, eg 600 cells/l of both *D. acuta* and *D. fortii* would mean a total count of 1200 cells/l, exceeding the critical level to initiate flesh testing.

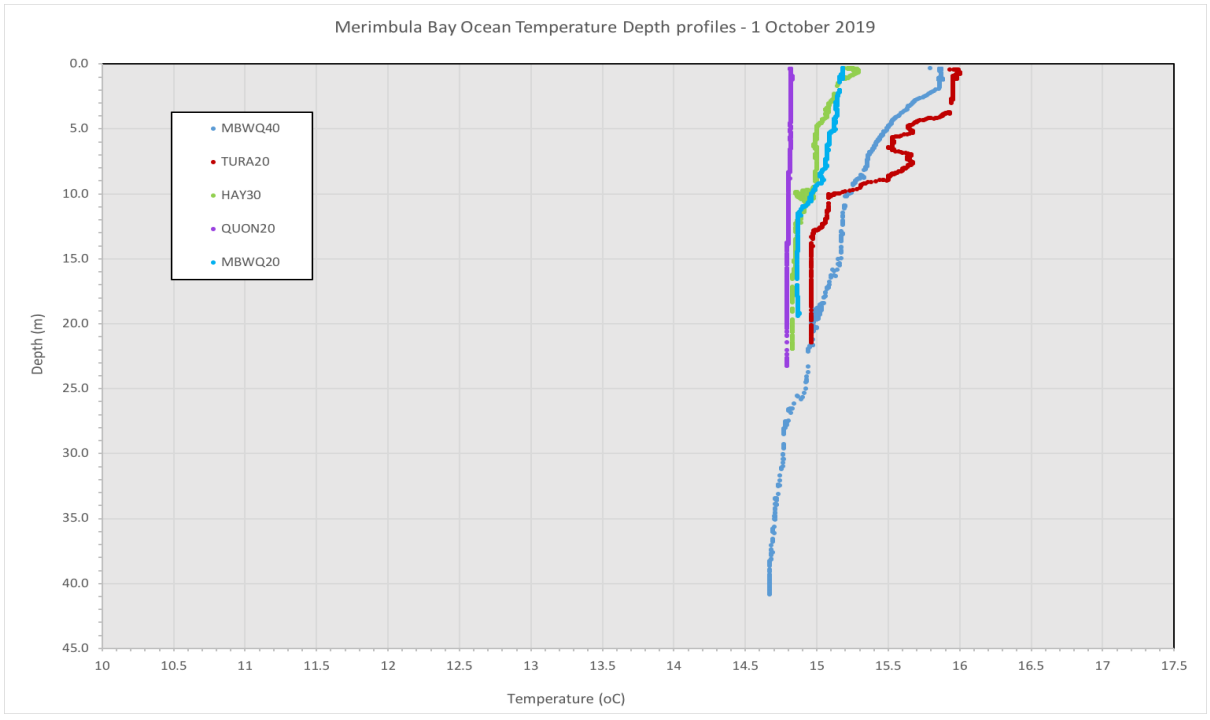
Alexandrium species may be difficult to identify when numbers are low. If any doubt exists, they should be treated as potentially toxic.

* Species within the Pseudo-nitzchia groups are difficult to identify. The toxic species of most concern in each group are listed for those laboratories that have capacity to identify these algae to species level. Otherwise all algae within these groups should be considered potentially toxic.

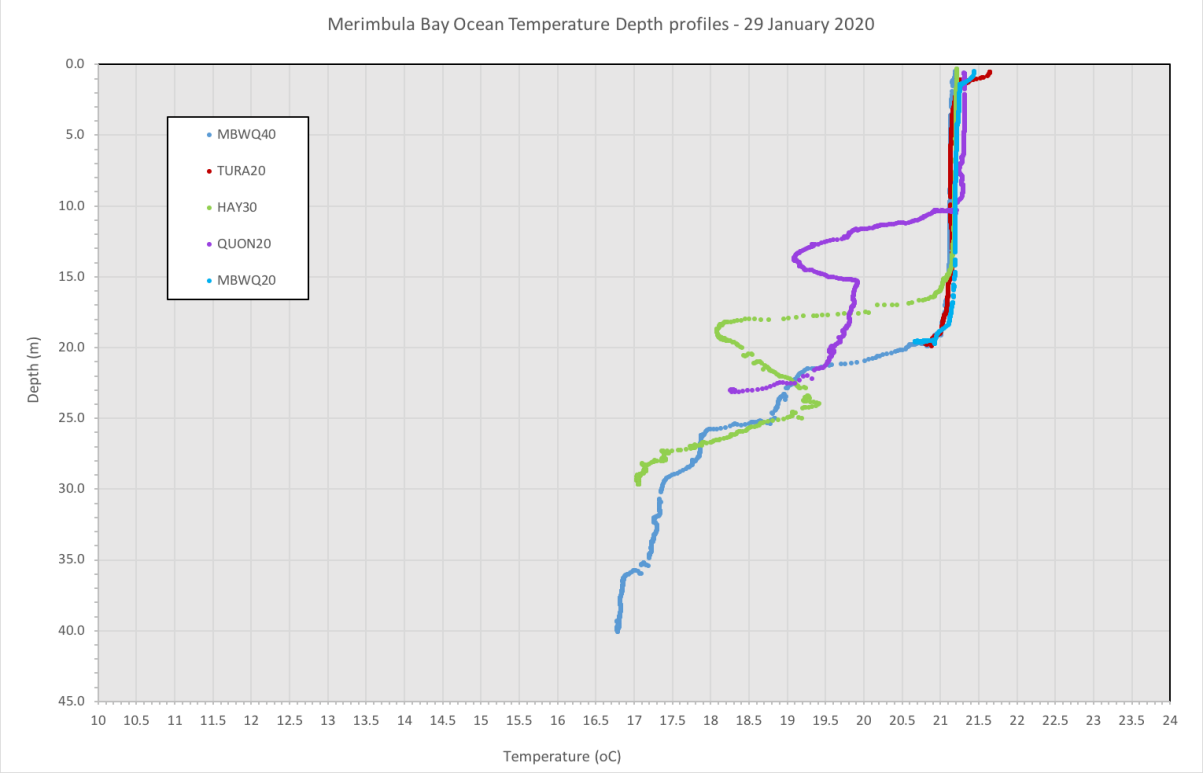
APPENDIX G

Appendix G-4 Water Quality Depth Profiles





APPENDIX G


Merimbula Bay Ocean Temperature Depth profiles - 29 January 2020
MBWQ40
TURA20
HAY30
QUON20
MBWQ20
Depth (m)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
10
10.5
11
11.5
12
12.5
13
13.5
14
14.5
15
15.5
16
16.5
17
17.5
18
18.5
19
19.5
20
20.5
21
21.5
22
22.5
23
23.5
24
Temperature (oC)

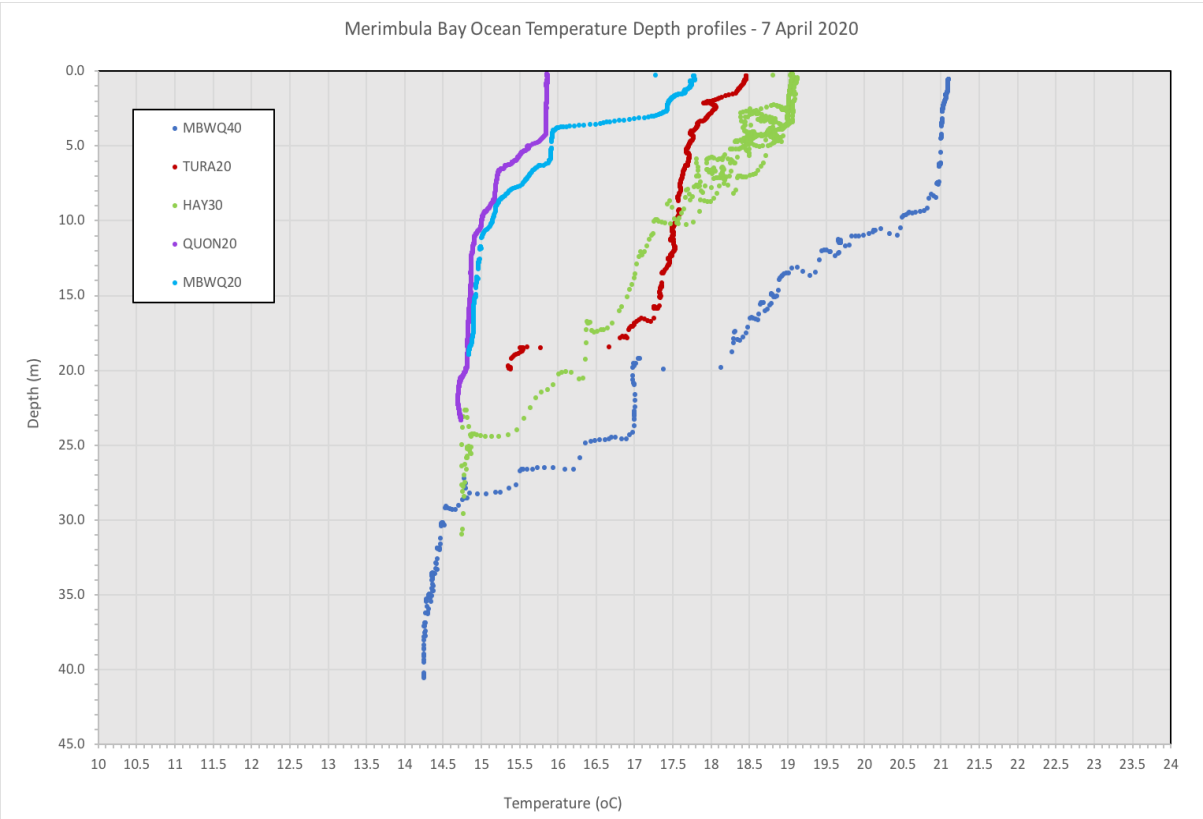

Merimbula Bay Ocean Temperature Depth profiles - 7 April 2020
MBWQ40
TURA20
HAY30
QUON20
MBWQ20
Depth (m)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
10
10.5
11
11.5
12
12.5
13
13.5
14
14.5
15
15.5
16
16.5
17
17.5
18
18.5
19
19.5
20
20.5
21
21.5
22
22.5
23
23.5
24
Temperature (oC)

Table G-4. Summary of physico-chemical water quality at Phytoplankton monitoring sites (surface and bottom waters)

Site	Date D/M/Y	Time HH:MM:SS	Surface / Bottom	Depth meters	Temp C	SpCond uS	Sal ppt	pH	Turbid+ NT	Chl ug/L	ODOsat %	ODO mg/L	Latitude Deg	Longitude Deg
	D/M/Y	hh:mm:ss		m	C	uS/cm	ppt		NTU	ug/L	%	mg/L	DD.dddd	DD.dddd
HAY30	21/11/17	08:49:16	surface	1.1	15.48	53279	35.18	8.10	0.0	1.1	105.5	8.49	-36.949650°	149.955500°
HAY30	21/11/17	09:09:05	bottom	29.2	13.32	53305	35.12	8.00	0.1	1.5	90.1	7.58	-36.949650°	149.955500°
HAY30	1/10/19	9:15:04	surface	1.0	15.2	53364	35.24	8.13	-76.9	-0.6	-2.2	8.74	-36.949650°	149.955500°
HAY30	1/10/19	9:27:19	bottom	21.9	14.83	53369	35.23	8.11	-75.6	0.1	6.7	8.48	-36.949650°	149.955500°
HAY30	29/1/20	8:40:13	surface	0.4	21.21	54059	35.8	8.18	-85.9	-0.8	-0.3	7.48	-36.949650°	149.955500°
HAY30	29/1/20	8:58:14	bottom	29.6	17.06	53849	35.63	8.08	-79.7	0.2	0.5	5.97	-36.949650°	149.955500°
HAY30	7/4/20	10:10:26	surface	0.2	19.04	49690	32.58	8.27	-93.3	3.1	0.3	7.66	-36.949650°	149.955500°
HAY30	7/4/20	10:27:57	bottom	31.0	14.74	53915	35.62	8.15	-86.2	-0.3	1.8	6.82	-36.949650°	149.955500°
QUON20	21/11/17	9:27:46	surface	1.1	15.88	53284	35.2	8.09	0.1	1.2	111.5	8.90	-36.976028°	149.937250°
QUON20	21/11/17	9:43:33	bottom	20.2	12.87	53272	35.08	7.97	0.2	0.8	78	6.62	-36.976028°	149.937250°
QUON20	1/10/19	8:06:29	surface	1.1	14.83	53368	35.23	8.08	-74.1	-0.4	-2.4	8.76	-36.976028°	149.937250°
QUON20	1/10/19	8:24:50	bottom	23.2	14.79	53344	35.2	8.11	-75.6	-0.1	10.2	8.58	-36.976028°	149.937250°
QUON20	29/1/20	7:41:33	surface	0.6	21.31	54049	35.79	8.08	-80.6	-0.8	0.3	7.42	-36.976028°	149.937250°
QUON20	29/1/20	7:55:45	bottom	23.0	18.29	53926	35.7	8.08	-79.9	-0.3	1.3	6.57	-36.976028°	149.937250°
QUON20	7/4/20	9:10:40	surface	0.2	15.85	53949	35.69	8.16	-87	-0.7	1.5	7.50	-36.976028°	149.937250°
QUON20	7/4/20	9:27:39	bottom	23.3	14.73	53935	35.64	8.13	-84.7	1.8	1.3	6.64	-36.976028°	149.937250°
MBWQ40	21/11/17	8:05:42	surface	1.1	16.14	53198	35.14	8.12	0.1	1.7	110.1	8.75	-36.919722°	149.953472°
MBWQ40	21/11/17	8:29:27	bottom	40.5	11.19	52921	34.73	7.93	0.1	0.1	73.5	6.48	-36.919722°	149.953472°
MBWQ40	1/10/19	10:15:04	surface	1.1	15.85	53383	35.27	8.16	-78.9	-0.6	-1.9	8.88	-36.919722°	149.953472°
MBWQ40	1/10/19	10:25:47	bottom	40.6	14.67	53369	35.21	8.08	-73.9	-0.2	-1.7	7.95	-36.919722°	149.953472°
MBWQ40	29/1/20	9:25:34	surface	0.5	21.19	54038	35.78	8.18	-86.2	-0.8	-1.3	7.46	-36.919722°	149.953472°
MBWQ40	29/1/20	9:44:52	bottom	39.6	16.79	53853	35.62	8.07	-79.1	-0.5	0.6	5.78	-36.919722°	149.953472°
MBWQ40	7/4/20	11:12:23	surface	0.5	21.1	54211	35.91	8.34	-98	-0.8	2.9	7.47	-36.919722°	149.953472°
MBWQ40	7/4/20	11:18:11	bottom	40.2	14.25	53926	35.61	8.16	-86.2	-0.1	0.4	6.45	-36.919722°	149.953472°
MBWQ20	21/11/17	10:13:28	surface	1.1	17.06	53290	35.22	8.11	0.1	1.2	112.3	8.76	-36.919778°	149.917805°
MBWQ20	21/11/17	10:23:39	bottom	19.1	13.68	53375	35.19	7.99	1.3	3.5	81.7	6.82	-36.919778°	149.917805°
MBWQ20	1/10/19	12:06:31	surface	1.0	15.17	53394	35.26	8.14	-77.3	-0.5	-2.3	8.87	-36.919778°	149.917805°
MBWQ20	1/10/19	12:17:20	bottom	19.3	14.87	53392	35.24	8.13	-76.6	1.0	2.6	8.88	-36.919778°	149.917805°
MBWQ20	29/1/20	10:10:12	surface	0.5	21.44	54013	35.76	8.19	-87	-1.0	0.6	7.49	-36.919778°	149.917805°
MBWQ20	29/1/20	10:21:11	bottom	19.5	20.7	53989	35.75	8.18	-86.1	-0.7	0.3	7.01	-36.919778°	149.917805°
MBWQ20	7/4/20	11:40:17	surface	0.3	17.27	54673	36.25	8.38	-99.3	1.7	0.3	7.86	-36.919778°	149.917805°
MBWQ20	7/4/20	11:47:01	bottom	18.8	14.84	53873	35.6	8.16	-86.5	23.9	6	7.07	-36.919778°	149.917805°
TURA20	21/11/17	7:23:16	surface	1.1	14.86	53042	34.99	8.03	0.1	3.6	110.8	9.04	-36.877935°	149.942080°
TURA20	21/11/17	7:36:37	bottom	21.0	13.42	53265	35.1	7.98	0.4	3.1	82	6.89	-36.877935°	149.942080°
TURA20	1/10/19	11:19:07	surface	1.1	15.95	53429	35.31	8.17	-79.1	-0.5	-2.2	9.01	-36.877935°	149.942080°
TURA20	1/10/19	11:29:27	bottom	21.4	14.96	53181	35.09	8.11	-75.5	1.6	0.2	8.47	-36.877935°	149.942080°
TURA20	29/1/20	10:52:20	surface	0.5	21.64	53995	35.75	8.19	-86.9	-0.8	0.9	7.59	-36.877935°	149.942080°
TURA20	29/1/20	11:04:00	bottom	19.5	20.81	53992	35.75	8.19	-86.7	-0.6	0.2	7.24	-36.877935°	149.942080°
TURA20	7/4/20	12:15:19	surface	0.3	18.45	54081	35.82	8.27	-93.7	-0.8	0.8	7.67	-36.877935°	149.942080°
TURA20	7/4/20	12:21:31	bottom	19.7	15.35	53929	35.65	8.18	-87.9	6.7	2.8	7.14	-36.877935°	149.942080°

Appendix G-5. List of phytoplankton species recorded from Merimbula Bay region (species list compiled from analysis of vertical net tows collected across 5 sites).

TAXON	21/11/17	1/10/19	29/1/20	7/4/20
Diatoms (43 taxa)				
Asteromphalus heptactis (Brébisson) Ralfs		x		
Bacteriastrum sp Shadbolt	x	x		x
Cerataulina pelagica (Cleve) Hendey	x	x	x	
Chaetoceros spp. Ehrenberg	x	x	x	x
Ceratoneis (Cylindrotheca) closterium Ehrenberg	x		x	x
Climacosphenia sp. Ehrenberg		x		x
Cocconeis sp. Ehrenberg		x		x
Dactyliosolen blavyanus (Peragallo) Hasle			x	
cf. Dactyliosolen phuketensis (Sundström) Hasle	x			
Detonula pumila (Castracane) Gran	x	x		
Diploneis sp. Ehrenberg ex Cleve	x			
Ditylum brightwellii (West) Grunow		x		
Entomoneis sp. Ehrenberg		x		
Eucampia cornuta (Cleve) Grunow	x			
Eucampia zodiacus Ehrenberg	x			x
Guinardia flaccida (Castracane) Peragallo	x			x
Guinardia striata (Stolterfoth) Hasle	x			x
Helicotheca tamesis Ricard		x		
Hemiaulus hauckii Grunow ex van Heurck				x
Hemiaulus membranaceus Cleve				x
Lauderia annulata Cleve	x	x		
Leptocylindrus danicus Cleve	x	x	x	
Leptocylindrus minimus Gran		x	x	x
Licmophora sp. Agardh	x	x		x
Meuniera membranacea (Cleve) Silva		x	x	x
Navicula spp. Bory	x	x		x
Nitzschia spp. Hassall	x			
Pleurosigma spp. Smith/*Gyrosigma* spp. Hassall	x			
Proboscia alata (Brightwell) Sundström	x		x	
Pseudo-nitzschia spp. Peragallo	x	x	x	x
Rhizosolenia cf. *setigera* Brightwell	x		x	
Rhizosolenia cf. *imbricata* gp. Brightwell	x	x	x	
Rhizololenia cf. *styliformis* Brightwell				x
Skeletonema japonicum Zingone & Sarno				x
Skeletonema sp. Greville			x	
Stephanopyxis turris (Greville) Ralfs		x		
Thalassionema frauenfeldii (Grunow) Hallegraeff	x			x
Thalassiosira cf. *mala/partheneia* Cleve	x	x		
Thalassiosira gravida Cleve	x	x		
Thalassiosira spp./*Porosira* spp. Cleve	x			x
Thalassiothrix sp. Cleve & Grunow/*Lioloma* sp. Hasle in Hasle & Syvertsen	x		x	x
Unidentified pennate diatom spp.	x	x		x
Unidentified centric diatom spp.	x	x		x

