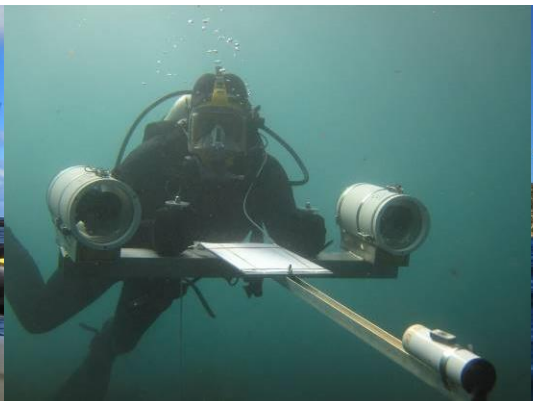
Witness Statement - Review of Gas Import Jetty and Pipeline EES, Westernport, Victoria

Matt Edmunds

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Witness Statement - Review of Gas Import Jetty and Pipeline EES, Westernport, Victoria

Document Control Sheet

Description

This document assesses potential impacts from a proposed gas import jetty, floating storage and regassification unit and pipeline on the environment and ecology of Westernport. The assessment reviews predictions of impacts in the Environmental Effects Statement documents. The assessment was done in context with the Victorian Marine and Coastal Act, state and national guidelines and contemporary scientific best practices.

Keywords

Westernport, gas import facility, floating storage and regassification unit, FSRU, ecological impact assessment, environmental effects statement, EES, sensitivity analysis, peer review, suspended sediments, sedimentation, light climate, burial, scouring, light attenuation, temperature, marine pests, contaminants, toxicants, noise, light, seagrass, bare sediments, littoral sediments, wetland, Ramsar, migratory birds.

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Amendments

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1	All	25-08-20	First version
2	All	01-09-20	Second version addressing scope questions
3	All	25-09-20	Finalisation as Witness Statement
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Executive Summary

Scope of the Review

This review assessed the GIJPP EES with respect to its capability to predict environmental effects of the proposed development and the potential implications for the Westernport marine and wetland ecosystems and natural values. The primary criteria were:

- was the information fit for purpose? and
- could there be significant biological impacts?

Competency of the EES

The methodology of the GIJPP EES was fundamentally flawed from multiple aspects. There was no transparent structure as to how the EES scoped and selected the concerns to address and it did not follow contemporary best practices. The EES was padded by large volumes of existing conditions information with almost none of it being applied for effects assessment.

The main analysis approach was a risk assessment that abstracted impact responses into levels of concern. The risk method was selective as to what concerns it addressed and based purely on opinion, without input from impact prediction and without traceable lines of evidence or modelling of impacts to support the opinions. The confused nature of the EES was highlighted by the fact that sections on impact assessment come ***after*** sections on risk assessment. The lack of repeatability and objectivity made the risk assessment un-scientific. The findings clearly showed the risk assessment was flawed, with risk ratings for all marine and wetland concerns lower than those caused by noise from temporary terrestrial construction. This is not a sensible finding.

Any high risks of concern in the EES were arbitrarily reduced by proposed mitigation measures. The mechanisms of the mitigation measures were not explained and could not be considered valid, given most were 'business as usual' measures where there is ample empirical evidence that they would not work as the EES presumed they would. The proposed environmental management framework did not reflect long-established standards, let alone contemporary practices for ecosystem-based management. The framework did not have any objective for good environmental outcomes, being solely concerned with getting regulatory approvals through up-front mitigation plans, after which there was no plan for ongoing environmental management. Notably missing was any handling of uncertainty, variability and unforeseen impacts – the proposed management framework was 'set-and-forget'.

The prediction of biological impacts was mostly absent in the EES. There was no specific assessment of types of biological impacts, magnitudes and spatial extents of potential change for any of the wetland and marine priority features. Instead, the assessment was 'dumbed-down', to over-generalised groupings which were not meaningful or representative of important ecosystem components. There was modelling of some physical effects, such temperature plumes or initial chlorine dilution, but there was no matching effort applied for modelling of the biology. Moreover, the physical modelling was divorced from biological context, such as overlaying plume modelling on benthic community maps.

There was clear evidence of subjectivity, bias and lack of transparency. The main areas of concern were:

- Avoidance of biological impact prediction in the EES, including the nature of species and community responses and the magnitudes and extents of change;
- Selectivity and ambiguity in the impact effects that were assessed;
- Dumbing-down and selectivity of the biological groupings in the assessment;
- Exclusion of existing empirical evidence for biological impacts, such as case studies on FSRU impacts elsewhere;
- No local (Westernport) studies to understand and model ecosystem-related impacts;
- No evidence-basis for the environmental predictions, with the bulk of the findings relying on the non-scientific risk assessment;
- No consideration for uncertainties and knowledge gaps;
- No wholistic ecosystem approach.

The structure and implementation of the GIJPP EES had no scientific rigour and the information cannot be considered reliable for environmental decisions and management. Most of the assessment was opinion-based and without supporting evidence. The 'favourable' findings of the EES should be considered with a high degree of caution and skepticism, especially given the lack of transparency and repeatability.