TAXON	21/11/17	1/10/19	29/1/20	7/4/20
Dinoflagellates (35 taxa)				
Alexandrium sp. Halim		x	x	x
Amphisolenia bidentata Schröder				x
Ceratium furca (Ehrenberg) Claparéde & Lachmann	x			
Ceratium spp. Schrank	x			
Corythodinium elegans (Pavillard) Taylor				x
Dinophysis acuminata Claparède & Lachmann	x	x	x	x
Dinophysis caudata Saville-Kent	x		x	x
Dinophysis tripos Gourret	x		x	x
Gonyaulax sp. Deising	x			
Heterocapsa sp. Stein	x		x	
Heterocapsa triquetra (Ehrenberg) Stein				x
Karenia sp. Hansen & Moestrup	x			
Noctiluca scintillans (Macartney) Kofoid et Swezy	x		x	x
Phalachroma rotundatum (Claparede & Lachmann) Kofoid and Michener				x
Podolampus elegans Schütt				x
Prorocentrum compressum (Bailey) Abé ex Dodge			x	
Prorocentrum dentatum Stein				x
Prorocentrum emarginatum Fukuyo		x		
Prorocentrum gracile Schütt	x		x	x
Prorocentrum micans Ehrenberg				x
Prorocentrum rhathymum Loeblich, Sherley & Schmidt				x
Prorocentrum triestinum Schiller			x	x
Protoperidinium spp. Bergh	x	x	x	x
Pyrophacus steinii (Schiller) Wall & Dale			x	
Scrippsiella trochoidea (Stein) Balech ex Loeblich III	x	x	x	x
Tripos furca (Ehrenberg) Gómez (previously *Ceratium furca*)		x	x	x
Tripos fusus (Ehrenberg) Gómez (previously *Ceratium fusus*)		x	x	
Tripos candelabrus (Ehrenberg) Gómez (previously *Ceratium candelabrum)*		x	x	
Tripos kofoidii (Jörgenen) F.Gómez				x
Tripos massiliensis (Gourret) Gómez (previously *Ceratium tripos* var. *massiliense)*			x	
Tripos muelleri (previously *Ceratium tripos* (Müller) Nitzsch*)*			x	x
Tripos lineatus (previously *Ceratium lineatum* (Ehrenberg) Cleve*)*			x	
*Tripos pentagonus (*syn. *Ceratium pentagonum* Gourret)				x
Tripos trichoceros (syn. *Ceratium trichoceros* (Ehrenberg) Kofoid)				x
Gymnodinoid spp.	x	x	x	x
Dictyochophytes (1 taxon)				
Dictyocha octonaria Ehrenberg	x	x		x
Prasinophytes (3 taxa)				
Apedinella sp. Throndsen				x
Pyramimonas sp. Schmarda		x		x
Eutreptiella sp. da Cunha		x		x
Cryptomonads (1 taxa)				
Unidentified chryptomonad spp.				x
Coccolithophorids (1 taxon)				
*Emiliana huxleyi (*Lohmann) Hay & Mohler */Gephyrocapsa oceánica* Kamptner			x	x
Cyanobacteria (1 taxon)				
Trichodesmium erythraeum Ehrenberg			x	x
Taxon Richness by Event	42	35	33	51

Appendix G-6 Merimbula Bay phytoplankton counts (cells/mL) from water samples collected at 0.5m depth

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	21/11/17	21/11/17	21/11/17	21/11/17	21/11/17	21/11/17
Dinoflagellates						
Actiniscus_pentasterias	0	0	0	0	0	0
cf_Alexandrium_sp	0	0	0	0	0	0
Amphidinium_sp	0	0	0	0	0	0
Amphisolenia_sp.	0	0	0	0	0	0
Amphisolenia_bidentata	0	0	0	0	0	0
Brachydinium_capitatum	0	0	0	0	0	0
Ceratium_candelabrum	0	0	0	0	0	0
Ceratium_concilians	0	0	0	0	0	0
Ceratium_contortum	0	0	0	0	0	0
Ceratium_falcatum	0	0	0	0	0	0
Ceratium_furca	0	3	0	0	0	3
Ceratium_fusus	0	0	0	0	0	0
Ceratium_gravidum	0	0	0	0	0	0
Ceratium_incisum	0	0	0	0	0	0
Ceratium_kofoidii	0	0	0	0	0	0
Ceratium_longiorstrum	0	0	0	0	0	0
Ceratium_lineatum	0	0	0	0	0	0
Ceratium_cf_macroceros	0	0	0	0	0	0
Ceratium_cf_pentagonum	0	0	0	0	0	0
Ceratium_symmetricum	0	0	0	0	0	0
Ceratium_tenue	0	0	0	0	0	0
Ceratium_trichoceros	0	0	0	0	0	0
Ceratium_tripos	0	0	0	0	0	0
Ceratium_vultur	0	0	0	0	0	0
Ceratium_spp.	0	0	0	0	0	0
Ceratocorys_sp.	0	0	0	0	0	0
Cladopyxis_brachiolata	0	0	0	0	0	0
Cochlodinium_sp.	0	0	0	0	0	0
Corythodinium_elegans/tesselatum	0	0	0	0	0	0
Dinophysis_acuminata	0	0	0	0	0	0
Dinophysis_acuta	0	0	0	0	0	0
Dinophysis_caudata	0	0	0	0	0	0
Dinophysis_dens	0	0	0	0	0	0
Dinophysis_fortii	0	0	0	0	0	0
Dinophysis_mitra	0	0	0	0	0	0
Dinophysis_schuettii	0	0	0	0	0	0
Dinophysis_tripos	0	0	0	0	0	0
Dissodinium_sp.	0	0	0	0	0	0
Gonyaulax_sp.	0	0	0	0	0	0
Gyrodinium_sp.	0	0	0	0	0	0
Karenia_sp.	0	0	0	0	0	0
Karlodinium_sp.	0	0	0	0	0	0
Gymnodinium_sp	0	0	1	0	0	1
Heterocapsa_sp.	6	10	4	6	14	40
Heterocapsa_triquetra	0	0	0	0	0	0
Histioneis_sp.	0	0	0	0	0	0
Noctiluca_scintillans	0	0	0	0	0	0
Ostreopsis_sp.	0	0	0	0	0	0
Ornithoceros_cf_magnificus	0	0	0	0	0	0
Ornithoceros_cf_thumii	0	0	0	0	0	0
Ornithoceros_sp.	0	0	0	0	0	0
Oxytoxum_sp	0	0	0	0	0	0
Phalachroma_argus	0	0	0	0	0	0
Phalachroma_rotundatum	0	0	0	0	0	0
Podolampas_bipes	0	0	0	0	0	0
Podolampas_elegans	0	0	0	0	0	0
Pronoctiluca_sp.	0	0	0	0	0	0
Prorocentrum_compressum	0	0	0	0	0	0
Prorocentrum_concarvum	0	0	0	0	0	0
Prorocentrum_dentatum	0	0	0	0	0	0
Prorocentrum_rhyathymum	0	0	0	0	0	0
Prorocentrum_micans	0	0	0	0	0	0
Prorocentrum_minimum	0	0	0	0	0	0
Prorocentrum_gracile	1	3	0	6	10	20
Prorocentrum_triestinum	0	0	0	0	0	0
Prorocentrum_sp.	0	0	0	0	0	0
Protoperidinium_spp.	1	0	1	0	0	2
Pseliodinium_sp.	0	0	0	0	0	0

Appendix G-6 Merimbula Bay phytoplankton counts (cells/mL) from water samples collected at 0.5m depth

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	21/11/17	21/11/17	21/11/17	21/11/17	21/11/17	21/11/17
Ptychodiscus_sp.	0	0	0	0	0	0
Pyrocystis_lunula	0	0	0	0	0	0
Pyrophacus_steinii	0	0	0	0	0	0
Pyrophacus_sp.	0	0	0	0	0	0
Scrippsiella_trochoidea	0	4	0	6	10	20
Gymnodinoid_sp.	0	0	0	0	0	0
Diatoms						
Actinocyclus_sp.	0	0	0	0	0	0
Amphora_sp.	0	0	0	0	0	0
Asterionellopsis_glacialis	0	0	0	0	0	0
Asteromphalus_sp	0	0	0	0	0	0
Asteromphalus_heptactis	0	0	0	0	0	0
Bacteriastrum_spp.	9	10	4	18	8	49
Bacillaria_sp.	0	0	0	0	0	0
Belloerochea_horologicales	0	0	0	0	0	0
Cerataulina_pelagica	16	24	37	39	39	155
Chaetoceros_<10 mm	34	9	13	10	18	84
Chaetoceros_>10 mm	21	49	27	75	53	225
Climacodium_frauenfeldianum	0	0	0	0	0	0
Climacosphenia_sp.	0	0	0	0	0	0
Cocconeis_sp.	0	0	0	0	0	0
Corethron_sp	0	0	0	0	0	0
Coscinodiscus_sp	0	0	0	0	0	0
Cyclotella_sp.	0	0	0	0	0	0
Ceratoneis_longissima/closterium	1	1	1	0	0	3
Dactyliosolen_blavyanus	0	0	0	0	0	0
Detonula_pumila	6	0	3	12	0	21
Diploneis_sp	0	0	0	0	0	0
Ditylum_brightwelli	0	0	0	0	0	0
Eucampia_cornuta	0	0	0	2	2	4
Eucampia_zodiacus	0	0	0	2	4	6
Entomoneis_sp.	0	0	0	0	0	0
Fragillaria_sp.	0	0	0	0	0	0
Guinardia_delicatula/Dactyliosole	0	0	0	0	0	0
Guinardia_flaccida	0	1	0	0	4	5
Guinardia_striata	0	0	0	0	6	6
Helicotheca_tamesis	0	0	0	0	6	6
Hemialus_hauckii	0	0	0	0	0	0
Hemialus_membranaceus	0	0	0	0	0	0
Lauderia_annulata	4	0	0	0	0	4
Leptocylindricus_minimus/mediterraneus	0	0	0	0	0	0
Leptocylindrus_danicus	10	12	7	29	26	84
Licmophora_cf._gracilis	0	1	0	0	0	1
Lithodesmium_cf._undulatum	0	0	0	0	0	0
Mastogloia_sp.	0	0	0	0	0	0
Melosira_nummuloides	0	0	0	0	0	0
Meuniera_membranacea	0	0	0	0	0	0
Navicula_sp	0	0	1	0	2	3
Nitzschia_sp.	0	0	1	0	0	1
Nitzschia_bicapitata	0	0	0	0	0	0
Odontella_sp.	0	0	0	0	0	0
Odontella_sinensis	0	0	0	0	0	0
Planktoniella_sol	0	0	0	0	0	0
Pleurosigma/Gyrosigma_sp	0	1	0	0	2	3
Pseudonitzschia_spp.	0	3	1	2	6	12
Proboscia_alata	40	53	52	41	47	233
Rhizosolenia_setigera	3	1	0	0	0	4
Rhizololenia_cf_styliformis	0	0	0	0	0	0
Rhizosolenia_cf_imbricata	0	0	0	0	0	0
Rhizosolenia_cf_fallax	0	0	0	0	0	0
Skeletonema_sp.	0	0	0	0	0	0
Stephanopyxis_turris	0	0	0	0	0	0
Suriella_sp.	0	0	0	0	0	0
Thalassionema_frauenfeldii	0	0	0	0	0	0
Thalassiosira_cf_partheneia	0	0	0	0	0	0
Thalassiosira_cf_punctigera	0	0	0	0	0	0
Thalassiosira_rotula	1	0	0	4	2	7

Appendix G-6 Merimbula Bay phytoplankton counts (cells/mL) from water samples collected at 0.5m depth

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	21/11/17	21/11/17	21/11/17	21/11/17	21/11/17	21/11/17
Thalassiosira_spp.	13	4	10	18	16	61
Thalassiothrix/Lioloma_sp.	0	0	0	0	0	0
cf._Trigonium_sp.	0	0	0	0	0	0
Unidentified_pennate_diatom	1	1	4	2	4	12
Unidentified_centric_diatom	0	0	0	0	0	0
Prasinophyceae						
Pyramimonas_sp.	0	0	0	0	0	0
Eutreptiella_sp.	0	0	0	0	0	0
Apedinella sp.	0	0	0	0	0	0
Cryptophyceae						
Cryptomonads	0	0	0	0	0	0
Euglenophyceae						
Euglenoid_sp.	0	0	0	0	0	0
Phacus_sp.	0	0	0	0	0	0
Raphidophyceae						
Chatonella_ovata	0	0	0	0	0	0
Unidentified_raphidophyte	0	0	0	0	0	0
Coccolithophorids						
Emiliana/Gephyrocapsa	0	0	0	0	0	0
Silicoflagellates						
Dictyocha_fibula	0	0	0	0	0	0
Dictyocha_octonaria	0	0	0	0	0	0
Ebria_tripartita	0	0	0	0	0	0
Cyanobacteria						
Trichodesmium_erythraeum	0	0	0	0	0	0
Other						
Unidentified_flagellates	0	0	1	0	0	1
Choanoflagellates	0	0	0	0	0	0
Total Abundance (cells/mL)	167	190	168	272	279	1076
Total Taxon Count	16	18	17	16	20	30

Summary of Major Phytoplankton Groups (cells/L)

	TURA20	**MBWQ20**	**MBWQ40**	**HAY30**	**QUON20**	**MERIMBULA BAY REGION**
	21/11/17	**21/11/17**	**21/11/17**	**21/11/17**	**21/11/17**	**21/11/17**
Dinoflagellates	8000	20000	6000	18000	34000	86000
Diatoms	159000	170000	161000	254000	245000	989000
Prasinophyceae	0	0	0	0	0	0
Cryptophyceae	0	0	0	0	0	0
Euglenophyceae	0	0	0	0	0	0
Raphidophyceae	0	0	0	0	0	0
Coccolithophorids	0	0	0	0	0	0
Silicoflagellates	0	0	0	0	0	0
Cyanobacteria	0	0	0	0	0	0
Other	0	0	1000	0	0	1000
TOTAL ABUNDANCE (cells/L)	167000	190000	168000	272000	279000	1076000

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	1/10/19	1/10/19	1/10/19	1/10/19	1/10/19	1/10/19
Dinoflagellates						
Actiniscus_pentasterias	0	0	0	0	0	0
cf_Alexandrium_sp	0	0	0	6	0	6
Amphidinium_sp	0	0	0	0	0	0
Amphisolenia_sp.	0	0	0	0	0	0
Amphisolenia_bidentata	0	0	0	0	0	0
Brachydinium_capitatum	0	0	0	0	0	0
Ceratium_candelabrum	0	0	0	0	0	0
Ceratium_concilians	0	0	0	0	0	0
Ceratium_contortum	0	0	0	0	0	0
Ceratium_falcatum	0	0	0	0	0	0
Ceratium_furca	0	0	0	0	0	0
Ceratium_fusus	0	0	0	0	0	0
Ceratium_gravidum	0	0	0	0	0	0
Ceratium_incisum	0	0	0	0	0	0
Ceratium_kofoidii	0	0	0	0	0	0
Ceratium_longiorstrum	0	0	0	0	0	0
Ceratium_lineatum	0	0	0	0	0	0
Ceratium_cf_macroceros	0	0	0	0	0	0
Ceratium_cf_pentagonum	0	0	0	0	0	0
Ceratium_symmetricum	0	0	0	0	0	0
Ceratium_tenue	0	0	0	0	0	0
Ceratium_trichoceros	0	0	0	0	0	0
Ceratium_tripos	0	0	0	0	0	0
Ceratium_vultur	0	0	0	0	0	0
Ceratium_spp.	0	0	0	0	0	0
Ceratocorys_sp.	0	0	0	0	0	0
Cladopyxis_brachiolata	0	0	0	0	0	0
Cochlodinium_sp.	0	0	0	0	0	0
Corythodinium_elegans/tesselatum	0	0	0	0	0	0
Dinophysis_acuminata	0	0	3	0	0	3
Dinophysis_acuta	0	0	0	0	0	0
Dinophysis_caudata	0	0	0	0	0	0
Dinophysis_dens	0	0	0	0	0	0
Dinophysis_fortii	0	0	0	0	0	0
Dinophysis_mitra	0	0	0	0	0	0
Dinophysis_schuettii	0	0	0	0	0	0
Dinophysis_tripos	0	0	0	0	0	0
Dissodinium_sp.	0	0	0	0	0	0
Gonyaulax_sp.	0	0	0	0	0	0
Gyrodinium_sp.	0	0	0	0	0	0
Karenia_sp.	0	0	0	0	0	0
Karlodinium_sp.	0	0	0	0	0	0
Gymnodinium_sp	0	6	0	0	0	6
Heterocapsa_sp.	0	0	0	0	0	0
Heterocapsa_triquetra	0	0	0	0	0	0
Histioneis_sp.	0	0	0	0	0	0
Noctiluca_scintillans	0	0	0	0	0	0
Ostreopsis_sp.	0	0	0	0	0	0
Ornithoceros_cf_magnificus	0	0	0	0	0	0
Ornithoceros_cf_thumii	0	0	0	0	0	0
Ornithoceros_sp.	0	0	0	0	0	0
Oxytoxum_sp	0	0	0	0	0	0
Phalachroma_argus	0	0	0	0	0	0
Phalachroma_rotundatum	0	0	0	0	0	0
Podolampas_bipes	0	0	0	0	0	0
Podolampas_elegans	0	0	0	0	0	0
Pronoctiluca_sp.	0	0	0	0	0	0
Prorocentrum_compressum	0	0	0	0	0	0
Prorocentrum_concarvum	0	0	0	0	0	0
Prorocentrum_dentatum	0	0	0	0	0	0
Prorocentrum_rhyathymum	0	0	0	0	0	0
Prorocentrum_micans	0	0	0	0	0	0
Prorocentrum_minimum	0	0	0	0	0	0
Prorocentrum_gracile	0	0	0	0	0	0
Prorocentrum_triestinum	0	0	0	0	0	0
Prorocentrum_sp.	0	0	0	0	0	0
Protoperidinium_spp.	0	4	0	0	0	4
Pseliodinium_sp.	0	0	0	0	0	0

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	1/10/19	1/10/19	1/10/19	1/10/19	1/10/19	1/10/19
Ptychodiscus_sp.	0	0	0	0	0	0
Pyrocystis_lunula	0	0	0	0	0	0
Pyrophacus_steinii	0	0	0	0	0	0
Pyrophacus_sp.	0	0	0	0	0	0
Scrippsiella_trochoidea	0	2	3	6	0	11
Gymnodinoid_sp.	0	0	0	0	0	0
Diatoms						
Actinocyclus_sp.	0	0	0	0	0	0
Amphora_sp.	0	0	0	0	0	0
Asterionellopsis_glacialis	0	0	0	0	0	0
Asteromphalus_sp	0	0	0	0	0	0
Asteromphalus_heptactis	0	0	0	6	0	6
Bacteriastrum_spp.	29	4	0	0	0	33
Bacillaria_sp.	0	0	0	0	0	0
Belloerochea_horologicales	0	0	0	0	0	0
Cerataulina_pelagica	0	0	3	0	6	9
Chaetoceros_<10 mm	0	0	0	0	0	0
Chaetoceros_>10 mm	442	55	360	419	18	1294
Climacodium_frauenfeldianum	0	0	0	0	0	0
Climacosphenia_sp.	0	0	0	0	0	0
Cocconeis_sp.	0	0	0	0	0	0
Corethron_sp	0	0	0	0	0	0
Coscinodiscus_sp	0	0	0	0	0	0
Cyclotella_sp.	0	0	0	0	0	0
Ceratoneis_longissima/closterium	0	0	0	0	0	0
Dactyliosolen_blavyanus	0	0	0	0	0	0
Detonula_pumila	0	0	0	0	0	0
Diploneis_sp	0	0	0	0	0	0
Ditylum_brightwelli	0	0	0	0	0	0
Eucampia_cornuta	0	0	0	0	0	0
Eucampia_zodiacus	0	0	0	0	0	0
Entomoneis_sp.	0	0	0	0	0	0
Fragillaria_sp.	0	0	0	0	0	0
Guinardia_delicatula/Dactyliosole	0	0	0	0	0	0
Guinardia_flaccida	0	0	0	0	0	0
Guinardia_striata	0	0	0	0	0	0
Helicotheca_tamesis	0	0	0	0	0	0
Hemialus_hauckii	0	0	0	0	0	0
Hemialus_membranaceus	0	0	0	0	0	0
Lauderia_annulata	0	6	0	0	0	6
Leptocylindricus_minimus/mediterraneus	18	4	0	0	0	22
Leptocylindrus_danicus	18	8	0	0	0	26
Licmophora_cf._gracilis	0	0	0	0	0	0
Lithodesmium_cf._undulatum	0	0	0	0	0	0
Mastogloia_sp.	0	0	0	0	0	0
Melosira_nummuloides	0	0	0	0	0	0
Meuniera_membranacea	0	0	0	0	0	0
Navicula_sp	0	0	0	0	0	0
Nitzschia_sp.	0	0	0	0	0	0
Nitzschia_bicapitata	0	0	0	0	0	0
Odontella_sp.	0	0	0	0	0	0
Odontella_sinensis	0	0	0	0	0	0
Planktoniella_sol	0	0	0	0	0	0
Pleurosigma/Gyrosigma_sp	0	0	0	0	0	0
Pseudonitzschia_spp.	77	59	50	30	29	245
Proboscia_alata	0	0	0	0	0	0
Rhizosolenia_setigera	0	0	0	0	0	0
Rhizololenia_cf_styliformis	0	0	0	0	0	0
Rhizosolenia_cf_imbricata	0	14	3	24	12	53
Rhizosolenia_cf_fallax	0	0	0	0	0	0
Skeletonema_sp.	0	0	0	0	0	0
Stephanopyxis_turris	0	0	0	0	18	18
Suriella_sp.	0	0	0	0	0	0
Thalassionema_frauenfeldii	0	0	0	0	0	0
Thalassiosira_cf_partheneia	436	132	183	212	732	1695
Thalassiosira_cf_punctigera	0	0	0	0	0	0
Thalassiosira_rotula	12	0	0	0	0	12

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	1/10/19	1/10/19	1/10/19	1/10/19	1/10/19	1/10/19
Thalassiosira_spp.	0	0	0	0	0	0
Thalassiothrix/Lioloma_sp.	0	0	0	0	0	0
cf._Trigonium_sp.	0	0	0	0	0	0
Unidentified_pennate_diatom	0	0	3	0	0	3
Unidentified_centric_diatom	0	0	0	0	0	0
Prasinophyceae						
Pyramimonas_sp.	0	0	3	0	0	3
Eutreptiella_sp.	0	0	3	0	0	3
Apedinella sp.	0	0	0	0	0	0
Cryptophyceae						
Cryptomonads	0	0	0	0	0	0
Euglenophyceae						
Euglenoid_sp.	0	0	0	0	0	0
Phacus_sp.	0	0	0	0	0	0
Raphidophyceae						
Chatonella_ovata	0	0	0	0	0	0
Unidentified_raphidophyte	0	0	0	0	0	0
Coccolithophorids						
Emiliana/Gephyrocapsa	12	6	3	0	0	21
Silicoflagellates						
Dictyocha_fibula	0	0	0	0	0	0
Dictyocha_octonaria	0	0	0	0	0	0
Ebria_tripartita	0	0	0	0	0	0
Cyanobacteria						
Trichodesmium_erythraeum	0	0	0	0	0	0
Other						
Unidentified_flagellates	18	4	12	18	0	52
Choanoflagellates	0	0	0	0	0	0
Total Abundance (cells/mL)	1062	304	629	721	815	3531
Total Taxon Count	9	13	12	8	6	22

Summary of Major Phytoplankton Gr

	TURA20	**MBWQ20**	**MBWQ40**	**HAY30**	**QUON20**	**MERIMBULA BAY REGION**
	1/10/19	**1/10/19**	**1/10/19**	**1/10/19**	**1/10/19**	**1/10/19**
Dinoflagellates	0	12000	6000	12000	0	30000
Diatoms	1032000	282000	602000	691000	815000	3422000
Prasinophyceae	0	0	6000	0	0	6000
Cryptophyceae	0	0	0	0	0	0
Euglenophyceae	0	0	0	0	0	0
Raphidophyceae	0	0	0	0	0	0
Coccolithophorids	12000	6000	3000	0	0	21000
Silicoflagellates	0	0	0	0	0	0
Cyanobacteria	0	0	0	0	0	0
Other	18000	4000	12000	18000	0	52000
TOTAL ABUNDANCE (cells/L)	1062000	304000	629000	721000	815000	3531000

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	29/1/20	29/1/20	29/1/20	29/1/20	29/1/20	29/1/20
Dinoflagellates						
Actiniscus_pentasterias	0	0	0	0	0	0
cf_Alexandrium_sp	0	0	1	0	0	1
Amphidinium_sp	0	0	0	0	0	0
Amphisolenia_sp.	0	0	0	0	0	0
Amphisolenia_bidentata	0	0	0	0	0	0
Brachydinium_capitatum	0	0	0	0	0	0
Ceratium_candelabrum	0	0	0	0	0	0
Ceratium_concilians	0	0	0	0	0	0
Ceratium_contortum	0	0	0	0	0	0
Ceratium_falcatum	0	0	0	0	0	0
Ceratium_furca	2	0	0	0	0	2
Ceratium_fusus	0	0	0	0	0	0
Ceratium_gravidum	0	0	0	0	0	0
Ceratium_incisum	0	0	0	0	0	0
Ceratium_kofoidii	0	0	0	0	0	0
Ceratium_longiorstrum	0	0	0	0	0	0
Ceratium_lineatum	0	0	0	0	0	0
Ceratium_cf_macroceros	0	0	0	0	0	0
Ceratium_cf_pentagonum	0	0	0	0	0	0
Ceratium_symmetricum	0	0	0	0	0	0
Ceratium_tenue	0	0	0	0	0	0
Ceratium_trichoceros	0	0	0	0	0	0
Ceratium_tripos	0	0	0	0	0	0
Ceratium_vultur	0	0	0	0	0	0
Ceratium_spp.	0	0	0	0	0	0
Ceratocorys_sp.	0	0	0	0	0	0
Cladopyxis_brachiolata	0	0	0	0	0	0
Cochlodinium_sp.	0	0	0	0	0	0
Corythodinium_elegans/tesselatum	0	0	0	0	0	0
Dinophysis_acuminata	0	0	0	0	0	0
Dinophysis_acuta	0	0	0	0	0	0
Dinophysis_caudata	0	0	0	0	0	0
Dinophysis_dens	0	0	0	0	0	0
Dinophysis_fortii	0	0	0	0	0	0
Dinophysis_mitra	0	0	0	0	0	0
Dinophysis_schuettii	0	0	0	0	0	0
Dinophysis_tripos	0	0	0	0	0	0
Dissodinium_sp.	0	0	0	0	0	0
Gonyaulax_sp.	0	0	0	0	0	0
Gyrodinium_sp.	0	0	0	0	0	0
Karenia_sp.	0	0	0	0	0	0
Karlodinium_sp.	0	0	0	0	0	0
Gymnodinium_sp	0	0	0	0	0	0
Heterocapsa_sp.	6	0	0	0	0	6
Heterocapsa_triquetra	0	0	0	0	0	0
Histioneis_sp.	0	0	0	0	0	0
Noctiluca_scintillans	2	0	0	0	0	2
Ostreopsis_sp.	0	0	0	0	0	0
Ornithoceros_cf_magnificus	0	0	0	0	0	0
Ornithoceros_cf_thumii	0	0	0	0	0	0
Ornithoceros_sp.	0	0	0	0	0	0
Oxytoxum_sp	0	0	0	0	0	0
Phalachroma_argus	0	0	0	0	0	0
Phalachroma_rotundatum	0	0	0	0	0	0
Podolampas_bipes	0	0	0	0	0	0
Podolampas_elegans	0	0	0	0	0	0
Pronoctiluca_sp.	0	0	0	0	0	0
Prorocentrum_compressum	2	0	0	0	0	2
Prorocentrum_concarvum	0	0	0	0	0	0
Prorocentrum_dentatum	0	0	0	0	0	0
Prorocentrum_rhyathymum	0	0	0	0	0	0
Prorocentrum_micans	0	0	0	0	0	0
Prorocentrum_minimum	0	0	0	0	0	0
Prorocentrum_gracile	2	0	2	1	3	8
Prorocentrum_triestinum	2	0	3	0	0	5
Prorocentrum_sp.	0	0	0	0	0	0
Protoperidinium_spp.	2	0	0	0	0	2
Pseliodinium_sp.	0	0	0	0	0	0

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	29/1/20	29/1/20	29/1/20	29/1/20	29/1/20	29/1/20
Ptychodiscus_sp.	0	0	0	0	0	0
Pyrocystis_lunula	0	0	0	0	0	0
Pyrophacus_steinii	0	0	0	0	0	0
Pyrophacus_sp.	0	0	0	0	0	0
Scrippsiella_trochoidea	0	2	1	2	0	5
Gymnodinoid_sp.	2	0	1	0	0	3
Diatoms						
Actinocyclus_sp.	0	0	0	0	0	0
Amphora_sp.	0	0	0	0	0	0
Asterionellopsis_glacialis	0	0	0	0	0	0
Asteromphalus_sp	0	0	0	0	0	0
Asteromphalus_heptactis	0	0	0	0	0	0
Bacteriastrum_spp.	0	0	0	0	0	0
Bacillaria_sp.	0	0	0	0	0	0
Belloerochea_horologicales	0	0	0	0	0	0
Cerataulina_pelagica	0	6	0	0	0	6
Chaetoceros_<10 mm	0	0	0	0	0	0
Chaetoceros_>10 mm	0	0	3	0	0	3
Climacodium_frauenfeldianum	0	0	0	0	0	0
Climacosphenia_sp.	0	0	0	0	0	0
Cocconeis_sp.	0	0	0	0	0	0
Corethron_sp	0	0	0	0	0	0
Coscinodiscus_sp	0	0	0	0	0	0
Cyclotella_sp.	0	0	0	0	0	0
Ceratoneis_longissima/closterium	6	0	3	1	0	10
Dactyliosolen_blavyanus	0	0	0	0	0	0
Detonula_pumila	0	0	0	0	0	0
Diploneis_sp	0	0	0	0	0	0
Ditylum_brightwelli	0	0	0	0	0	0
Eucampia_cornuta	0	0	0	0	0	0
Eucampia_zodiacus	0	0	0	0	0	0
Entomoneis_sp.	0	0	0	0	0	0
Fragillaria_sp.	0	0	0	0	0	0
Guinardia_delicatula/Dactyliosole	0	6	1	0	0	7
Guinardia_flaccida	0	0	0	0	0	0
Guinardia_striata	0	0	0	0	0	0
Helicotheca_tamesis	0	0	0	0	0	0
Hemialus_hauckii	0	0	0	0	0	0
Hemialus_membranaceus	0	0	0	0	0	0
Lauderia_annulata	0	0	0	0	0	0
Leptocylindricus_minimus/mediterraneus	2	9	0	0	0	11
Leptocylindrus_danicus	138	245	41	105	289	818
Licmophora_cf._gracilis	0	0	0	0	0	0
Lithodesmium_cf._undulatum	0	0	0	0	0	0
Mastogloia_sp.	0	0	0	0	0	0
Melosira_nummuloides	0	0	0	0	0	0
Meuniera_membranacea	0	0	4	0	0	4
Navicula_sp	0	0	0	0	0	0
Nitzschia_sp.	0	0	0	0	0	0
Nitzschia_bicapitata	0	0	0	0	0	0
Odontella_sp.	0	0	0	0	0	0
Odontella_sinensis	0	0	0	0	0	0
Planktoniella_sol	0	0	0	0	0	0
Pleurosigma/Gyrosigma_sp	0	0	0	0	0	0
Pseudonitzschia_spp.	0	12	22	1	21	56
Proboscia_alata	0	3	1	1	0	5
Rhizosolenia_setigera	0	0	0	0	0	0
Rhizololenia_cf_styliformis	0	0	0	0	0	0
Rhizosolenia_cf_imbricata	0	0	0	0	0	0
Rhizosolenia_cf_fallax	0	0	0	0	0	0
Skeletonema_sp.	0	9	0	0	0	9
Stephanopyxis_turris	0	0	0	0	0	0
Suriella_sp.	0	0	0	0	0	0
Thalassionema_frauenfeldii	0	0	0	0	0	0
Thalassiosira_cf_partheneia	0	0	0	0	0	0
Thalassiosira_cf_punctigera	0	0	0	0	0	0
Thalassiosira_rotula	0	0	0	0	0	0

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	29/1/20	29/1/20	29/1/20	29/1/20	29/1/20	29/1/20
Thalassiosira_spp.	4	0	0	0	0	4
Thalassiothrix/Lioloma_sp.	0	0	0	0	0	0
cf._Trigonium_sp.	0	0	0	0	0	0
Unidentified_pennate_diatom	0	0	0	0	0	0
Unidentified_centric_diatom	0	0	0	0	0	0
Prasinophyceae						
Pyramimonas_sp.	0	0	0	0	0	0
Eutreptiella_sp.	0	0	0	0	0	0
Apedinella sp.	0	0	0	0	0	0
Cryptophyceae						
Cryptomonads	0	0	0	0	0	0
Euglenophyceae						
Euglenoid_sp.	0	0	0	0	0	0
Phacus_sp.	0	0	0	0	0	0
Raphidophyceae						
Chatonella_ovata	0	0	0	0	0	0
Unidentified_raphidophyte	0	0	0	0	0	0
Coccolithophorids						
Emiliana/Gephyrocapsa	2	0	0	0	0	2
Silicoflagellates						
Dictyocha_fibula	0	0	0	0	0	0
Dictyocha_octonaria	0	0	0	0	0	0
Ebria_tripartita	0	0	0	0	0	0
Cyanobacteria						
Trichodesmium_erythraeum	88	44	15	2	0	149
Other						
Unidentified_flagellates	2	0	2	12	3	19
Choanoflagellates	0	0	0	0	0	0
Total Abundance (cells/mL)	262	336	100	125	316	1139
Total Taxon Count	15	9	14	8	4	24

Summary of Major Phytoplankton Gr

	TURA20	**MBWQ20**	**MBWQ40**	**HAY30**	**QUON20**	**MERIMBULA BAY REGION**
	29/1/20	**29/1/20**	**29/1/20**	**29/1/20**	**29/1/20**	**29/1/20**
Dinoflagellates	20000	2000	8000	3000	3000	36000
Diatoms	150000	290000	75000	108000	310000	933000
Prasinophyceae	0	0	0	0	0	0
Cryptophyceae	0	0	0	0	0	0
Euglenophyceae	0	0	0	0	0	0
Raphidophyceae	0	0	0	0	0	0
Coccolithophorids	2000	0	0	0	0	2000
Silicoflagellates	0	0	0	0	0	0
Cyanobacteria	88000	44000	15000	2000	0	149000
Other	2000	0	2000	12000	3000	19000
TOTAL ABUNDANCE (cells/L)	262000	336000	100000	125000	316000	1139000

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	7/4/20	7/4/20	7/4/20	7/4/20	7/4/20	7/4/20
Dinoflagellates						
Actiniscus_pentasterias	0	0	0	0	0	0
cf_Alexandrium_sp	1	1	0	0	0	2
Amphidinium_sp	0	0	0	0	0	0
Amphisolenia_sp.	0	0	0	0	0	0
Amphisolenia_bidentata	0	0	0	0	0	0
Brachydinium_capitatum	0	0	0	0	0	0
Ceratium_candelabrum	0	0	0	0	0	0
Ceratium_concilians	0	0	0	0	0	0
Ceratium_contortum	0	0	0	0	0	0
Ceratium_falcatum	0	0	0	0	0	0
Ceratium_furca	0	0	0	0	0	0
Ceratium_fusus	0	0	0	0	0	0
Ceratium_gravidum	0	0	0	0	0	0
Ceratium_incisum	0	0	0	0	0	0
Ceratium_kofoidii	0	0	0	0	0	0
Ceratium_longiorstrum	0	0	0	0	0	0
Ceratium_lineatum	0	0	0	0	0	0
Ceratium_cf_macroceros	0	0	0	0	0	0
Ceratium_cf_pentagonum	0	0	0	0	0	0
Ceratium_symmetricum	0	0	0	0	0	0
Ceratium_tenue	0	0	0	0	0	0
Ceratium_trichoceros	0	0	0	0	0	0
Ceratium_tripos	0	0	0	0	0	0
Ceratium_vultur	0	0	0	0	0	0
Ceratium_spp.	0	0	0	0	0	0
Ceratocorys_sp.	0	0	0	0	0	0
Cladopyxis_brachiolata	0	0	0	0	0	0
Cochlodinium_sp.	0	0	0	0	0	0
Corythodinium_elegans/tesselatum	0	0	0	1	0	1
Dinophysis_acuminata	0	0	0	0	0	0
Dinophysis_acuta	0	0	0	0	0	0
Dinophysis_caudata	0	0	0	0	0	0
Dinophysis_dens	0	0	0	0	0	0
Dinophysis_fortii	0	0	0	0	0	0
Dinophysis_mitra	0	0	0	0	0	0
Dinophysis_schuettii	0	0	0	0	0	0
Dinophysis_tripos	0	0	0	0	0	0
Dissodinium_sp.	0	0	0	0	0	0
Gonyaulax_sp.	0	0	0	0	0	0
Gyrodinium_sp.	0	0	0	0	0	0
Karenia_sp.	0	0	0	0	0	0
Karlodinium_sp.	0	0	0	0	0	0
Gymnodinium_sp	3	6	1	14	2	26
Heterocapsa_sp.	0	8	0	1	2	11
Heterocapsa_triquetra	0	0	0	0	0	0
Histioneis_sp.	0	0	0	0	0	0
Noctiluca_scintillans	0	0	0	0	0	0
Ostreopsis_sp.	0	0	0	0	0	0
Ornithoceros_cf_magnificus	0	0	0	0	0	0
Ornithoceros_cf_thumii	0	0	0	0	0	0
Ornithoceros_sp.	0	0	0	0	0	0
Oxytoxum_sp	0	0	0	0	0	0
Phalachroma_argus	0	0	0	0	0	0
Phalachroma_rotundatum	0	0	0	0	0	0
Podolampas_bipes	0	0	0	0	0	0
Podolampas_elegans	0	0	0	0	0	0
Pronoctiluca_sp.	0	0	0	0	0	0
Prorocentrum_compressum	0	0	0	0	0	0
Prorocentrum_concarvum	0	0	0	0	0	0
Prorocentrum_dentatum	0	1	1	2	0	4
Prorocentrum_rhyathymum	0	1	0	0	1	2
Prorocentrum_micans	1	8	0	1	1	11
Prorocentrum_minimum	0	0	1	0	0	1
Prorocentrum_gracile	0	0	1	0	0	1
Prorocentrum_triestinum	0	0	0	0	0	0
Prorocentrum_sp.	0	0	0	0	0	0
Protoperidinium_spp.	0	0	0	0	0	0
Pseliodinium_sp.	0	0	0	0	0	0

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	7/4/20	7/4/20	7/4/20	7/4/20	7/4/20	7/4/20
Ptychodiscus_sp.	0	0	0	0	0	0
Pyrocystis_lunula	0	0	0	0	0	0
Pyrophacus_steinii	0	0	0	0	0	0
Pyrophacus_sp.	0	0	0	0	0	0
Scrippsiella_trochoidea	0	2	0	4	0	6
Gymnodinoid_sp.	0	0	0	0	0	0
Diatoms						
Actinocyclus_sp.	0	0	0	0	0	0
Amphora_sp.	0	0	0	0	0	0
Asterionellopsis_glacialis	0	0	0	0	0	0
Asteromphalus_sp	0	0	0	0	0	0
Asteromphalus_heptactis	0	0	0	0	0	0
Bacteriastrum_spp.	0	0	0	0	0	0
Bacillaria_sp.	0	0	0	0	0	0
Belloerochea_horologicales	0	0	0	0	0	0
Cerataulina_pelagica	0	0	0	0	0	0
Chaetoceros_<10 mm	0	0	0	0	0	0
Chaetoceros_>10 mm	0	0	2	0	2	4
Climacodium_frauenfeldianum	0	0	0	0	0	0
Climacosphenia_sp.	0	1	0	0	0	1
Cocconeis_sp.	0	0	0	0	1	1
Corethron_sp	0	0	0	0	0	0
Coscinodiscus_sp	0	0	0	0	0	0
Cyclotella_sp.	0	0	0	0	0	0
Ceratoneis_longissima/closterium	5	5	3	6	3	22
Dactyliosolen_blavyanus	0	0	0	0	0	0
Detonula_pumila	0	0	0	0	0	0
Diploneis_sp	0	0	0	0	0	0
Ditylum_brightwelli	0	0	0	0	0	0
Eucampia_cornuta	0	0	0	0	0	0
Eucampia_zodiacus	0	0	0	0	0	0
Entomoneis_sp.	0	0	0	0	0	0
Fragillaria_sp.	0	0	0	0	0	0
Guinardia_delicatula/Dactyliosole	0	0	0	0	0	0
Guinardia_flaccida	0	0	0	0	0	0
Guinardia_striata	0	0	1	0	0	1
Helicotheca_tamesis	0	0	0	0	0	0
Hemialus_hauckii	0	0	0	0	0	0
Hemialus_membranaceus	0	0	0	0	0	0
Lauderia_annulata	0	0	0	0	0	0
Leptocylindricus_minimus/mediterraneus	0	0	0	0	0	0
Leptocylindrus_danicus	0	0	0	0	0	0
Licmophora_cf._gracilis	0	1	0	0	0	1
Lithodesmium_cf._undulatum	0	0	0	0	0	0
Mastogloia_sp.	0	0	0	0	0	0
Melosira_nummuloides	0	0	0	0	0	0
Meuniera_membranacea	0	0	0	0	0	0
Navicula_sp	0	0	0	0	2	2
Nitzschia_sp.	0	0	0	0	0	0
Nitzschia_bicapitata	0	0	0	0	0	0
Odontella_sp.	0	0	0	0	0	0
Odontella_sinensis	0	0	0	0	0	0
Planktoniella_sol	0	0	0	0	0	0
Pleurosigma/Gyrosigma_sp	0	0	0	0	0	0
Pseudonitzschia_spp.	0	0	2	6	1	9
Proboscia_alata	0	0	0	0	0	0
Rhizosolenia_setigera	0	0	0	0	0	0
Rhizololenia_cf_styliformis	0	0	0	0	0	0
Rhizosolenia_cf_imbricata	0	0	0	0	0	0
Rhizosolenia_cf_fallax	0	0	0	0	0	0
Skeletonema_sp.	2	2	0	0	1	5
Stephanopyxis_turris	0	0	0	0	0	0
Suriella_sp.	0	0	0	0	0	0
Thalassionema_frauenfeldii	0	0	0	0	0	0
Thalassiosira_cf_partheneia	0	0	0	0	0	0
Thalassiosira_cf_punctigera	0	0	0	0	0	0
Thalassiosira_rotula	0	0	0	0	0	0

Appendix G-6 Merimbula Bay phytc

SITE	TURA20	MBWQ20	MBWQ40	HAY30	QUON20	MERIMBULA BAY REGION
Date	7/4/20	7/4/20	7/4/20	7/4/20	7/4/20	7/4/20
Thalassiosira_spp.	0	0	0	0	0	0
Thalassiothrix/Lioloma_sp.	0	0	0	0	0	0
cf._Trigonium_sp.	0	0	0	0	0	0
Unidentified_pennate_diatom	0	1	0	0	0	1
Unidentified_centric_diatom	0	0	0	0	0	0
Prasinophyceae						
Pyramimonas_sp.	1	1	0	0	1	3
Eutreptiella_sp.	0	2	0	0	1	3
Apedinella sp.	2	5	0	0	1	8
Cryptophyceae						
Cryptomonads	5	4	2	7	5	23
Euglenophyceae						
Euglenoid_sp.	0	0	0	0	0	0
Phacus_sp.	0	0	0	0	0	0
Raphidophyceae						
Chatonella_ovata	0	0	0	0	0	0
Unidentified_raphidophyte	0	0	0	0	0	0
Coccolithophorids						0
Emiliana/Gephyrocapsa	19	25	8	15	19	86
Silicoflagellates						
Dictyocha_fibula	0	0	0	0	0	0
Dictyocha_octonaria	0	0	0	0	1	1
Ebria_tripartita	0	0	0	0	0	0
Cyanobacteria						
Trichodesmium_erythraeum	41	0	35	142	0	218
Other						
Unidentified_flagellates	0	0	0	0	0	0
Choanoflagellates	0	0	0	0	0	0
Total Abundance (cells/mL)	80	74	57	199	44	454
Total Taxon Count	10	17	11	11	16	65

Summary of Major Phytoplankton Gr

	TURA20	**MBWQ20**	**MBWQ40**	**HAY30**	**QUON20**	**MERIMBULA BAY REGION**
	7/4/20	**7/4/20**	**7/4/20**	**7/4/20**	**7/4/20**	**7/4/20**
Dinoflagellates	5000	27000	4000	23000	6000	65000
Diatoms	7000	10000	8000	12000	10000	47000
Prasinophyceae	3000	8000	0	0	3000	14000
Cryptophyceae	5000	4000	2000	7000	5000	23000
Euglenophyceae	0	0	0	0	0	0
Raphidophyceae	0	0	0	0	0	0
Coccolithophorids	19000	25000	8000	15000	19000	86000
Silicoflagellates	0	0	0	0	1000	1000
Cyanobacteria	41000	0	35000	142000	0	218000
Other	0	0	0	0	0	0
TOTAL ABUNDANCE (cells/L)	80000	74000	57000	199000	44000	454000

APPENDIX H

ESTUARIES

the glassy perchlet (*Ambassis jacksoniensis*) and luderick (*Girella tricuspidata*). Other economically important fish species caught were silver trevally (*Pseudocaranx dentex*) and Monacanthids, namely the Chinaman leatherjacket (*Nelusetta ayraudi*) and six-spined leatherjacket (*Meuschenia freycinetti*).