Potential for Environmental Harm

The GIJPP has the potential to cause severe biological and ecological impacts over large areas and may be irreversible. The EES avoided addressing the most concerning impact pathways and the associated empirical evidence. Two of these have an uncertain likelihood, but catastrophic consequences: shipping incidences resulting in a major oil spill and the introduction of invasive marine pests. A full account and understanding of these risks are critical for responsible management decisions. The existing evidence is contrary to the claims and assumptions made in the EES.

A major issue is the release of many different types of brominated toxicants into the Westernport environment as by-products of the chlorine anti-fouling system. There is empirical evidence that such contaminants can disperse widely, up to 10 km and accumulate in sediments and the biota. These contaminants are carcinogenic, mutagenic, endocrine disrupters and depress nervous systems. There is documented evidence some of these compounds are toxic at very low concentrations and that some Australian ports are already likely to be over effect limits from ballast-water disinfection systems. The EES was ambiguous in its assessment of chlorination impacts and dismissed brominated contaminant issues based on opinion that only bromoform would be produced, bromoform is not an issue because it occurs naturally and it will evaporate away. That opinion was contrary to the evidence: 10s to 100s of brominated contaminants can be formed and this varies day-to-day with changes in water quality; bromoform occurs naturally in concentrations 1000s times lower than would be released by the FSRU and just because it occurs naturally is not an indication there would not be impacts; and bromoform can be transient but other brominated compounds are not transient – despite being transient bromoform has been measured in significant accumulations in the environment up to 10 km from discharge. Given the existing evidence, there is a need to address potential toxicant impacts on flora and fauna within a wide range of the proposed Cribb Point FSRU.

The combined effects of the FSRU operations and discharges, including temperature changes, toxicants and sediment disturbance has the potential to affect a high diversity of different community types on the seabed. Some of these communities are unique and only documented in the Cribb Point area, such as the lamp shell beds. The EES does not make any assessment of how such species and communities may be impacted.

The Cribb Point FSRU location is within the North Arm channel which has considerable movements and migrations of fauna past this site. The combinations of noise, vibration, lighting, odour, discharges and seabed habitat changes may result in behaviour barrier effects on movement. These types of impacts were not considered in the EES, but may have considerable larger scale ecosystem implications.

The lack of specificity in the EES assessment extended to no consideration of Ramsar wetland values and associated species. Each of the values, including listed migratory birds, form different functions and components of the ecosystem, with different sensitivities and consequences for impacts. There was no attention to such specifics, with Ramsar species and values treated as single general groups in the assessment. There are foreseeable impacts on these values, especially if there are impacts on bird energetics such as from noise, lighting, visual presence or even subtle changes to prey availability and accessibility. Bird trophic guilds form critical parts to the functioning of Westernport ecosystem as a whole. There are considerable wider spatial linkages in the ecosystem, such as through tidal current transport and faunal movement and migration. There are pathways for the FSRU to have broader ecosystem impacts. The EES only considered a selection of atomised impact processes in isolation of ecosystem linkages.

Ecosystem-level effects and ecologically sustainable development was not addressed in the GIPP. Given the known tight linkages in the ecosystem, wholistic ecosystem effects should be transparently assessed. This also permits an evaluation of cumulative impacts and the implementation of ecosystem-based management, neither of which were properly addressed in the EES.

Conclusions

In conclusion, the methodology of the EES was not scientifically valid and there was a high degree of subjectivity, selectivity and bias. The findings were not supported by empirical evidence.

The GIJPP has the potential to cause significant environmental and ecological harm however critical biological impact assessments were absent from the EES. There are considerable knowledge gaps and uncertainties that need to be addressed and this should be done using best-practice, wholistic ecosystem-based methods.

Contents

1 Introduction

1.1 Background

AGL Wholesale Gas Ltd (AGL) and APA Transmission Pty Ltd (APA) propose a new facility for importing and regasifying liquefied natural gas (LNG) and supplying it to the gas transmission network. The project comprises two main components:

a. Gas Import Jetty Works comprising a floating storage and regasification unit (FSRU) at Crib Point Jetty, jetty infrastructure including marine loading arms and gas piping on the jetty, and the Crib Point Receiving Facility on land adjacent to the jetty (Gas Import Jetty Works).
b. Pipeline Works consisting of an underground gas transmission pipeline approximately 57 kilometres long to transport gas from the Crib Point Receiving Facility to the Victorian Transmission System east of Pakenham, and associated infrastructure (Pipeline Works).

On 8 October 2018 the Minister for Planning issued a decision determining that an Environment Effects Statement (EES) was required for the Project due to the potential for a range of significant environmental effects. The purpose of the EES is to provide a sufficiently detailed description of the proposed project, assess its potential effects on the environment and assess alternative project layouts, designs and approaches to avoid and mitigate effects.

An Inquiry and Advisory Committee (IAC) will be appointed to review the EES and public submissions. The IAC will hold public hearings for 6 to 8 weeks, after which it will produce a report for the Minister for Planning. Following receipt of the IAC's report, the Minister for Planning will then make an assessment as to whether the likely environmental effects of the project are acceptable (Minister's Assessment).