Table 4.18: Total number of fish caught by each species, at the entrance of Pambula Lake during February and July 1998.

Family *Species*	**Number caught**
Engraulididae	
*Engraulis australis**	1
Syngnathidae	
Stigmatophora argus	3
Stigmatophora nigra	7
Urocampus carinirostiis	5
Vanacampus poecilolaemus	60
Ambassidae	
Ambassis jacksoniensis	295
Teraponidae	
Pelates quadrilineatus	3
Pomatomidae	
*Pomatomus saltator**	2
Carangidae	
*Pseudocaranx dentex**	65
Lethrinidae	
Lethrinidae species	2
Mullidae	
Parupeneus signatus	2
Girellidae	
*Girella tricuspidata**	376
Enoplosidae	
Enoplosus armatus	17
Labridae	
*Achoerodus viridis**	1
Clinidae	
Cristiceps australis	2
Gobiidae	
Afurcagobius tamarensis	5
Gobiopterus semivestitus	25
Siganidae	
Siganus nebulosus	52
Monacanthidae	
Brachaluteres jacksonianus	1
*Meuschenia freycineti**	46
*Meuschenia trachylepis**	2
*Nelusetta ayraudi**	48
Diodontidae	
Dicotylichthys punctulatus	1
TOTAL (nos. of species = 23)	**1021**

Table 4.39: Total number of fish caught by each species, at the entrance location, central location and upper location within Merimbula Lake during pooled across sampling events from July 1998 to July 2000. (* indicates species of commercial and/or recreational importance.)

	NUMBER CAUGHT			
Family *Species*	**Entrance**	**Central**	**Upper**	**Total**
Clupeidae				
*Hyperlophus vittatus**	0	0	1	1
Spratellloides robustus	9	0	0	9
Hemiramphidae				
*Hyporhamphus australis**	0	0	10	10
Atherinidae				
Atherinasoma microstoma	175	592	669	1436
Atherinasoma elongata	90	1	1	92
Pseudomuglidae				
Psuedomugil signifer	0	0	5	5
Syngnathidae				
Syngnathoides biaculeatus	0	7	5	12
Vanacampus poecilolaemus	36	61	29	126
Urocampus carinirostris	39	46	15	100
Vanacampus phillipi	16	38	7	61
Stigmatophora nigra	21	20	0	41
Stigmatophora argus	38	67	58	163
Scorpaenidae				
Centropogon australis	12	15	4	31
Ambassidae				
Ambassis jacksoniensis	237	733	98	1068
Terapontidae				
Pelates quadrilineatus	18	30	4	52
Apongonidae				
Apogon limenus	0	1	0	1
Siphamia cephalotes	38	4	37	79
Pomatomidae				
*Pomatomus saltator**	1	0	9	10
Carangidae				
*Pseudocaranx dentex**	69	0	0	69
Sparidae				
*Acanthopagrus australis**	5	12	0	17
*Chrysophrys auratus**	12	6	0	18
*Rhabdosargus sarba **	4	6	0	10
Gerreidae				
*Gerres subfasciatus**	0	31	45	76
Mullidae				
Upeneuss species	1	0	0	1
Upeneichthys species	3	0	0	3
*Parupeneus signatus**	4	0	0	4
Girellidae				
*Girella tricuspidata**	481	67	28	546
Scorpididae				
*Scorpis lineolatus**	0	5	0	5
Enoplosidae				
Enoplosus armatus	1	0	1	2
Mugilidae				
*Myxus elongatus**	0	82	2	84
*Mugil cephalus**	0	11	21	32

Table 4.39 Continued

Family *Species*	NUMBER CAUGHT Entrance	Central	Upper	Total
Labridae				
*Achoerodus viridis**	26	52	0	78
Odacidae				
Haletta semifasciata	1	1	79	81
Neodax balteatus	1	13	20	34
Blennidae				
Petroscirtes lupus	5	10	1	16
Clinidae				
Heteroclinus perspicillatus	0	3	3	6
Cristiceps australis	0	3	3	6
Gobiidae – subfamily Eleotridinae				
Philypnodon grandiceps	9	2	19	30
Gobiidae				
Bathygobius kreffti	0	9	1	10
Favonigobius lateralis	123	245	1	369
Favonigobius exsquisites	0	30	0	30
Amoya bifrenatus	4	14	3	21
Amoya frenatus	30	8	23	61
Afurcagobius tamarensis	26	40	1	67
Pseudogobius olorum	7	0	0	7
Redigobius macrostoma	3	2	35	40
Gobiopterus semivestitus	4	2	0	6
Siganidae				
Siganus nebulosus	18	2	0	19
Bothidae				
*Pseudorhombus arsius**	0	2	0	2
Monacanthidae				
Acanthaluteres spilomelanurus	12	7	77	96
*Scobinichthys granulatus**	4	4	2	10
*Penicipelta vittiger**	2	0	0	2
*Monacanthus chinensis**	7	13	4	24
Brachaluteres jacksoniensis	8	2	0	10
*Meuschenia freycineti**	64	16	26	106
*Meuschenia trachyylepis**	0	4	5	9
Meuschenia species	2	20	8	30
Nelusetta ayraudi	1	3	1	4
Tetraodontidae				
Tetractenos hamiltoni	1	21	17	39
Tetractenos glaber	10	30	6	46
Diodontidae				
Dicotylichthys punctulatus	1	1	6	8
Total individuals	**1649**	**2393**	**1388**	**5430**
Total species	**46**	**49**	**42**	**61**

APPENDIX I

THREATENED SPECIES

Appendix I-1. Summary of NSW threatened species reported within a 5km radius of project area.

Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°; ^^ rounded to 0.01°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Public Report of all Valid Records of Animals in selected area [North: -36.83 West: 149.84 East: 150 South: -36.97] returned a total of 3,333 records of 313 species.

Report generated on 29/06/2017 10:50 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records
Animalia	Amphibia	Myobatrachidae	3131	*Crinia parinsignifera*		Eastern Sign-bearing Froglet	P		1
Animalia	Amphibia	Myobatrachidae	3134	*Crinia signifera*		Common Eastern Froglet	P		10
Animalia	Amphibia	Myobatrachidae	3042	*Heleioporus australiacus*		Giant Burrowing Frog	V,P	V	1
Animalia	Amphibia	Myobatrachidae	3058	*Limnodynastes dumerilii*		Eastern Banjo Frog	P		2
Animalia	Amphibia	Myobatrachidae	3061	*Limnodynastes peronii*		Brown-striped Frog	P		11
Animalia	Amphibia	Myobatrachidae	3103	*Paracrinia haswelli*		Haswell's Froglet	P		1
Animalia	Amphibia	Myobatrachidae	3117	*Pseudophryne bibronii*		Bibron's Toadlet	P		2
Animalia	Amphibia	Myobatrachidae	3329	*Uperoleia sp.*			P		1
Animalia	Amphibia	Myobatrachidae	3302	*Uperoleia tyleri*		Tyler's Toadlet	P		5
Animalia	Amphibia	Hylidae	3166	*Litoria aurea*		Green and Golden Bell Frog	E1,P	V	5
Animalia	Amphibia	Hylidae	3180	*Litoria dentata*		Bleating Tree Frog	P		1
Animalia	Amphibia	Hylidae	3182	*Litoria ewingii*		Brown Tree Frog	P		8
Animalia	Amphibia	Hylidae	3183	*Litoria fallax*		Eastern Dwarf Tree Frog	P		1
Animalia	Amphibia	Hylidae	3190	*Litoria jervisiensis*		Jervis Bay Tree Frog	P		2
Animalia	Amphibia	Hylidae	3204	*Litoria peronii*		Peron's Tree Frog	P		14
Animalia	Amphibia	Hylidae	3215	*Litoria verreauxii*		Verreaux's Frog	P		6
Animalia	Reptilia	Cheloniidae	2008	*Eretmochelys imbricata*		Hawksbill Turtle	P	V	1
Animalia	Reptilia	Scincidae	2557	*Eulamprus quoyii*		Eastern Water-skink	P		1
Animalia	Reptilia	Scincidae	2561	*Eulamprus tympanum*		Southern Water-skink	P		1
Animalia	Reptilia	Scincidae	2450	*Lampropholis delicata*		Dark-flecked Garden Sunskink	P		3
Animalia	Reptilia	Scincidae	2451	*Lampropholis guichenoti*		Pale-flecked Garden Sunskink	P		2
Animalia	Reptilia	Scincidae	T117	*Lampropholis sp.*		unidentified grass skink	P		1
Animalia	Reptilia	Scincidae	2452	*Saproscincus mustelinus*		Weasel Skink	P		1
Animalia	Reptilia	Scincidae	2580	*Tiliqua scincoides*		Eastern Blue-tongue	P		2
Animalia	Reptilia	Agamidae	2194	*Amphibolurus muricatus*		Jacky Lizard	P		4
Animalia	Reptilia	Agamidae	2182	*Rankinia diemensis*		Mountain Dragon	P		5
Animalia	Reptilia	Varanidae	2283	*Varanus varius*		Lace Monitor	P		4
Animalia	Reptilia	Pythonidae	2625	*Morelia spilota*		Carpet & Diamond Pythons	P		2
Animalia	Reptilia	Pythonidae	5096	*Morelia spilota spilota*		Diamond Python	P		3
Animalia	Reptilia	Elapidae	2640	*Acanthophis antarcticus*		Common Death Adder	P		6
Animalia	Reptilia	Elapidae	2665	*Drysdalia coronoides*		White-lipped Snake	P		1
Animalia	Reptilia	Elapidae	2805	*Drysdalia rhodogaster*		Mustard-bellied Snake	P		2
Animalia	Reptilia	Elapidae	2693	*Pseudechis porphyriacus*		Red-bellied Black Snake	P		4
Animalia	Reptilia	Elapidae	2699	*Pseudonaja textilis*		Eastern Brown Snake	P		1
Animalia	Aves	Casuariidae	0001	*Dromaius novaehollandiae*		Emu	P		2
Animalia	Aves	Phasianidae	0011	*Coturnix ypsilophora*		Brown Quail	P		2
Animalia	Aves	Anatidae	0210	*Anas castanea*		Chestnut Teal	P		18
Animalia	Aves	Anatidae	0211	*Anas gracilis*		Grey Teal	P		13
Animalia	Aves	Anatidae	0212	*Anas rhynchotis*		Australasian Shoveler	P		1
Animalia	Aves	Anatidae	0208	*Anas superciliosa*		Pacific Black Duck	P		17
Animalia	Aves	Anatidae	0215	*Aythya australis*		Hardhead	P		2
Animalia	Aves	Anatidae	0217	*Biziura lobata*		Musk Duck	P		2
Animalia	Aves	Anatidae	0202	*Chenonetta jubata*		Australian Wood Duck	P		21
Animalia	Aves	Anatidae	0203	*Cygnus atratus*		Black Swan	P		22
Animalia	Aves	Podicipedidae	0062	*Poliocephalus poliocephalus*		Hoary-headed Grebe	P		2
Animalia	Aves	Podicipedidae	0061	*Tachybaptus novaehollandiae*		Australasian Grebe	P		8
Animalia	Aves	Columbidae	0028	*Columba leucomela*		White-headed Pigeon	P		1
Animalia	Aves	Columbidae	9931	*Geopelia striata*		Peaceful Dove	P		21
Animalia	Aves	Columbidae	0044	*Leucosarcia melanoleuca*		Wonga Pigeon	P		8
Animalia	Aves	Columbidae	0029	*Macropygia amboinensis*		Brown Cuckoo-Dove	P		1
Animalia	Aves	Columbidae	0043	*Ocyphaps lophotes*		Crested Pigeon	P		2
Animalia	Aves	Columbidae	0034	*Phaps chalcoptera*		Common Bronzewing	P		26
Animalia	Aves	Columbidae	0035	*Phaps elegans*		Brush Bronzewing	P		20
Animalia	Aves	Columbidae	0989	*Streptopelia chinensis*	*	Spotted Turtle-Dove			4
Animalia	Aves	Podargidae	0313	*Podargus strigoides*		Tawny Frogmouth	P		3
Animalia	Aves	Caprimulgidae	0330	*Eurostopodus mystacalis*		White-throated Nightjar	P		2
Animalia	Aves	Aegothelidae	0317	*Aegotheles cristatus*		Australian Owlet-nightjar	P		4
Animalia	Aves	Apodidae	0334	*Hirundapus caudacutus*		White-throated Needletail	P	C,J,K	5
Animalia	Aves	Diomedeidae	0847	*Diomedea gibsoni*		Gibson's Albatross	V,P	V	1
Animalia	Aves	Diomedeidae	0091	*Thalassarche cauta*		Shy Albatross	V,P	V	1

Appendix I-1. Summary of NSW threatened species reported within a 5km radius of project area.

Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°; ^^ rounded to 0.01°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Public Report of all Valid Records of Animals in selected area [North: -36.83 West: 149.84 East: 150 South: -36.97] returned a total of 3,333 records of 313 species.

Report generated on 29/06/2017 10:50 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records
Animalia	Aves	Procellariidae	0069	*Ardenna pacificus*		Wedge-tailed Shearwater	P	J	2
Animalia	Aves	Procellariidae	0071	*Ardenna tenuirostris*		Short-tailed Shearwater	P	J,K	5
Animalia	Aves	Procellariidae	0074	*Fulmarus glacialoides*		Southern Fulmar	P		1
Animalia	Aves	Procellariidae	0955	*Pterodroma nigripennis*		Black-winged Petrel	V,P		1
Animalia	Aves	Procellariidae	0068	*Puffinus gavia*		Fluttering Shearwater	P		1
Animalia	Aves	Spheniscidae	0005	*Eudyptula minor*		Little Penguin	P		13
Animalia	Aves	Sulidae	0104	*Morus serrator*		Australasian Gannet	P		4
Animalia	Aves	Anhingidae	8731	*Anhinga novaehollandiae*		Australasian Darter	P		1
Animalia	Aves	Phalacrocoracidae	0100	*Microcarbo melanoleucos*		Little Pied Cormorant	P		22
Animalia	Aves	Phalacrocoracidae	0096	*Phalacrocorax carbo*		Great Cormorant	P		17
Animalia	Aves	Phalacrocoracidae	0098	*Phalacrocorax fuscescens*		Black-faced Cormorant	P		1
Animalia	Aves	Phalacrocoracidae	0097	*Phalacrocorax sulcirostris*		Little Black Cormorant	P		11
Animalia	Aves	Phalacrocoracidae	0099	*Phalacrocorax varius*		Pied Cormorant	P		5
Animalia	Aves	Pelecanidae	0106	*Pelecanus conspicillatus*		Australian Pelican	P		16
Animalia	Aves	Ardeidae	0977	*Ardea ibis*		Cattle Egret	P	C,J	1
Animalia	Aves	Ardeidae	0186	*Ardea intermedia*		Intermediate Egret	P		1
Animalia	Aves	Ardeidae	8712	*Ardea modesta*		Eastern Great Egret	P		9
Animalia	Aves	Ardeidae	0189	*Ardea pacifica*		White-necked Heron	P		2
Animalia	Aves	Ardeidae	0197	*Botaurus poiciloptilus*		Australasian Bittern	E1,P	E	1
Animalia	Aves	Ardeidae	0193	*Butorides striatus*		Striated Heron	P		1
Animalia	Aves	Ardeidae	0185	*Egretta garzetta*		Little Egret	P		2
Animalia	Aves	Ardeidae	0188	*Egretta novaehollandiae*		White-faced Heron	P		21
Animalia	Aves	Ardeidae	0191	*Egretta sacra*		Eastern Reef Egret	P	C	2
Animalia	Aves	Ardeidae	0192	*Nycticorax caledonicus*		Nankeen Night Heron	P		2
Animalia	Aves	Threskiornithidae	0182	*Platalea flavipes*		Yellow-billed Spoonbill	P		1
Animalia	Aves	Threskiornithidae	0181	*Platalea regia*		Royal Spoonbill	P		3
Animalia	Aves	Threskiornithidae	0178	*Plegadis falcinellus*		Glossy Ibis	P	C	1
Animalia	Aves	Threskiornithidae	0179	*Threskiornis molucca*		Australian White Ibis	P		15
Animalia	Aves	Threskiornithidae	0180	*Threskiornis spinicollis*		Straw-necked Ibis	P		3
Animalia	Aves	Accipitridae	0221	*Accipiter fasciatus*		Brown Goshawk	P		2
Animalia	Aves	Accipitridae	0220	*Accipiter novaehollandiae*		Grey Goshawk	P		2
Animalia	Aves	Accipitridae	0224	*Aquila audax*		Wedge-tailed Eagle	P		2
Animalia	Aves	Accipitridae	0219	*Circus approximans*		Swamp Harrier	P		3
Animalia	Aves	Accipitridae	0232	*Elanus axillaris*		Black-shouldered Kite	P		6
Animalia	Aves	Accipitridae	0226	*Haliaeetus leucogaster*		White-bellied Sea-Eagle	V,P	C	27
Animalia	Aves	Accipitridae	0228	*Haliastur sphenurus*		Whistling Kite	P		19
Animalia	Aves	Accipitridae	0225	*Hieraaetus morphnoides*		Little Eagle	V,P		2
Animalia	Aves	Accipitridae	0230	*^^Lophoictinia isura*		Square-tailed Kite	V,P,3		3
Animalia	Aves	Accipitridae	8739	*^^Pandion cristatus*		Eastern Osprey	V,P,3		1
Animalia	Aves	Falconidae	0239	*Falco berigora*		Brown Falcon	P		4
Animalia	Aves	Falconidae	0235	*Falco longipennis*		Australian Hobby	P		1
Animalia	Aves	Falconidae	0237	*Falco peregrinus*		Peregrine Falcon	P		2
Animalia	Aves	Falconidae	0238	*Falco subniger*		Black Falcon	V,P		1
Animalia	Aves	Rallidae	0059	*Fulica atra*		Eurasian Coot	P		4
Animalia	Aves	Rallidae	0056	*Gallinula tenebrosa*		Dusky Moorhen	P		4
Animalia	Aves	Rallidae	0046	*Gallirallus philippensis*		Buff-banded Rail	P		5
Animalia	Aves	Rallidae	0045	*Lewinia pectoralis*		Lewin's Rail	P		2
Animalia	Aves	Rallidae	0058	*Porphyrio porphyrio*		Purple Swamphen	P		6
Animalia	Aves	Rallidae	0049	*Porzana fluminea*		Australian Spotted Crake	P		2
Animalia	Aves	Rallidae	0050	*Porzana pusilla*		Baillon's Crake	P		4
Animalia	Aves	Haematopodidae	0131	*Haematopus fuliginosus*		Sooty Oystercatcher	V,P		8
Animalia	Aves	Haematopodidae	0130	*Haematopus longirostris*		Pied Oystercatcher	E1,P		54
Animalia	Aves	Charadriidae	0140	*Charadrius bicinctus*		Double-banded Plover	P		2
Animalia	Aves	Charadriidae	0143	*Charadrius ruficapillus*		Red-capped Plover	P		3
Animalia	Aves	Charadriidae	0144	*Elseyornis melanops*		Black-fronted Dotterel	P		14
Animalia	Aves	Charadriidae	0132	*Erythrogonys cinctus*		Red-kneed Dotterel	P		1
Animalia	Aves	Charadriidae	0138	*Thinornis rubricollis*		Hooded Plover	E4A,P	V	7
Animalia	Aves	Charadriidae	0133	*Vanellus miles*		Masked Lapwing	P		36
Animalia	Aves	Scolopacidae	0157	*Actitis hypoleucos*		Common Sandpiper	P	C,J,K	1
Animalia	Aves	Scolopacidae	0166	*Calidris alba*		Sanderling	V,P	C,J,K	1
Animalia	Aves	Scolopacidae	0164	*Calidris canutus*		Red Knot	P	E,C,J,K	2

Appendix I-1. Summary of NSW threatened species reported within a 5km radius of project area.

Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°; ^^ rounded to 0.01°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Public Report of all Valid Records of Animals in selected area [North: -36.83 West: 149.84 East: 150 South: -36.97] returned a total of 3,333 records of 313 species.

Report generated on 29/06/2017 10:50 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records
Animalia	Aves	Scolopacidae	0168	*Gallinago hardwickii*		Latham's Snipe	P	C,J,K	10
Animalia	Aves	Scolopacidae	0153	*Limosa lapponica*		Bar-tailed Godwit	P	C,J,K	4
Animalia	Aves	Scolopacidae	0149	*Numenius madagascariensis*		Eastern Curlew	P	CE,C,J,K	7
Animalia	Aves	Scolopacidae	0150	*Numenius phaeopus*		Whimbrel	P	C,J,K	3
Animalia	Aves	Scolopacidae	0155	*Tringa brevipes*		Grey-tailed Tattler	P	C,J,K	2
Animalia	Aves	Stercorariidae	0128	*Stercorarius parasiticus*		Arctic Jaeger	P	J,K	1
Animalia	Aves	Laridae	0125	*Chroicocephalus novaehollandiae*		Silver Gull	P		40
Animalia	Aves	Laridae	0112	*Hydroprogne caspia*		Caspian Tern	P	C,J	2
Animalia	Aves	Laridae	0126	*Larus pacificus*		Pacific Gull	P		1
Animalia	Aves	Laridae	0115	*Thalasseus bergii*		Crested Tern	P		25
Animalia	Aves	Cacatuidae	0269	*Cacatua galerita*		Sulphur-crested Cockatoo	P		9
Animalia	Aves	Cacatuidae	0268	*^^Callocephalon fimbriatum*		Gang-gang Cockatoo	V,P,3		19
Animalia	Aves	Cacatuidae	0267	*Calyptorhynchus funereus*		Yellow-tailed Black-Cockatoo	P		23
Animalia	Aves	Cacatuidae	0265	*^Calyptorhynchus lathami*		Glossy Black-Cockatoo	V,P,2		11
Animalia	Aves	Cacatuidae	0273	*Eolophus roseicapillus*		Galah	P		16
Animalia	Aves	Psittacidae	0281	*Alisterus scapularis*		Australian King-Parrot	P		13
Animalia	Aves	Psittacidae	0258	*Glossopsitta concinna*		Musk Lorikeet	P		15
Animalia	Aves	Psittacidae	0260	*Glossopsitta pusilla*		Little Lorikeet	V,P		16
Animalia	Aves	Psittacidae	0309	*^^Lathamus discolor*		Swift Parrot	E1,P,3	CE	14
Animalia	Aves	Psittacidae	8913	*^^Pezoporus wallicus wallicus*		Eastern Ground Parrot	V,P,3		1
Animalia	Aves	Psittacidae	0282	*Platycercus elegans*		Crimson Rosella	P		28
Animalia	Aves	Psittacidae	0288	*Platycercus eximius*		Eastern Rosella	P		18
Animalia	Aves	Psittacidae	0295	*Psephotus haematonotus*		Red-rumped Parrot	P		1
Animalia	Aves	Psittacidae	9947	*Trichoglossus haematodus*		Rainbow Lorikeet	P		38
Animalia	Aves	Cuculidae	0338	*Cacomantis flabelliformis*		Fan-tailed Cuckoo	P		19
Animalia	Aves	Cuculidae	0337	*Cacomantis pallidus*		Pallid Cuckoo	P		15
Animalia	Aves	Cuculidae	0339	*Cacomantis variolosus*		Brush Cuckoo	P		1
Animalia	Aves	Cuculidae	0342	*Chalcites basalis*		Horsfield's Bronze-Cuckoo	P		8
Animalia	Aves	Cuculidae	0343	*Chalcites lucidus*		Shining Bronze-Cuckoo	P		12
Animalia	Aves	Cuculidae	0347	*Eudynamys orientalis*		Eastern Koel	P		1
Animalia	Aves	Strigidae	0246	*^^Ninox connivens*		Barking Owl	V,P,3		1
Animalia	Aves	Strigidae	9922	*Ninox novaeseelandiae*		Southern Boobook	P		6
Animalia	Aves	Strigidae	0248	*^^Ninox strenua*		Powerful Owl	V,P,3		9
Animalia	Aves	Tytonidae	0250	*^^Tyto novaehollandiae*		Masked Owl	V,P,3		7
Animalia	Aves	Tytonidae	9924	*^^Tyto tenebricosa*		Sooty Owl	V,P,3		3
Animalia	Aves	Alcedinidae	0319	*Ceyx azureus*		Azure Kingfisher	P		2
Animalia	Aves	Alcedinidae	0322	*Dacelo novaeguineae*		Laughing Kookaburra	P		29
Animalia	Aves	Alcedinidae	0326	*Todiramphus sanctus*		Sacred Kingfisher	P		6
Animalia	Aves	Coraciidae	0318	*Eurystomus orientalis*		Dollarbird	P		1
Animalia	Aves	Menuridae	0350	*Menura novaehollandiae*		Superb Lyrebird	P		12
Animalia	Aves	Climacteridae	0558	*Cormobates leucophaea*		White-throated Treecreeper	P		24
Animalia	Aves	Ptilonorhynchidae	0679	*Ptilonorhynchus violaceus*		Satin Bowerbird	P		5
Animalia	Aves	Maluridae	0529	*Malurus cyaneus*		Superb Fairy-wren	P		132
Animalia	Aves	Maluridae	0536	*Malurus lamberti*		Variegated Fairy-wren	P		4
Animalia	Aves	Maluridae	0526	*Stipiturus malachurus*		Southern Emu-wren	P		4
Animalia	Aves	Dasyornithidae	0506	*Pycnoptilus floccosus*		Pilotbird	P		1
Animalia	Aves	Acanthizidae	0486	*Acanthiza chrysorrhoa*		Yellow-rumped Thornbill	P		26
Animalia	Aves	Acanthizidae	0470	*Acanthiza lineata*		Striated Thornbill	P		42
Animalia	Aves	Acanthizidae	0471	*Acanthiza nana*		Yellow Thornbill	P		3
Animalia	Aves	Acanthizidae	0475	*Acanthiza pusilla*		Brown Thornbill	P		80
Animalia	Aves	Acanthizidae	0453	*Gerygone olivacea*		White-throated Gerygone	P		3
Animalia	Aves	Acanthizidae	0488	*Sericornis frontalis*		White-browed Scrubwren	P		66
Animalia	Aves	Acanthizidae	0494	*Sericornis magnirostra*		Large-billed Scrubwren	P		2
Animalia	Aves	Pardalotidae	0565	*Pardalotus punctatus*		Spotted Pardalote	P		31
Animalia	Aves	Pardalotidae	0976	*Pardalotus striatus*		Striated Pardalote	P		4

Appendix I-1. Summary of NSW threatened species reported within a 5km radius of project area.

Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°; ^^ rounded to 0.01°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Public Report of all Valid Records of Animals in selected area [North: -36.83 West: 149.84 East: 150 South: -36.97] returned a total of 3,333 records of 313 species.

Report generated on 29/06/2017 10:50 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records
Animalia	Aves	Meliphagidae	0591	*Acanthorhynchus tenuirostris*		Eastern Spinebill	P		39
Animalia	Aves	Meliphagidae	0638	*Anthochaera carunculata*		Red Wattlebird	P		39
Animalia	Aves	Meliphagidae	0710	*Anthochaera chrysoptera*		Little Wattlebird	P		44
Animalia	Aves	Meliphagidae	0603	*Anthochaera phrygia*		Regent Honeyeater	E4A,P	CE	1
Animalia	Aves	Meliphagidae	0614	*Caligavis chrysops*		Yellow-faced Honeyeater	P		28
Animalia	Aves	Meliphagidae	0448	*Epthianura albifrons*		White-fronted Chat	V,P		21
Animalia	Aves	Meliphagidae	0593	*Gliciphila melanops*		Tawny-crowned Honeyeater	P		2
Animalia	Aves	Meliphagidae	0619	*Lichenostomus melanops*		Yellow-tufted Honeyeater	P		4
Animalia	Aves	Meliphagidae	0634	*Manorina melanocephala*		Noisy Miner	P		1
Animalia	Aves	Meliphagidae	0633	*Manorina melanophrys*		Bell Miner	P		81
Animalia	Aves	Meliphagidae	0605	*Meliphaga lewinii*		Lewin's Honeyeater	P		9
Animalia	Aves	Meliphagidae	0583	*Melithreptus brevirostris*		Brown-headed Honeyeater	P		12
Animalia	Aves	Meliphagidae	0578	*Melithreptus lunatus*		White-naped Honeyeater	P		13
Animalia	Aves	Meliphagidae	0586	*Myzomela sanguinolenta*		Scarlet Honeyeater	P		3
Animalia	Aves	Meliphagidae	0617	*Nesoptilotis leucotis*		White-eared Honeyeater	P		3
Animalia	Aves	Meliphagidae	0645	*Philemon corniculatus*		Noisy Friarbird	P		11
Animalia	Aves	Meliphagidae	0632	*Phylidonyris niger*		White-cheeked Honeyeater	P		1
Animalia	Aves	Meliphagidae	0631	*Phylidonyris novaehollandiae*		New Holland Honeyeater	P		38
Animalia	Aves	Meliphagidae	0630	*Phylidonyris pyrrhoptera*		Crescent Honeyeater	P		7
Animalia	Aves	Meliphagidae	0625	*Ptilotula penicillatus*		White-plumed Honeyeater	P		1
Animalia	Aves	Psophodidae	0436	*Cinclosoma punctatum*		Spotted Quail-thrush	P		2
Animalia	Aves	Psophodidae	0421	*Psophodes olivaceus*		Eastern Whipbird	P		37
Animalia	Aves	Neosittidae	0549	*Daphoenositta chrysoptera*		Varied Sittella	V,P		5
Animalia	Aves	Campephagidae	0424	*Coracina novaehollandiae*		Black-faced Cuckoo-shrike	P		22
Animalia	Aves	Campephagidae	0425	*Coracina papuensis*		White-bellied Cuckoo-shrike	P		1
Animalia	Aves	Campephagidae	0429	*Coracina tenuirostris*		Cicadabird	P		1
Animalia	Aves	Campephagidae	0430	*Lalage sueurii*		White-winged Triller	P		5
Animalia	Aves	Pachycephalidae	0408	*Colluricincla harmonica*		Grey Shrike-thrush	P		27
Animalia	Aves	Pachycephalidae	9951	*Falcunculus frontatus*			P		1
Animalia	Aves	Pachycephalidae	0416	*Falcunculus frontatus frontatus*		Eastern Shrike-tit	P		7
Animalia	Aves	Pachycephalidae	0405	*Pachycephala olivacea*		Olive Whistler	V,P		4
Animalia	Aves	Pachycephalidae	0398	*Pachycephala pectoralis*		Golden Whistler	P		19
Animalia	Aves	Pachycephalidae	0401	*Pachycephala rufiventris*		Rufous Whistler	P		25
Animalia	Aves	Oriolidae	0671	*Oriolus sagittatus*		Olive-backed Oriole	P		14
Animalia	Aves	Artamidae	8519	*Artamus cyanopterus cyanopterus*		Dusky Woodswallow	V,P		16
Animalia	Aves	Artamidae	0700	*Cracticus nigrogularis*		Pied Butcherbird	P		1
Animalia	Aves	Artamidae	0705	*Cracticus tibicen*		Australian Magpie	P		34
Animalia	Aves	Artamidae	0702	*Cracticus torquatus*		Grey Butcherbird	P		31
Animalia	Aves	Artamidae	0694	*Strepera graculina*		Pied Currawong	P		30
Animalia	Aves	Artamidae	0697	*Strepera versicolor*		Grey Currawong	P		5
Animalia	Aves	Rhipiduridae	0361	*Rhipidura albiscapa*		Grey Fantail	P		49
Animalia	Aves	Rhipiduridae	0364	*Rhipidura leucophrys*		Willie Wagtail	P		25
Animalia	Aves	Rhipiduridae	0362	*Rhipidura rufifrons*		Rufous Fantail	P		10
Animalia	Aves	Corvidae	0930	*Corvus coronoides*		Australian Raven	P		25
Animalia	Aves	Monarchidae	0415	*Grallina cyanoleuca*		Magpie-lark	P		20
Animalia	Aves	Monarchidae	0373	*Monarcha melanopsis*		Black-faced Monarch	P		3
Animalia	Aves	Monarchidae	9955	*Myiagra inquieta*		Restless Flycatcher	P		7
Animalia	Aves	Monarchidae	0365	*Myiagra rubecula*		Leaden Flycatcher	P		2
Animalia	Aves	Petroicidae	0392	*Eopsaltria australis*		Eastern Yellow Robin	P		59
Animalia	Aves	Petroicidae	8367	*Melanodryas cucullata cucullata*		Hooded Robin (south-eastern form)	V,P		1
Animalia	Aves	Petroicidae	0377	*Microeca fascinans*		Jacky Winter	P		25
Animalia	Aves	Petroicidae	0380	*Petroica boodang*		Scarlet Robin	V,P		12
Animalia	Aves	Petroicidae	0382	*Petroica phoenicea*		Flame Robin	V,P		1
Animalia	Aves	Petroicidae	0384	*Petroica rosea*		Rose Robin	P		5

Appendix I-1. Summary of NSW threatened species reported within a 5km radius of project area.

Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°; ^^ rounded to 0.01°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Public Report of all Valid Records of Animals in selected area [North: -36.83 West: 149.84 East: 150 South: -36.97] returned a total of 3,333 records of 313 species.

Report generated on 29/06/2017 10:50 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records
Animalia	Aves	Alaudidae	0993	*Alauda arvensis*	*	Eurasian Skylark			1
Animalia	Aves	Cisticolidae	0525	*Cisticola exilis*		Golden-headed Cisticola	P		6
Animalia	Aves	Acrocephalidae	0524	*Acrocephalus australis*		Australian Reed-Warbler	P		6
Animalia	Aves	Megaluridae	0509	*Cincloramphus mathewsi*		Rufous Songlark	P		1
Animalia	Aves	Megaluridae	0522	*Megalurus gramineus*		Little Grassbird	P		1
Animalia	Aves	Timaliidae	0574	*Zosterops lateralis*		Silvereye	P		23
Animalia	Aves	Hirundinidae	0357	*Hirundo neoxena*		Welcome Swallow	P		31
Animalia	Aves	Hirundinidae	0360	*Petrochelidon ariel*		Fairy Martin	P		7
Animalia	Aves	Hirundinidae	0359	*Petrochelidon nigricans*		Tree Martin	P		1
Animalia	Aves	Turdidae	0991	*Turdus merula*	*	Eurasian Blackbird			23
Animalia	Aves	Turdidae	0779	*Zoothera lunulata*		Bassian Thrush	P		1
Animalia	Aves	Turdidae	7000	*Zoothera sp.*		unidentified ground thrush	P		2
Animalia	Aves	Sturnidae	0999	*Sturnus vulgaris*	*	Common Starling			22
Animalia	Aves	Estrildidae	0662	*Neochmia temporalis*		Red-browed Finch	P		52
Animalia	Aves	Estrildidae	0650	*Stagonopleura bella*		Beautiful Firetail	P		1
Animalia	Aves	Estrildidae	0652	*Stagonopleura guttata*		Diamond Firetail	V,P		2
Animalia	Aves	Estrildidae	0655	*Taeniopygia bichenovii*		Double-barred Finch	P		2
Animalia	Aves	Passeridae	0995	*Passer domesticus*	*	House Sparrow			11
Animalia	Aves	Motacillidae	0647	*Anthus novaeseelandiae*		Australian Pipit	P		18
Animalia	Aves	Fringillidae	0996	*Carduelis carduelis*	*	European Goldfinch			4
Animalia	Mammalia	Ornithorhynchidae	1001	*Ornithorhynchus anatinus*		Platypus	P		8
Animalia	Mammalia	Tachyglossidae	1003	*Tachyglossus aculeatus*		Short-beaked Echidna	P		21
Animalia	Mammalia	Dasyuridae	1668	*Antechinus agilis*		Agile Antechinus	P		13
Animalia	Mammalia	Dasyuridae	1674	*Antechinus stuartii*		Brown Antechinus	P		3
Animalia	Mammalia	Dasyuridae	1033	*Antechinus swainsonii*		Dusky Antechinus	P		5
Animalia	Mammalia	Dasyuridae	1008	*Dasyurus maculatus*		Spotted-tailed Quoll	V,P	E	3
Animalia	Mammalia	Dasyuridae	1017	*Phascogale tapoatafa*		Brush-tailed Phascogale	V,P		2
Animalia	Mammalia	Dasyuridae	1069	*Sminthopsis leucopus*		White-footed Dunnart	V,P		1
Animalia	Mammalia	Dasyuridae	1800	*Sminthopsis sp.*		Dunnart	P		1
Animalia	Mammalia	Peramelidae	T081	*Isoodon/Perameles sp.*		unidentified Bandicoot	P		18
Animalia	Mammalia	Peramelidae	1097	*Perameles nasuta*		Long-nosed Bandicoot	P		12
Animalia	Mammalia	Phascolarctidae	1162	*Phascolarctos cinereus*		Koala	V,P	V	3
Animalia	Mammalia	Vombatidae	1165	*Vombatus ursinus*		Common Wombat	P		22
Animalia	Mammalia	Burramyidae	1150	*Cercartetus nanus*		Eastern Pygmy-possum	V,P		5
Animalia	Mammalia	Petauridae	1136	*Petaurus australis*		Yellow-bellied Glider	V,P		51
Animalia	Mammalia	Petauridae	1138	*Petaurus breviceps*		Sugar Glider	P		16
Animalia	Mammalia	Pseudocheiridae	1129	*Pseudocheirus peregrinus*		Common Ringtail Possum	P		15
Animalia	Mammalia	Acrobatidae	1147	*Acrobates pygmaeus*		Feathertail Glider	P		4
Animalia	Mammalia	Phalangeridae	T082	*Trichosurus sp.*		brushtail possum	P		5
Animalia	Mammalia	Phalangeridae	1113	*Trichosurus vulpecula*		Common Brushtail Possum	P		16
Animalia	Mammalia	Potoroidae	T086	*Potorous sp.*		Potoroo	P		2
Animalia	Mammalia	Potoroidae	1175	*Potorous tridactylus*		Long-nosed Potoroo	V,P	V	7
Animalia	Mammalia	Macropodidae	1265	*Macropus giganteus*		Eastern Grey Kangaroo	P		23
Animalia	Mammalia	Macropodidae	1261	*Macropus rufogriseus*		Red-necked Wallaby	P		7
Animalia	Mammalia	Macropodidae	T085	*Macropus sp.*		kangaroo / wallaby	P		1
Animalia	Mammalia	Macropodidae	1242	*Wallabia bicolor*		Swamp Wallaby	P		26
Animalia	Mammalia	Pteropodidae	1280	*Pteropus poliocephalus*		Grey-headed Flying-fox	V,P	V	13
Animalia	Mammalia	Pteropodidae	1281	*Pteropus scapulatus*		Little Red Flying-fox	P		2
Animalia	Mammalia	Pteropodidae	T087	*Pteropus sp.*		Flying-fox	P		36
Animalia	Mammalia	Rhinolophidae	1303	*Rhinolophus megaphyllus*		Eastern Horseshoe-bat	P		1
Animalia	Mammalia	Molossidae	1324	*Austronomus australis*		White-striped Freetail-bat	P		1
Animalia	Mammalia	Vespertilionidae	1349	*Chalinolobus gouldii*		Gould's Wattled Bat	P		2
Animalia	Mammalia	Vespertilionidae	1351	*Chalinolobus morio*		Chocolate Wattled Bat	P		5
Animalia	Mammalia	Vespertilionidae	1372	*Falsistrellus tasmaniensis*		Eastern False Pipistrelle	V,P		3
Animalia	Mammalia	Vespertilionidae	1834	*Miniopterus schreibersii oceanensis*		Eastern Bentwing-bat	V,P		3
Animalia	Mammalia	Vespertilionidae	1335	*Nyctophilus geoffroyi*		Lesser Long-eared Bat	P		11
Animalia	Mammalia	Vespertilionidae	1334	*Nyctophilus gouldi*		Gould's Long-eared Bat	P		7
Animalia	Mammalia	Vespertilionidae	T092	*Nyctophilus sp.*		long-eared bat	P		1
Animalia	Mammalia	Vespertilionidae	1361	*Scoteanax rueppellii*		Greater Broad-nosed Bat	V,P		3
Animalia	Mammalia	Vespertilionidae	1022	*Vespadelus darlingtoni*		Large Forest Bat	P		3
Animalia	Mammalia	Vespertilionidae	1378	*Vespadelus regulus*		Southern Forest Bat	P		2

Appendix I-1. Summary of NSW threatened species reported within a 5km radius of project area.

Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°; ^^ rounded to 0.01°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Public Report of all Valid Records of Animals in selected area [North: -36.83 West: 149.84 East: 150 South: -36.97] returned a total of 3,333 records of 313 species.

Report generated on 29/06/2017 10:50 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records
Animalia	Mammalia	Vespertilionidae	T088	*Vespadelus sp.*		Unidentified Eptesicus	P		1
Animalia	Mammalia	Vespertilionidae	1379	*Vespadelus vulturnus*		Little Forest Bat	P		24
Animalia	Mammalia	Muridae	1412	*Mus musculus*	*	House Mouse			2
Animalia	Mammalia	Muridae	1395	*Rattus fuscipes*		Bush Rat	P		30
Animalia	Mammalia	Muridae	1398	*Rattus lutreolus*		Swamp Rat	P		6
Animalia	Mammalia	Muridae	1408	*Rattus rattus*	*	Black Rat			3
Animalia	Mammalia	Dugongidae	1558	*Dugong dugon*		Dugong	E1,P		3
Animalia	Mammalia	Otariidae	1543	*Arctocephalus forsteri*		New Zealand Fur-seal	V,P		1
Animalia	Mammalia	Otariidae	1882	*Arctocephalus pusillus doriferus*		Australian Fur-seal	V,P		2
Animalia	Mammalia	Otariidae	9040	*Seal sp.*		Unidentified Seal	P		2
Animalia	Mammalia	Phocidae	1549	*Hydrurga leptonyx*		Leopard Seal	P		3
Animalia	Mammalia	Canidae	1531	*Canis lupus*	*	Dingo, domestic dog			12
Animalia	Mammalia	Canidae	1532	*Vulpes vulpes*	*	Fox			96
Animalia	Mammalia	Felidae	1536	*Felis catus*	*	Cat			33
Animalia	Mammalia	Leporidae	1510	*Oryctolagus cuniculus*	*	Rabbit			8
Animalia	Mammalia	Neobalaenidae	1564	*Caperea marginata*		Pygmy Right Whale	P		1
Animalia	Mammalia	Balaenopteridae	1575	*Megaptera novaeangliae*		Humpback Whale	V,P	V	15
Animalia	Mammalia	Physeteridae	1578	*Physeter macrocephalus*		Sperm Whale	V,P		1
Animalia	Mammalia	Ziphiidae	1593	*Mesoplodon grayi*		Gray's Beaked Whale	P		1
Animalia	Mammalia	Delphinidae	1616	*Delphinus delphis*		Common Dolphin	P		2
Animalia	Mammalia	Delphinidae	1600	*Orcinus orca*		Killer Whale	P		1
Animalia	Mammalia	Delphinidae	1900	*Tursiops truncatus*		Bottlenose Dolphin	P		3

Note

1	Sensitivity Class 1 (Sensitive Species Data Policy)
2	Sensitivity Class 2 (Sensitive Species Data Policy)
3	Sensitivity Class 3 (Sensitive Species Data Policy)
CH	Critical Habitat (Threatened Species Conservation Act 1995)
E1	Endangered (Threatened Species Conservation Act 1995)
E2	Endangered Population (Threatened Species Conservation Act 1995)
E3	Endangered Ecological Community (Threatened Species Conservation Act 1995)
E4	Presumed Extinct (Threatened Species Conservation Act 1995)
E4A	Critically Endangered (Threatened Species Conservation Act 1995)
E4B	Critically Endangered Ecological Community (Threatened Species Conservation Act 1995)
FCE	Critically Endangered Fish (Fisheries Management Act 1994)
FE	Endangered Fish (Fisheries Management Act 1994)
FEC	Endangered Ecological Community of Fish (Fisheries Management Act 1994)
FEP	Endangered Population of Fish (Fisheries Management Act 1994)
FKTP	Key Threatening Process of Fish (Fisheries Management Act 1994)
FP	Protected Fish (Fisheries Management Act 1994)
FV	Vulnerable Fish (Fisheries Management Act 1994)
FX	Extinct Fish (Fisheries Management Act 1994)
KTP	Key Threatening Process (Threatened Species Conservation Act 1995)
P	Protected (National Parks & Wildlife Act 1974)
V	Vulnerable (Threatened Species Conservation Act 1995)
V2	Vulnerable Ecological Community (Threatened Species Conservation Act 1995)

Appendix I-2. Likelihood of occurrence of threatened species recorded or modelled to occur within a 5 km radius of the project area.

Species Name	Common Name	Legal Status			Source	Last Reported in BVSC region [1]	NOTES	Score	Likelihood of Occurrence [2]
		EPBC Act	BC Act	FM Act					
Cetaceans (whales and dolphins)									
Balaenoptera acutorostrata	Minke whale	W	P	-	ALA	1990	Broadly distributed in Australian waters and it is likely that the whales occur right around the continent at various times of the year usually in offshore waters. Two records in BVSC region offshore from Tathra in 1990, >10km from the project area.	3	Unlikely
Balaenoptera borealis	Sei whale	V, W	P	-	ALA	1991	Broadly distributed in southern temperate waters and often observed in areas of upwelling. One record in BVSC region from Twofold Bay in 1991.	3	Unlikely
Balaenoptera edeni	Bryde's whale	W	P	-	ALA	1991	Found in temperate to tropical waters but rarely observed in NSW waters. Two records in BVSC region, both >10km from the project area.	3	Unlikely
Balaenoptera musculus	Blue whale	E, M, W	E	-	ALA	1996	Blue Whale sightings in Australian waters have been widespread, and it is likely that the whales occur right around the continent at various times of the year usually in offshore waters. There are no known aggregation areas near the project area. The most sighting in the BVSC region was at Twofold Bay in 1996.	3	Unlikely
Balaenoptera physalus	Fin whale	V, W	P	-	ALA	1982	Broadly distributed in southern cool temperate waters and often observed in areas of upwelling. Rarely observed in BVSC region with two records in offshore waters, the most recent from 1982.	3	Unlikely
Caperea marginata	Pygmy right whale	M, W	P	-	ALA	1989	Broadly distributed in southern temperate waters and often observed in areas of upwelling. Rarely observed in BVSC region with one record offshore from Haycock Point in 1989.	3	Unlikely
Eubalaena australis	Southern right whale	E, M, W	E	-	ALA	2016	The species migrates to coastal region of southern Australia for calving during winter period (June to August). Species is occasionally observed in coastal waters and embayments of the BVSC region where mothers and calves may be observed resting in shallow waters close to the beach. There are several records of the species occuring within Merimbula Bay but no records specifically with the Project area.	20	High
Megaptera novaeangliae	Humpback whale	V, M, W	V	-	Elgin	2020 *	Observed annually in Merimbula Bay during spring southerly migration (August to November). Groups of individuals and mothers and their calves were observed passing through the project area during marine ecology investigations in 2017, 2019, and 2020.	25	High
Orcinus orca	Killer whale, Orca	M, W	P	-	ALA	2015	Inhabit all of worlds oceans with a total of nine records in the BVSC region since 1930, most recently reported in 2015 from Twofold Bay. Typically forages in offshore waters over the continental shelf.	15	Moderate
Delphinus delphis	Common dolphin	W	P	-	Elgin	2020 *	Regularly observed in waters offshore to the BVSC coastal region all year. Groups of individuals were observed in the project area in October 2019.	25	High
Grampus griseus	Risso's dolphin	W	P	-	ALA	-	The EPBC Act Protected Matters Search Tool indicates *'Species or species habitat may occur within area'*. However, there are no confirmed records of this species in BVSC region.	2	Unlikely
Lagenorhynchus obscurus	Dusky dolphin	M, W	P	-	ALA	-	The EPBC Act Protected Matters Search Tool indicates *'Species or species habitat may occur within area'*. However, there are no confirmed records of this species in BVSC region.	2	Unlikely

Appendix I-2. Likelihood of occurrence of threatened species recorded or modelled to occur within a 5 km radius of the project area.

Species Name	Common Name	Legal Status			Source	Last Reported in BVSC region [1]	NOTES	Score	Likelihood of Occurrence [2]
		EPBC Act	BC Act	FM Act					
Tursiops aduncus	Indian Ocean bottlenose dolphin	W	P	-	ALA	2015	The EPBC Act Protected Matters Search Tool indicates *'Species or species habitat may occur within area'*. One record of the species in Twofold Bay in 2015, >10km south of project area.	10	Low
Tursiops truncatus s. str.	Indo-Pacific Bottlenose dolphin	W	P	-	Elgin	2020 *	Broadly distributed around the Australian coast found in temperate and tropical waters. Regularly observed in waters offshore to the BVSC coastal region all year. Groups of individuals were observed in the project area in 2020.	25	High
Other mammal									
Dugong dugon	Dugong	M	E	-	ALA	2016	Occur in wide shallow protected bays, wide shallow mangrove channels and in the lee of large inshore islands. Will also occupy deeper waters if their seagrass food is available. Five records of Dugong in BVSC region since 1986 with some of those records likely to be the same individual reported from different locations. Last sighted in Merimbula Lake in 2016. No suitable habitat (i.e. seagrass meadows) exists in the project area.	5	Unlikely
Pinnipeds (Seals)									
Arctocephalus forsteri	New Zealand fur-seal	L	V	-	ALA	2012	Colony of non-breeding New Zealand fur-seal exist at Montague Island 80 km to the north of the project area. New Zealand fur-seal are known to forage in waters offshore of Merimbula and Pambula including the project area.	25	High
Arctocephalus pusillus	Australian fur-seal	L	V	-	Elgin	2020 *	Colonies of non-breeding fur-seal exist at Montague Island 80 km to the north and Green Cape 40 km to the south of the project area respectively. Australian fur-seal are known to forage in waters offshore of Merimbula and Pambula with individuals sighted in 2017 during fieldwork including the project area.	25	High
Hydrurga leptonyx	Leopard Seal	L	P	-	ALA	2002	There are a total of six confirmed records in BVSC region since 1970 with four records in the Merimbula-Pambula region. The last sighting was in 2002 on Haycock Beach. Typically inhabits in sub-antarctic waters. No suitable habitat exists in the project area.	1	Unlikely
Sea turtles									
Caretta caretta	Loggerhead turtle	E, L	P	-	ALA	2014	Loggerhead turtles nest, forage and migrate across tropical northern Australia. One individual has been reported in BVSC region near Wallaga Lake in 2014. They are unlikely to frequent the waters of Merimbula Bay.	5	Unlikely
Chelonia mydas	Green turtle	V, M, L	P	-	ALA	2000	Green turtles nest, forage and migrate across tropical northern Australia. One individual has been recorded >10km to the south of the project area in 2000. They are unlikely to frequent the waters of Merimbula Bay.	1	Unlikely
Dermochelys coriacea	Leatherback turtle	E, M, L	P	-	ALA	-	This species has a broad oceanic distribution and is known to frequent temperate water in southern Australia for feeding but they breed in tropical areas. Rarely found close to the shore in Australia and known to feed and nest within the Great Barrier Reef World Heritage Areas with nesting recorded at Wreck Rock and adjacent beaches near Bundaberg, and sporadic nesting at other widely scattered sites in Queensland. No confirmed records in BVSC region. Suitable foraging habitat exists within the project area.	2	Unlikely
Eretmochelys imbricata	Hawksbill turtle	V, L	P	-	ALA	2009	Hawksbill turtles nest, forage and migrate across tropical northern Australia. There are three records in BVSC region since 1989 with one record in Merimbula Lake. The last sighting was in 2009 north of Bermagui. They are unlikely to frequent Merimbula Bay and the project area.	5	Unlikely
Natator depressus	Flatback turtle	V, L	P	-	ALA	-	Flat back turtles nest, forage and migrate across tropical northern Australia. No confirmed records in BVSC region.	1	Unlikely

Appendix I-2. Likelihood of occurrence of threatened species recorded or modelled to occur within a 5 km radius of the project area.

Species Name	Common Name	Legal Status			Source	Last Reported in BVSC region [1]	NOTES	Score	Likelihood of Occurrence [2]
		EPBC Act	BC Act	FM Act					
Bony Fish									
Epinephelus daemelii	Black cod	V, L	-	V	ALA, pers. comm.	2005 / 2017	Found on coastal reefs, estuaries or in deep water offshore. The species has been reported from locations >30km to the south and north of Merimbula Bay with the last recorded sighting from Bermagui in 2005. Anectdotal reports from local spearfishers indicate individuals are regularly observed at Mowarry Point south of Eden. Suitable habitat exists within the project area.	15	Moderate
Thunnus maccoyii	Southern bluefin tuna	-	-	E	ALA	2017	Highly migratory species found in Australian oceanic waters from northwestern Australia, around southern Australia to NSW and the broader Pacific ocean. The southern bluefin tuna is targeted by fishers in waters offshore to the BVSC coast each year, typically during summer and autumn period coinciding with warmer currents. The species is usually observed in offshore waters but has been sighted within Merimbula Bay on occasion. Suitable foraging habitat exists within the project area.	20	High
Syngnathiformes	Seahorses, pipefish, pipehorses, sea moths	L	-	P	ALA, RLS	2017	Majority of species are typically found in seagrass and macroalgal habitats of estuaries and protected embayments. EPBC Protected Matters Search Tool indicates 28 spp. may occur within 5km radius of the project area. A total of 31 spp are known from NSW waters. Of these, only 10 species are recorded within the BVSC region and mostly from estuarine and sheltered environments. Two species that may be observed in habitats of Merimbula Bay at Long Point and Haycock Point include the bigbelly seahorse and weedy seadragon.	15	Moderate
Sharks									
Carcharias taurus	Grey nurse shark	CE	-	CE	ALA, RLS, Dorsal	2018	Grey nurse shark have been observed in coastal waters within the BVSC region with the the most recent sighting at Long Pont, Merimbula Bay in 2018. The closest known aggregation site critical to the species is Montague Island (80 km north of Merimbula). Suitable habitat (i.e. sand gutters and rocky reef) exists at the project site.	15	Moderate
Carcharodon carcharias	Great white shark	V, M, W	-	V	ALA, RLS, Dorsal	2020	Found in Ausralian coastal waters over a broad range. White shark individuals are sighted along the BVSC coast each year, typically in spring and summer coinciding with the southerly migration of humpback whales. The Great white shark was reported within Merimbula Bay on at least eight different occasions over 12-month period between January 2017 to May 2020 (Dorsal 2020).	15	Moderate
Lamna nasus	Porbeagle, Mackerel shark	L, M	-	-	ALA	-	Widley distributed in cold temperate marine waters of southern hemisphere and North Atlatntic ocean. Targeted by commecial fishers. Recorded from deep waters offshore the continental shelf.	2	Unlikely
Rhincodon typus	Whale shark	V, M, W	-	-	ALA	2012	The Whale Shark is most commonly found in WA, NT and QLD, with the main aggregation site at Ningaloo Reef (WA) and prefers waters between 21-25 degrees C. An indiviudal was briefly sighted at Tathra wharf in 2012 though its	3	Unlikely

Appendix I-2. Likelihood of occurrence of threatened species recorded or modelled to occur within a 5 km radius of the project area.

Species Name	Common Name	Legal Status			Source	Last Reported in BVSC region [1]	NOTES	Score	Likelihood of Occurrence [2]
		EPBC Act	BC Act	FM Act					
Birds									
Actitis hypoleucos	Common Sandpiper	L	P	-	ALA		Occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. No suitable habitat exists within the project area.	3	Unlikely
Apus pacificus	Fork-tailed Swift	L	-	-	ALA		Forages in low to very high airspace over varied habitat types. May aerially forage over the project area.	10	Low
Ardea alba	Great Egret, White Egret	L	-	-	ALA	2017	Prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. No suitable habitat exists within project area.	5	Unlikely
Ardea ibis	Cattle Egret	L	P	-	ALA	2017	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. No suitable habitat exists within project area.	5	Unlikely
Ardenna grisea	Sooty Shearwater	-	P	-	ALA	2013	A migratory seabird that is known to nest on islands in NSW south of Port Stephens. Foraging habitat exists within the project area.	15	Moderate
Ardenna pacificus	Wedge-tailed Shearwater	-	P	-	Elgin	2020 *	A migratory seabird that nests on islands off coast of NSW. Foraging habitat exists within the project area with indiviudals observed foraging during fieldwork in November 2017 and October 2020.	25	High
Ardenna tenuirostris	Short-tailed Shearwater	-	P	-	Elgin	2020 *	A migratory seabird that nests along the eastern and southern coastlines of Australia. Foraging habitat exists within the project area with indiviudals observed foraging during fieldwork in November 2017 and October 2020.	25	High
Calidris acuminata	Sharp-tailed Sandpiper	L	-	-	ALA	2017	The Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. No suitable habitat exists within project area.	5	Unlikely
Calidris alba	Sanderling	-	V,P	-	ALA	2017	Often found in coastal areas on low beaches of firm sand, near reefs and inlets, along tidal mudflats and bare open coastal lagoons; individuals are rarely recorded in near-coastal wetlands. Limited suitable habitat exists in project area.	5	Unlikely
Calidris canutus	Red Knot, Knot	E, L	P	-	ALA	2016	Gather in large flocks on the coast in sandy estuaries with tidal mudflats. No suitable habitat exists within project area.	5	Unlikely
Calidris ferruginea	Curlew Sandpiper	CE, L	-	-	ALA	2017	It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland. It forages in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach -cast seagrass or seaweed. No suitable habitat exists within project area.	5	Unlikely
Calidris melanotos	Pectoral Sandpiper	L	-	-	ALA	_	The species is usually found in coastal or near coastal habitat but occasionally found further inland. Prefers coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. Has not been recorded in southern NSW. No suitable habitat exists within the project area.	1	Unlikely
Catharacta skua	Great Skua	L	-	-	ALA	1972	A seabird commonly observed around southern Australia and has been sighted offshore from Merimbula Bay. Suitable foraging habitat exists within the project area.	3	Unlikely
Chroicocephalus novaehollandiae	Silver Gull	-	P	-	Elgin	2020 *	Coastal, offshore waters; beaches, mudflats, estuaries, larger rivers, reservoirs, lakes; some inland. Suitable habitat present within project area.	25	High
Cuculus saturatus	Oriental Cuckoo, Himalayan Cuckoo	L	-	-	ALA		A migratory bird from northern hemisphere found in coastal and inland forest. Not observed from Merimbula-Pambula region. Suitable habitat exists within the project area.	3	Unlikely
Diomedea antipodensis	Antipodean Albatross	V, L	-	-	ALA		The Antipodean Albatross is endemic to New Zealand, however forages widely in open water in the south-west Pacific Ocean, Southern Ocean and the Tasman Sea, notably off the coast of NSW. Foraging habitat exists within the project area.	10	Low
Diomedea antipodensis gibsoni	Gibson's Albatross	V, L	V, P	-	ALA	2006	Gibson's Albatross has been recorded foraging between Coffs Harbour, NSW, and Wilson's Promontory, Victoria. There are no specific records from waters offshore of Merimbula Bay, NSW. Foraging habitat exists within the project area.	3	Unlikely

Appendix I-2. Likelihood of occurrence of threatened species recorded or modelled to occur within a 5 km radius of the project area.

Species Name	Common Name	Legal Status			Source	Last Reported in BVSC region [1]	NOTES	Score	Likelihood of Occurrence [2]
		EPBC Act	BC Act	FM Act					
Diomedea epomophora	Southern Royal Albatross	V, L	-	-	ALA		Has been observed in offshore waters south of Eden. Foraging habitat exists within the project area.	10	Low
Diomedea exulans	Wandering Albatross	V, L	-	-	ALA		Regularly observed foraging in waters offshore from Merimbula Bay. Foraging habitat exists within the project area.	15	Moderate
Diomedea sanfordi	Northern Royal Albatross	E, L	-	-	ALA		The Northern Royal Albatross ranges widely over the Southern Ocean, with individuals seen in Australian waters off south-eastern Australia. The Northern Royal Albatross feeds regularly in Tasmanian and South Australian waters, and less frequently in NSW waters. Foraging habitat exists within the project area.	10	Low
Eudyptula minor	Little Penguin	-	P	-	Elgin	2020 *	Nearest breeding, nesting colonies are Montague Island and Gabo Island, approx 80km to the north and south of the project area respectively. Foraging habitat exists within the project area and individuals were observed foraging within Merimbula Bay during fieldwork in November 2017 and October 2020.	25	High
Fulmarus glacialoides	Southern Fulmar	-	P	-	ALA		A seabird that breeds and nest on sub-antarctic islands and mainland Antarctica. Ocassionally observed foraging over waters in southern NSW. Suitable foraging habitat exists within the project area.	3	Unlikely
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	L	P	-	ALA		They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). No suitable habitat exists within the project area.	3	Unlikely
Gallinago megala	Swinhoe's Snipe	L	-	-	ALA		Boggy edges of vegetated wetlands, sewage and other ponds, stubbles, grasslands with shrubs, pastures. No suitable habitat exists within the project area.	3	Unlikely
Gallinago stenura	Pin-tailed Snipe	L	-	-	ALA		Favours wet grassy ground; edges of reedy swamps. No suitable habitat exists within the project area.	3	Unlikely
Haematopus fuliginosus	Sooty Oystercatcher	-	V,P	-	ALA		Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. Known to occur from a range of locations around Merimbula Bay including Long Point and Haycock Point. No suitable habitat exists within the project area.	10	Low
Haematopus longirostris	Pied Oystercatcher	-	E1,P	-	ALA	2017	Favours intertidal flats of inlets and bays, open beaches and sandbanks. Limited suitable habitat exists within the project area.	15	Moderate
Haliaeetus leucogaster	White-bellied Sea-Eagle	L	V, P	-	ALA	2017	Inhabits coastal areas, over islands, reefs, beaches, estuaries, lagoons and floodplains. Foraging habitat exists within the project area.	15	Moderate
Halobaena caerulea	Blue Petrel	V, L	-	-	ALA		A seabird of sub-antarctic islands and mainland Antarctica. Commonly observed around southern Australia. Has not been recorded in southern NSW. Suitable foraging habitat exists within the project area.	10	Low
Hirundapus caudacutus	White-throated Needletail	L	P	-	ALA		A largely aerial migratory bird from northern hemisphere observed in large numbers across eastern and northern Australia. May forage over the project area.	10	Low
Hydroprogne caspia	Caspian Tern	-	P	-	ALA		Coastal, offshore waters; beaches, mudflats, estuaries, larger rivers, reservoirs, lakes; some inland. Suitable habitat present within project area.	10	Low
Larus pacificus	Pacific Gull	-	P	-	ALA		Typically found around southern Australia and Tasmania though is known from habitats around Merimbla Bay. Foraging habitat exists within the project area.	10	Low
Lathamus discolor	Swift Parrot	L	-	-	ALA		This migratory species has been recorded on the mainland from a variety of habitat types including dry and wet sclerophyll forest, forested wetlands, coastal swamp forests and heathlands. Suitable foraging habitat exists with the project area.	10	Low
Limosa lapponica	Bar-tailed Godwit	L	P	-	ALA		Primarily a coastal species usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Known to occur inside Merimbula Lake. No suitable habitat exists in project area.	10	Low
Macronectes giganteus	Southern Giant-Petrel, Southern Giant Petrel	E, L	-	-	ALA	2013	The Southern Giant-Petrel is widespread throughout the Southern Ocean. Has been observed in waters ofshore from Merimbula Bay. Foraging habitat exists within the project area.	15	Moderate
Macronectes halli	Northern Giant Petrel	V, L	-	-	ALA	2017	Immature and some adult birds are commonly seen in offshore and inshore waters from around Fremantle (WA) to around Sydney (NSW). Has been observed in waters ofshore from Merimbula Bay. Foraging habitat exists within the project area.	15	Moderate

Appendix I-2. Likelihood of occurrence of threatened species recorded or modelled to occur within a 5 km radius of the project area.

Species Name	Common Name	Legal Status			Source	Last Reported in BVSC region [1]	NOTES	Score	Likelihood of Occurrence [2]
		EPBC Act	BC Act	FM Act					
Merops ornatus	Rainbow Bee-eater	L	-	-	ALA		Most often found in open forests, woodlands and shrublands, and cleared areas, usually near water. It will be found on farmland with remnant vegetation and in orchards and vineyards. No suitable habitat exists within project area.	3	Unlikely
Microcarbo melanoleucos	Little Pied Cormorant	-	P	-	ALA		Prefers inland wetlands but do occur in sheltered bays and inlets. No suitable habitat exists within the project area.	3	Unlikely
Monarcha melanopsis	Black-faced Monarch	L	P	-	ALA		Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. No suitable habitat exists within the project area.	3	Unlikely
Monarcha trivirgatus	Spectacled Monarch	L	-	-	ALA		Prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves. No suitable habitat exists within project area.	3	Unlikely
Morus serrator	Australasian Gannet	-	P	-	Elgin	2019 *	Coastal bird usually breeding on islands or artificial structures. Foraging habitat exists within the project area with individuals observed within Merimbula Bay during fieldwork in November 2017 and October 2019.	25	High
Myiagra cyanoleuca	Satin Flycatcher	L	-	-	ALA		Inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. No suitable habitat exists within project area.	3	Unlikely
Neophema chrysogaster	Orange-bellied Parrot	CE, L	-	-	ALA		Orange-bellied Parrot spends winter mostly within 3 km of the coast in sheltered coastal habitats including bays, lagoons, estuaries, coastal dunes and saltmarshes. The species also inhabits small islands and peninsulas and occasionally saltworks and golf courses. Birds forage in low samphire herbland or taller coastal shrubland. No suitable habitat exists in project area.	3	Unlikely
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	CE, L	P	-	ALA		Found on intertidal mudflats and sandflats, often with beds of seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons. Known to occur inside Merimbula Lake. No suitable habiat exists in the project area.	10	Low
Numenius minutus	Little Curlew, Little Whimbrel	L	-	-	ALA		Dry grasslands, floodplains, margins of drying swamps, tidal mudflats, airfields, playing fields, crops, commercial saltfields, sewage ponds. No suitable habitat exists within the project area.	3	Unlikely
Numenius phaeopus	Whimbrel	-	P	-	ALA		Estuaries, mangroves, tidal flats, coral cays, exposed reefs, flooded paddocks, sewage ponds, bare grasslands, sports grounds, lawns. Known to occur inside Merimbula Lake. Marginal habitat exists within the project area.	10	Low
Pachyptila turtur	Fairy Prion	L	-	-	ALA		Breeds on subantarctic and cool temperate islands. Beachcast birds are found along the whole coast of NSW, and the species is common offshore along the entire Victorian coast. Recorded from Merimbula Bay and broader BVSC region. Foraging habitat exists within the project area.	10	Low
Pandion haliaetus	Osprey	L	-	-	ALA	2017	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water. Observed within the Merimbula coastal region. Foraging habitat exists within the project area.	15	Moderate
Phalacrocorax carbo	Great Cormorant	-	P	-	ALA	2017	Prefers freshwater wetlands but also observed in coastal inlets and estuaries. Known from Merimbula and Pambula region. May forage in coastal habitats within the project area.	15	Moderate
Phalacrocorax fuscescens	Black-faced Cormorant	-	P	-	Elgin	2019 *	Found primarily around southern Australian coastline where it breeds on rocky headlands, islands and inlets building nests of seaweed and driftwood. Known from the Merimbula and Pambula region and observed foraging within the project area.	25	High
Phalacrocorax sulcirostris	Little Black Cormorant	-	P	-	ALA		Found throughout Australia, prefers freshwater wetlands but also observed in sheltered coastal waters. Known from Merimbula and Pambula estuaries. No suitable habitat exists within the project area.	10	Low
Phalacrocorax varius	Pied Cormorant	-	P	-	Elgin	2019 *	Found throughout Australia, in marine habitats including estuaries, harbours and bays. It is also found in mangroves and on large inland wetlands in eastern Australia. Known from the Merimbula and Pambula region and observed foraging within the project area.	25	High
Phoebetria fusca	Sooty Albatross	V, L	-	-	ALA		The Sooty Albatross is a regular migrant to Australia, mostly in the autumn-winter months, occurring in offshore waters north to south-east Queensland, NSW, Victoria, Tasmania and South Australia. Not recorded from Merimbula Bay. Foraging habitat exists within the project area.	10	Low

Appendix I-2. Likelihood of occurrence of threatened species recorded or modelled to occur within a 5 km radius of the project area.

Species Name	Common Name	Legal Status			Source	Last Reported in BVSC region [1]	NOTES	Score	Likelihood of Occurrence [2]
		EPBC Act	BC Act	FM Act					
Pterodroma nigripennis	Black-winged Petrel	-	V,P	-	ALA		A seabird that breeds and nest on sub-antarctic islands and mainland Antarctica. Ocassionally observed foraging over offshore waters in southern NSW. Foraging habitat exists within the project area.	10	Low
Puffinus carneipes	Flesh-footed Shearwater, Fleshy-footed Shearwater	L	-	-	ALA		Ranges throughout the Pacific and Indian oceans, with main breeding areas Lord Howe Island, New Zealand and along coast of Western Australia. Occasionally observed foraging in waters offshore from Merimbula. Foraging habitat exists within the project area.	15	Moderate
Puffinus gavia	Fluttering Shearwater	-	P	-	ALA		Endemic to New Zealand and migrates to Australia and Solomon Islands. Occasionally observed foraging in waters offshore from Merimbula. Foraging habitat exists within the project area.	15	Moderate
Rhipidura rufifrons	Rufous Fantail	L	P	-	ALA		Found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. No suitable habitat exists within project area.	3	Unlikely
Rostratula benghalensis (sensu lato)	Painted Snipe	E, L	-	-	ALA		Prefers shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. No suitable habitat exists within the project area.	3	Unlikely
Sternula albifrons	Little Tern	L	-	-	Elgin	2019*	Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers. Suitable foraging habitat exists within the project area.	25	High
Thalassarche bulleri	Buller's Albatross, Pacific Albatross	V, L	-	-	ALA		Frequently observed off the coast from Coffs Harbour, south to Tasmania and west to Eyre Peninsula. Foraging habitat exists within the project area.	10	Low
Thalassarche cauta	Tasmanian Shy Albatross	V, L	V, P	-	ALA	2017	Shy Albatrosses appear to occur over all Australian coastal waters below 25° S. It is most commonly observed over the shelf waters around Tasmania and south eastern Australia. Foraging habitat exists within the project area.	15	Moderate
Thalassarche eremita	Chatham Albatross	E, L		-	ALA		The principal foraging range for this species is in coastal waters off eastern and southern New Zealand and Tasmania. Not likely to occur in waters off Merimbula Bay.	3	Unlikely
Thalassarche impavida	Campbell Albatross, Campbell Black-browed Albatross	V, L	-	-	ALA		Non-breeding birds are most commonly seen foraging over the oceanic continental slopes off Tasmania, Victoria and New South Wales. Foraging habitat exists within the project area.	10	Low
Thalassarche melanophris	Black-browed Albatross	V, L	-	-	ALA		Forages offshore from Antarctica to subtropical waters over upwellings and boundary currents. Has been observed offshore from Merimbula Bay. Foraging habitat is present within the project area.	10	Low
Thalassarche salvini	Salvin's Albatross	V, L	-	-	ALA		Salvin's Albatross is a non-breeding visitor to Australian waters, however it is possible that it frequents the Merimbula area during non-breeding periods. However, no sightings have been recorded.	10	Low
Thalassarche steadi	White-capped Albatross	V, L	-	-	ALA		The White-capped Albatross is probably common off the coast of south-east Australia throughout the year. Foraging habitat exists within the project area.	10	Low
Thalasseus bergii	Crested Tern	-	P	-	ALA	2019*	Widespread around the Australian coastline. Known from Merimbula Bay. Foraging habitat exists within the project area.	20	High
Thinornis rubricollis rubricollis	Hooded Plover (eastern)	V, L	E4A,P	-	ALA		In south-eastern Australia Hooded Plovers prefer sandy ocean beaches, especially those that are broad and flat, with a wide wave-wash zone for feeding, much beachcast seaweed, and backed by sparsely vegetated sand-dunes for shelter and nesting. Limited suitable habitat exists within the project area.	10	Low
Tringa nebularia	Common Greenshank, Greenshank	L	-	-	ALA		Found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. No suitable habitat exists within project area.	3	Unlikely

Notes

EPBC Act 1999 Status: L = listed marine species, V = vulnerable, E = endangered, CE = critically endangered, W = whales and other cetaceans, M = migratory.

NSW *Biodiversity Conservation Act 2016* Status: E = endangered, V = vulnerable, P = protected.

NSW *Fisheries Management Act 1994* Status: CE = critically endangered, V = vulnerable.

[1] Last reported occurrence in Bega Valley Shire Region according to ALA (2017), RLS (2017) and Dorsal (2018) databases, or confirmed by observations during marine ecology fieldwork*

[3] Likelihood of occurrence score: 20-25 = high, 11-19 = Moderate, 6-10 = Low, Unlikely = 1-5 (Refer scoring criteria Table 13-1)

APPENDIX I

SIGNIFICANCE ASSESSMENTS

APPENDIX I

1. SIGNIFICANCE ASSESSMENTS (*FM ACT*)

Black Cod (*Epinephelus daemelii)*

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The black cod (*Epinephelus daemelii*) is a large reef-dwelling species belonging to the grouper family (Serrandiae). It occurs in the warm temperate and subtropical waters of the south western Pacific including south-eastern Australia, Lord Howe Island, Norfolk Island, the Kermadec Islands and northern New Zealand. The species Australian range includes from southern Queensland to eastern Victoria, with the NSW coastline forming the species main range.

Black cod live to at least 65 years and can grow up to 1.7 metres in length and over 80 kilograms in weight (DPI, 2015). It is a protogynous hermaphrodite, first developing as a female and then changing into a male later in life when reaching approximately 100 – 110 cm in length. Within NSW, adults are considered most abundant north of Port Stephens and the central to south coast region of NSW is an important area for the recruitment of juveniles where they are known to recruit to intertidal shallow reefs and rock pools (Harasti *et al.,* 2014).

According to sighting records held by ALA (2017) and RLS (2017), there have been four recorded observations of the black cod in the BVSC region since 1972, none from Merimbula. These include Twofold Bay in 1972, Bitangabee Bay and Green Cape in 1989, and Bermagui in 2005. More regular sightings of black cod are reported from locations in the Eurobodalla shire region such as the Narooma breakwater and Montague Island (RLS 2017). With only 4 confirmed sightings since 1972, the occurrence of a local viable population of black cod in the BVSC region can be considered rare.

As the Project is situated on sandy seabed with the nearest rocky reef approximately 1,400 m to the south-east, and the effluent mixing zone typically a 25 m radius the majority of time, it is considered unlikely that the life cycle of the species would be disrupted such that a viable local population would be placed at risk of extinction.

(*b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.*

Not applicable – No endangered population of black cod is listed in NSW.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – the species does not constitute an EEC.

(d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the

APPENDIX I

Black Cod (*Epinephelus daemelii)*

threatened species, population or ecological community in the locality.

No area of habitat for black cod would be removed or modified or become fragmented as a result of the Project.

(e) Whether the action proposed is likely to have an adverse effect on any critical habitat (either directly or indirectly).

No critical habitat for black cod has been declared in NSW.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The black cod recovery plan (DPI, 2012) lists water pollution including sewage and stormwater discharges, estuarine outputs and marine debris, as a moderate risk with potential to negatively impact the species long-term viability in certain parts of its habitat and life cycle. The plan includes actions to address Objective 8: mitigate the impacts of water pollution on black cod.

The operational phase of the Project would result in the discharge of treated effluent to an ocean outfall at 30m depth over sandy sediments where it is expected to rapidly dilute and meet WQOs within a 25 m mixing zone. Potential impacts are expected to be confined to the mixing zone which is approximately 1400 m away from the nearest rocky reef habitat that may or may not be suitable for black cod.

It should be noted that treated sewage effluent has been discharged to a beach-face outfall at Merimbula Bay since 1971. The Project would result in the improved management of treated effluent providing a disposal option during peak wet weather events that currently, can result in episodic sewage overflows to Merimbula estuary that then poses a threat to estuarine values including oyster aquaculture. The Project also includes upgrades to the STP that would result in improved effluent quality and disposal at the proposed ocean outfall would provide improved dispersion of the treated effluent compared to the current beach-face outfall.

Overall, the Project is contributing to mitigating the potential impact of water pollution on black cod and it is unlikely that the species would be adversely affected by the Project. Therefore, the Project is consistent with objective 8 of the plan (DPI 2012).

(g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Project as a whole is not considered a KTP. However, in relation to the recognised KTP - *introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales*, a potential risk exists for this KTP to occur during Project construction activities. The Project construction phase would require vessels and materials to mobilise from Twofold Bay where a number of introduced marine pests (IMPs) are known to occur. The risk of translocating an IMP via construction vessels is considered a medium risk that can be reduced by implementing environmental management controls as discussed in Section 15.

Conclusion – The Project is unlikely to have adverse effects on black cod hence no SIS is required. The Project would result in improved effluent quality and improved dispersion such that WQOs of Merimbula Bay are met within a 25 m mixing zone. The Project is not a KTP to the species.

APPENDIX I

Southern bluefin tuna (*Thunnus maccoyii)*

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Southern bluefin tuna (*Thunnus maccoyii*) are listed as endangered under the FM Act. They are a highly migratory pelagic fish, found in oceanic waters normally on the seaward side of the continental shelf. In Australian waters, they range from north-western Australia around southern Australia to northern NSW. The western boundary of the species migratory path lies within NSW State waters. Southern bluefin tuna are long-lived (up to 40 years) and can reach a maximum length of 2.35 metres with a weight of around 200kg, but rarely exceed 100kg in Australian waters (DPI, 2014). Both adult and juvenile SBT occur in NSW waters although the warm waters of the north-east Indian Ocean between Java and Australia is the only known spawning ground (Cardno, 2012).

The southern bluefin tuna is targeted by recreational fishers in BVSC coastal waters each year, typically during July to January period as the species migrates northwards. The species is usually observed in deep offshore waters along the continental shelf and rarely sighted within Merimbula Bay. However, in January 2018, a solitary SBT was observed in the Pambula broadwater likely having followed baitfish up the river (Merimbula News Weekly, 16 January 2018).

As the Project is situated within inshore coastal waters that the species may only transit on rare occasion, it is considered unlikely that the life cycle of the species would be disrupted such that a viable local population would be placed at risk of extinction. Pressures associated with overfishing are considered the key threat to the species viability.

(*b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.*

Not applicable – No endangered population of southern bluefin tuna is listed in NSW.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – the species does not constitute an EEC.

(d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality.

No area of habitat for southern bluefin tuna would be removed or modified or become fragmented as a result of the Project.

(e) Whether the action proposed is likely to have an adverse effect on any critical habitat (either directly or indirectly).

No critical habitat for southern bluefin tuna has been declared in NSW.

APPENDIX I

Southern bluefin tuna (*Thunnus maccoyii)*

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

Currently, there is no recovery plan for southern bluefin tuna in NSW waters. However, a priority action statement (DPI 2020) and a species impact statement (Cardno, 2012) recommend improved monitoring and reporting to accurately estimate the recreational catch to inform appropriate species management and recovery.

The Project would adopt standard practices and mitigation measures to prevent or minimise potential impacts and it is expected that the Project would not impact the southern bluefin tuna or impede actions recommended for the species recovery. Therefore, the Project is consistent with the recovery actions stated in the priority action statement.

(g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Project as a whole is not considered a KTP. However, in relation to the recognised KTP - *introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales*, a potential risk exists for this KTP to occur during Project construction activities. The Project construction phase would require vessels and materials to mobilise from Twofold Bay where a number of IMPs are known to occur. The risk of translocating an IMP via construction vessels is considered a medium risk that can be reduced by implementing environmental management controls as discussed in **Section 15.**

Conclusion – The Project is unlikely to have adverse effects on southern bluefin tuna hence no SIS is required. The Project would result in improved effluent quality and improved dispersion such that WQOs of Merimbula Bay are met within a 25m mixing zone. The Project is not a KTP to the species.

Grey nurse shark (*Carcharius taurus)*

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Grey nurse shark (GNS) is listed as Critically Endangered on both the NSW *FM Act* and *EPBC Act*. Grey nurse are a large shark native to subtropical to cool temperate waters, living to approximately 35 years (DPI, 2007). In NSW, GNS are typically found in coastal inshore waters, around rocky reefs and boulders or sand filled gutters in water depths of 15 – 40 m but also spend some time in deeper waters (DPI, 2007). They tend to be found in groups at specific locations known as aggregation sites. It is these aggregation sites that are considered habitat critical to the survival of the species.

The GNS has been reported from at least seven locations in the BVSC region (Refer Appendix 1 in DoE 2014) including at Tura Head and Twofold Bay, to the north and south of Merimbula Bay respectively. In addition, GNS sightings have been reported near to the Merimbula wharf on five occasions (2/12/2016, 8/4/2017, 12/10/2017, 21/1/2018, 11/12/2018 as listed by ALCW 2020). No GNS were observed during marine ecology field surveys undertaken for this Project. The nearest known aggregation site of the GNS considered critical to the species survival is Montague Island approximately 80km north of the study area (DoE, 2014).

As the Project is situated on sandy seabed with the nearest rocky reef approximately 1,400m to the south-east, and the effluent mixing zone typically a 25m radius the majority of time, it is considered

APPENDIX I

unlikely that the life cycle of the species would be adversely effected such that a viable local population would be placed at risk of extinction.

(*b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.*

The entire population of GNS on the east coast of Australia is considered critically endangered with only those locations known as aggregation sites currently considered critical to the species survival. As mentioned above, the Project is unlikely to have an adverse effect on the life cycle of the species such that a viable population would be placed at risk of extinction.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – the species does not constitute an EEC.

(d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality.

No area of habitat for GNS would be removed or modified or become fragmented as a result of the Project.

(e) Whether the action proposed is likely to have an adverse effect on any critical habitat (either directly or indirectly).

The nearest critical habitat for GNS is the aggregation site at Montague Island approximately 80km north of the study area. The Project would not impact on these sites.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The revised national recovery plan for GNS (DSEWPC, 2014) includes an action to address plan Objective 7: Improve the understanding of the threat of pollution and disease to the GNS.

The operational phase of the Project would result in the discharge of treated effluent to an ocean outfall at 30m depth over sandy sediments where it is expected to rapidly dilute and meet WQOs within a 25m mixing zone. Potential impacts are expected to be confined to the mixing zone which is approximately 1400m away from the nearest rocky reef habitat that represents the nearest potentially suitable habitat for grey nurse shark. The effects of water pollution on GNS are not yet clearly understood and large mobile fauna such as GNS may transit the mixing zone for short periods of time.

It should be noted that treated sewage effluent has been discharged to a beach-face outfall at Merimbula Bay since 1971. The Project would result in the improved management of treated effluent providing a disposal option during peak wet weather events that currently, can result in episodic

Grey nurse shark (*Carcharius taurus)*

sewage overflows to Merimbula estuary that then poses a threat to estuarine values including oyster aquaculture. The Project also includes upgrades to the STP that would result in improved effluent quality and disposal at the proposed ocean outfall would provide improved dispersion of the treated effluent compared to the current beach-face outfall.

Overall, the Project is contributing to mitigating the potential impact of water pollution on GNS and it is unlikely that the species would be adversely affected by the Project. Therefore, the Project is consistent with Objective 7 of the plan (DSEWPC, 2014).

(g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Project as a whole is not considered a KTP. However, in relation to the recognised KTP - *introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales*, a potential risk exists for this KTP to occur during Project construction activities. The Project construction phase would require vessels and materials to mobilise from Twofold Bay where a number of IMPs are known to occur. The risk of translocating an IMP via construction vessels is considered a medium risk that can be reduced by implementing environmental management controls as discussed in **Section 15**.

Conclusion – The Project is unlikely to have adverse effects on GNS hence no SIS is required. The Project would result in improved effluent quality and improved dispersion such that WQOs of Merimbula Bay are met within a 25m mixing zone. The Project is not a KTP to the species.

White shark (*Carcharodon Carcharias*)

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The White shark (*Carcharodon carcharias*) is a migratory species listed as Vulnerable under the *FM Act*. White sharks are found around south-eastern Australia from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas. Their life cycle is poorly understood although evidence is emerging from tagging programs suggests both adults and juveniles can be wide ranging. Adult white sharks are more frequently observed in regions with high prey density, such as fur seal colonies, and are long-lived, living for 30 years or more (DSEWPaC 2013). Juveniles appear to aggregate seasonally in certain areas and in NSW, those areas include the coastal region between Newcastle and Forster.

White shark individuals are sighted along the BVSC coast each year, typically in spring to summer with the pattern of sightings coinciding with the southerly migration of humpback whales that occurs between September to November. No white sharks were observed during marine ecology field surveys undertaken for this Project.

Based on what is known of the species life cycle, migratory patterns and areas considered important to the species biology, it is unlikely that the Project would have an adverse effect on the life cycle of the species such that a viable local population would be placed at risk of extinction.

(*b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.*

APPENDIX I

White shark (*Carcharodon Carcharias*)

There is no endangered population of white shark listed in NSW.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – the species does not constitute an EEC.

(d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality.

No area of habitat for white shark would be removed or modified or become fragmented as a result of the Project.

(e) Whether the action proposed is likely to have an adverse effect on any critical habitat (either directly or indirectly).

Areas of critical habitat, those areas considered biologically important to the species include high density foraging sites, mostly around seal and sea lion colonies, and juvenile aggregation sites, where known. Based on this, the nearest critical habitat is Montague Island and Gabo Island that support colonies of fur seal. Both sites are approximately 80km from the study area and would not be adversely impacted by the Project.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The national recovery plan for white shark (DSEWPaC 2013) includes actions to address ten objectives. These are based on the principal threats of accidental or illegal catch by recreational and commercial fishers, mortality related to shark controls such as beach meshing or drumlining and protecting critical habitat. The Project is consistent with the objectives outlined in the recovery plan (DSEWPaC 2013).

(g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Project as a whole is not considered a KTP. However, in relation to the recognised KTP - *introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales*, a potential risk exists for this KTP to occur during Project construction activities. The Project construction phase would require vessels and materials to mobilise from Twofold Bay where a number of IMPs are known to occur. The risk of translocating an IMP via construction vessels is considered a medium risk that can be reduced by implementing environmental management controls as discussed in **Section 15.**

Conclusion – The Project is unlikely to have adverse effects on white shark hence no SIS is required. The Project would result in improved effluent quality and improved dispersion such that WQOs of Merimbula Bay are met within a 25m mixing zone. The Project is not a key threatening

process to the species.

2. SYNGNATHIFORMES

Syngnathiformes are a unique group of bony fish including seahorses, seadragons, pipefish, pipehorses, ghostpipefish and seamoths. They are protected under the NSW *FM Act* and *EPBC Act* and there are currently up to 31 syngnathids (seahorse, pipefish, pipehorse and seadragon), four solenostomids (ghostpipefish) and two species of pegasids (seamoths) that are known to exist in NSW waters. Off the NSW coast, syngnathiformes are found in a variety of habitats ranging from deep reefs to coastal algae, weed or seagrass habitats, or around man-made structures such as jetties or mesh nets.

Ten members of Syngnathiformes have been reported from the BVSC region according to ALA (2020) and RLS (2017) databases, including:

- Bigbelly seahorse (*Hippocampus abdominalis*)
- Hairy pipefish (*Urocampus carinirostris*)
- Spotted pipefish (*Stigmatopora argus*)
- Widebody pipefish (*Stigmatipora nigra*)
- Port phillip pipefish (*Vanacampus phillipi*)
- Mother-of-pearl pipefish (*Vanacampus margaritifer*)
- Solegnathus sp.
- Javelin pipefish (*Lissocampus runa*)
- Smooth flutemouth (*Fistularia commersonii*)
- Weedy seadragon (*Phyllopteryx taeniolatus*)

The majority of these species are typically found in seagrass and algal habitats of estuaries and protected embayments. Three species that may occur on the rocky reef habitats of Merimbula Bay include the bigbelly seahorse and weedy seadragon.

The bigbelly seahorse has been reported from shallow habitats at Long Point and Merimbula Lake. The nearest reported population of the weedy seadragon is from *Posidonia* seagrass and algal habitats in East Boyd Bay (Wilson *et al.* 2016), approximately 30km south of the study area. Syngnathiformes were not observed in marine ecology field surveys undertaken for this Project.

As the Project would be situated over the sandy seabed with the nearest suitable habitat at Long Point more than 2 km to the north and at Haycock Point more than 2 km to the south, and the effluent mixing zone typically a 25 m radius majority of time and 200 m radius under worse-case scenario, it is considered unlikely that the Project would have adverse effects on members of the synganthiformes in terms of their life cycle and habitat requirements. Further detailed assessment of potential impacts to members of synganthiformes is deemed not required.

2.1. DISTRIBUTION OF THREATENED AND PROTECTED SPECIES LISTED UNDER FM ACT

Distribution records and predicted distribution range of Black cod, Grey nurse shark, Great white shark and Syngnathiformes as provided by ALA (2017) are shown in **Figure I-1**.

APPENDIX I

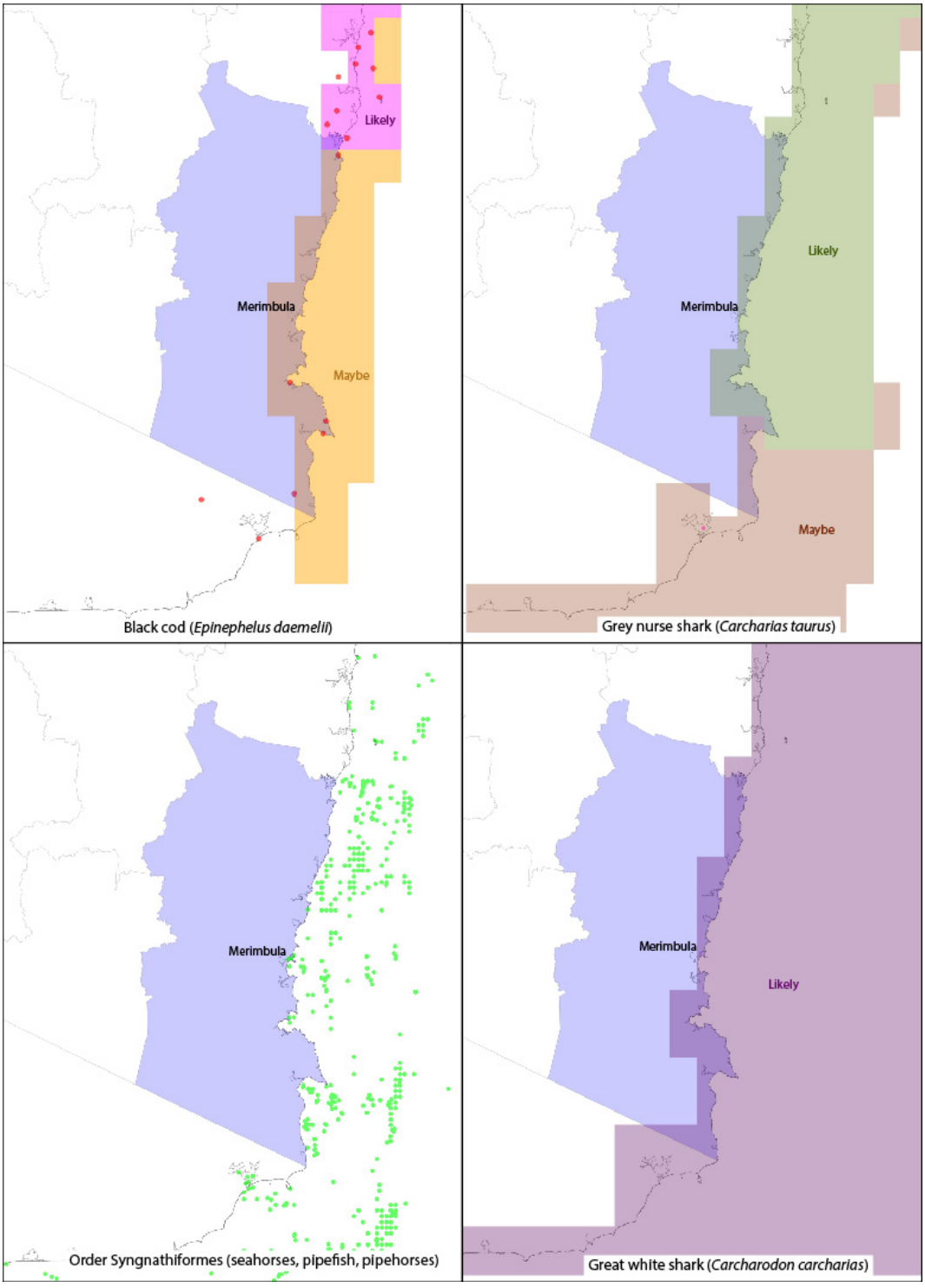


Figure I-1. Distribution records and predicted distribution range of Black cod, Grey nurse shark, Great white shark and Syngnathiformes as provided by ALA (2020).

APPENDIX I

3. SIGNIFICANCE ASSESSMENTS (*BC ACT*)

New Zealand fur seal (*Arctocephalus forsteri*) and Australian fur seal (*Arctocephalus pusillus*)

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

New Zealand and Australian fur seals are listed as Vulnerable under the BC Act and as marine species on the EPBC Act. Colonies of non-breeding New Zealand and Australian fur-seal exist at Montague Island approximately 80 km to the north of the project area, and a colony of non-breeding Australian fur seal are known at Green Cape. Both seal species are known to forage in waters offshore of Merimbula and Pambula and solitary Australian fur seals were observed within the project area on multiple occasions during marine ecology investigations undertaken for this Project.

Seals may be disturbed by vessels during construction phase activities resulting in altered foraging behaviour during this period (*i.e.* preference to move away to another area). Any potential change in their foraging behaviour is expected to be short-term. Seals are exposed to regular boating traffic in the area from the recreational, commercial and charter fishing sector and easily avoid vessels when approached. Noise disturbance and water pollution from construction vessels also pose an impact to seals. However control measures would be adopted by the project to effectively mitigate the risk of these impacts (**Section 15 – Environmental Management**).

The Project is not likely to have an adverse effect on the life cycle of a threatened seal species such that a viable local population of the species is likely to be placed at risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – No EECs occur within the marine environment of the study area.

(c) In relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.

No area of habitat for the New Zealand fur seal or Australian fur seal would be removed or modified or become fragmented as a result of the Project.

(d) Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).

No Area of Outstanding Biodiversity Value (AOBV) listed under the BC Act are located near to the study area and would not be impacted by the Project.

(*e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

The Project is not a KTP as listed under the BC Act.

APPENDIX I

New Zealand fur seal (*Arctocephalus forsteri*) and Australian fur seal (*Arctocephalus pusillus*)

Conclusion – The Project is unlikely to have adverse effects on the New Zealand fur seal or Australian fur seal and as such the Project does not represent a KTP to the species.

Humpback whale (*Megaptera novaeangliae*)

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Humpback whales are listed as Vulnerable on both the NSW *BC Act* and *EPBC Act*. The life cycle of humpback whales in the Southern Hemisphere involves feeding and advancement to maturity in the Southern Ocean during summer months, followed by northward migration during winter months (June to August) to reproduce and give birth in subtropical and tropical waters (Jefferson *et al.*, 1993).

Merimbula Bay is part of the biologically important area identified for the species and they are commonly observed within the embayment during their southern migration between August to November each year as they travel closer to the coastline with their calves. Locally, the western edge of the species southerly migratory pathway appears to follow the approximate 30 m depth contour of Merimbula Bay commencing offshore from Long Point south to Hunter Reef then south-east to Haycock Point. Individuals or mothers and calves may use Merimbula Bay for resting and foraging prior to moving southward. They are less likely to be observed in Merimbula Bay during their northward migration as they travel further offshore when heading north.

Project construction phase activities pose a potential impact to humpback whales through vessel strike, water pollution and underwater noise impacts should construction activities be undertaken during the species southerly migration. However, control measures can be implemented to effectively mitigate the risk of these impacts (**Section 15 – Environmental Management**). Whales may also be disturbed by construction vessels resulting in altered foraging and migratory behaviour (*i.e.* preference to move away to another area). Any potential change in their foraging and migratory behaviour is expected to be short-term.

The humpback whale migrates vast distances to reproduce and forage. The Project is not likely to have an adverse effect on the life cycle of the humpback whale such that a viable local population of the species is likely to be placed at risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – No EECs occur within the marine environment of the study area.

(c) In relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.

APPENDIX I

Humpback whale (*Megaptera novaeangliae*)

No area of habitat for the humpback whale would be removed or modified or become fragmented as a result of the Project.

(d) Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).

No AOBV listed under the BC Act are located near to the study area so would not be impacted by the Project.

(e*) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

The Project is not a KTP as listed under the BC Act.

Conclusion – Control measures would be adopted to effectively mitigate risk of potential impacts such that the Project is unlikely to have adverse effects on humpback whale (**Section 15**). The Project does not represent a KTP to the species.

Southern Right whale (*Eubalaena australis*)

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Southern right whales are listed as Endangered under both the NSW BC Act and EPBC Act. The species life cycle is based around summer feeding grounds in the Southern Ocean before migrating to warmer waters along the coastal region of southern Australia between winter and spring (June to August) to calve and breed (DSEWPaC, 2012). Southern right whales were subject to severe depletion across their range due to whaling in the late 18th and early 19th centuries and the current global population is estimated at 16,000 or between 16 - 27% of estimated pre-exploitation levels (IWC 2010). The Australian population of Southern right whales is comprised of two genetically distinct sub-populations, a south-west and south-east population. Whales visiting NSW waters belong to the south-east population that is considered very small. Documented sighting records suggest there are a growing series of biologically important areas (BIAs) for the south-east population that includes Disaster Bay and Twofold Bay. Although it is generally thought that mainly non-calving individuals are frequenting these areas.

Smith (2001) has estimated the total number of Southern right whales now visiting NSW in any one year to be less than ten. There are several records of the species occurring within Merimbula Bay with the most recent sighting in 2016. For the most part, sighting a Southern right whale in Merimbula Bay could be considered a rare occurrence.

Project construction phase activities pose a potential impact to Southern right whales through vessel strike, water pollution and underwater noise impacts. However, control measures can be adopted by the project to effectively mitigate the risk of these impacts (**Section 15 – Environmental Management**). Whales may also be disturbed by construction vessels resulting in altered foraging and migratory behaviour (*i.e.* preference to move away to another area). Any potential change in their foraging and migratory behaviour is expected to be short-term.

The Southern right whale migrates vast distances to reproduce and forage. The Project is not likely to have an adverse effect on the life cycle of the Southern right whale such that a viable local population of the species is likely to be placed at risk of extinction.

APPENDIX I

Southern Right whale (*Eubalaena australis*)

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – No EECs occur within the marine environment of the study area.

(c) In relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.

No area of habitat for the southern right whale would be removed or modified or become fragmented as a result of the Project.

(d) Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).

No AOBV listed under the BC Act are located near to the study area and would not be impacted by the Project.

(e*) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

The Project is not a KTP as listed under the BC Act.

Conclusion – Control measures would be implemented to effectively mitigate risk of potential impacts such that the Project is unlikely to have adverse effects on Southern right whale (**Section 15**). The Project does not represent a KTP to the species.

Orca (*Orcinus orca*)

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Orca are listed as Protected under the *BC Act* and migratory under the *EPBC Act*. They inhabit all of the world's oceans but are generally more common in near-shore waters and areas of high productivity and often sighted around seal colonies and during whale migration periods. Their distributional range is not restricted by water temperature or depth. While

At the local level, nine records of orca have been reported in the BVSC region since 1930 (ALA, 2020), with the most recent report in 2015 from Twofold Bay. For the most part, sighting an orca in waters of the far south coast region could be considered a rare occurrence and they are unlikely to occur within Merimbula Bay. They are most likely to occur in offshore waters foraging along the edge of the East Australian boundary current.

Project construction phase activities pose a potential impact to Orca whales through vessel strike, water pollution and underwater noise impacts. However, control measures can be adopted by the

Orca (*Orcinus orca*)

project to effectively mitigate the risk of these impacts (**Section 15 – Environmental Management**). Orca may also be disturbed by construction vessels resulting in altered foraging and migratory behaviour (*i.e.* preference to move away to another area). Any potential change in their foraging and migratory behaviour is expected to be short-term.

Orca migrate vast distances to reproduce and forage. The Project is not likely to have an adverse effect on the life cycle of the Orca such that a viable local population of the species is likely to be placed at risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – No EECs occur within the marine environment of the study area.

(c) In relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.

No area of habitat for orca would be removed or modified or become fragmented as a result of the Project.

(d) Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).

No AOBV listed under the *BC Act* are located near to the study area and would not be impacted by the Project.

(*e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

The Project is not a KTP as listed under the BC Act.

Conclusion – Control measures would be implemented to effectively mitigate risk of potential impacts such that the Project is unlikely to have adverse effects on orca (**Section 15**). The Project does not represent a KTP to the species.

Common dolphin (*Delphinus delphis*) and Indo-Pacific bottlenose dolphin (*Tursiops truncatus s. str.*)

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The common dolphin and Indo-Pacific bottlenose dolphin are listed as Protected under the *BC Act.* Both species have a wide global distribution including the Temperate East and South East Marine regions. The common dolphin mainly occurs in offshore waters while the Indo-Pacific bottlenose

dolphin prefers inshore coastal waters. Both species are regularly observed foraging across Merimbula Bay and the wider coastal waters of the BVSC region and both were sighted during marine ecology investigations for the Project. Merimbula Bay is not reported to be a breeding ground for either species.

Project construction phase activities pose a potential impact to dolphin species through vessel strike, water pollution and underwater noise impacts. Dolphins are exposed to regular boating traffic in the area from the recreational, commercial and charter fishing sector and are considered a lower risk of vessel strike as they can easily out manoeuvre approaching vessels. Dolphins may also be disturbed by construction vessels resulting in altered foraging behaviour (*i.e.* preference to move away to another area). Any potential change in their foraging and migratory behaviour is expected to be short-term. Control measures would be implemented to effectively mitigate the risk of these impacts (**Section 15 – Environmental Management**).

The Project is not likely to have an adverse effect on the life cycle of either the common dolphin or Indo-Pacific bottlenose dolphin such that a viable local population of the species is likely to be placed at risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable – No EECs occur within the marine environment of the study area.

(c) In relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.

No area of habitat for the common dolphin or Indo-Pacific bottlenose dolphin would be removed or modified or become fragmented as a result of the Project.

(d) Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).

No AOBV listed under the BC Act are located near to the study area so would not be impacted by the Project.

(*e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

The Project is not a KTP as listed under the BC Act.

Conclusion – Control measures would be implemented to effectively mitigate risk of potential impacts such that the Project is unlikely to have adverse effects on common dolphin or Indo-Pacific bottlenose dolphin (**Section 15**). The Project does not represent a KTP to either species.

APPENDIX I

2.1.1 Migratory and Marine Birds

Twenty migratory and marine birds listed under the *BC Act* and or *EPBC Act* are considered to have moderate to high likelihood of occurrence within the study area. The project area offers suitable foraging habitat for these marine birds, though none are reliant on the area for roosting or nesting. Nine of the species listed in Table 2-2 were observed foraging or transiting over Merimbula Bay waters within the study area during marine ecology investigations including the Wedge-tailed shearwater, Short-tailed shearwater, Silver gull, Little Penguin, Australasian Gannet, Black–faced cormorant, Pied cormorant, Little tern and Crested tern.

Merimbula Bay represents a small proportion of the total area used for foraging by these species. Disturbance during construction phase may alter foraging behaviour for some species over the short-term but is not expected to cause adverse effects on a species life cycle or habitat. The Project would not cause a decline in food resources for any of the listed migratory or marine birds. A limited area of the beach zone that falls within the Project area may be used by some species for resting such as silver gull, little tern and crested tern. During construction phase, such species may avoid the beach zone until the disturbance has passed.

The Project is unlikely to have an adverse effect on any migratory or marine bird and thus no further assessment of significance is required.