The Gas Import Jetty and Pipeline Project (GIPP) EES includes 27 substantive chapters and 17 technical reports addressing a range of topics.

1.2 Scope of the Brief

A review of the GIJPP EES was commissioned by Inquiry Submitter No. 3004. The Brief is provided as an attachment. The scope of the review encompassed:

a. The significance and value of marine biodiversity and ecological assets within the project area (and more broadly as relevant).
b. Actual or likely impacts on marine ecology and marine biodiversity arising from the project.
c. The effectiveness of any ameliorative or compensatory measures proposed to account for the environmental effects arising from the project.
d. Any appropriate qualifications or conditions that should be attached to findings or conclusions, such as uncertainties or gravity of threats or impacts.
e. Review the following EES documents (as relevant to marine ecology):
    i. Technical Report A – Marine biodiversity and appendices.
    ii. Technical Report B – Terrestrial and freshwater
    iii. Technical Report H – Noise and vibration
    iv. Attachment I – Matters of National Environmental Significance
    v. Attachment III – Environmental risk report
    vi. Chapter 25 – Environmental Management Framework
f. Review of the EES documents against the best practice marine impact assessment criteria and overarching standards.
g. Review of the EES documents against the State Environment Protection Policy (Waters).
h. Any other matters identified which are considered relevant within the limits of expertise.
i. In addition to a detailed synthesis of the conditions, issues and gaps, the report includes a high-level summary of the key issues.

1.3 Expert Witness – Dr Matt Edmunds

1.3.1 Full Name and Address

Dr Matthew John Edmunds
82 Parsons St
Kensington
Victoria 3031

1.3.2 Qualifications, Experience and Expertise

Appendix A provides a *curriculum* vitae for Dr Edmunds, including his general qualifications, experience and expertise.

1.3.3 Relevant Expertise

Dr Edmunds has experience and knowledge of the Westernport marine habitats, biotope, natural values and ecosystem functioning. This work included:

- Mapping bathymetry and topography of Westernport to a high resolution;
- Ground truthing of habitats and biodiversity surveys;
- Compilation and reprocessing of historical scientific data and imagery into the Victorian Marine Knowledge Framework;
- Identification and mapping of priority marine features;
- Development of socio-ecological models for ecosystem-based management;
- Assessing, mapping and monitoring of ecosystem status and condition throughout the bay;

Dr Edmunds has considerable experience in both predicting, detection and monitoring impacts on marine environments in Victoria. This has included integration of long-term monitoring, ecophysiology and modelling techniques. Impact assessments include for dredging, wastewater discharges, coastal changes, fishing, seismic surveys, subsea structures, nutrient release, groundwater contamination, climate change and underwater rockfalls.

His experience with respect to implementing and reviewing the requirements and standards of marine environmental assessments includes:

- Development of environmental decision support systems for EPA and DELWP;
- Port of Melbourne Corporation - Channel Deepening Project, EES and Supplementary EES inquiries (expert witness including inquiry hearings);
- AquaSure - Victorian Desalination Project (expert reviewer only);
- Tas RPDC - Gunns Pulp Mill (expert reviewer);
- Tas RPDC - Bruny Bioregion Marine Protected Area Inquiry (panel member);
- Scientific Advisory Committee for the FFG Act;
- Mornington Environment Association - Mornington Safe Harbour (expert witness, inquiry hearing);

- East Gippsland Shire Council - Tambo Bluff Estate - coastal and marine implications (expert witness, VCAT);
- EPA - Ship litter discarding (expert witness);
- Rock lobster fisher (expert witness for a fishery matter);
- Save Ralphs Bay - Walkers Lauderdale Quay DIIS (expert reviewer, witness, inquiry hearings);
- Yumbah Aquaculture - proposed dredging activity in Portland Bay (expert reviewer and witness).

1.3.4 Declarations

I, Dr Edmunds, declare that I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

The matters addressed within this report are within my scientific expertise. I note in the body of my report where I have specifically relied on supporting documentation prepared by others to assist my assessment of this particular matter.

Dr Matt Edmunds 25 September 2020
Principal Ecologist
Australian Marine Ecology Pty Ltd

2 Review Findings

2.1 Significance of Ecological Assets

The significance and value of marine biodiversity and ecological assets within the project area (and more broadly as relevant).

Westernport has a high diversity of species, biotopes, habitats and environments. It has many unique, rare and special features including:

- Large areas of intertidal sediment and dendritic channel habitat;
- Ramsar wetland, wetland bird and migratory bird features;
- Listed coastal saltmarsh community and a diversity of saltmarsh biotopes;
- Mangrove habitat;
- FFG listed ghost shrimp species and Rhyll intertidal opisthobranch community;
- Unique sponge garden (circalittoral rock) biotopes at Crawfish Rock (a special management area) and Corinella;
- Bass River Delta special management area;
- Unique bryozoan reefs in the Rhyll basin;
- Unique rhodolith beds;
- Large biomass of subtidal seagrass beds, including subtidal *Amphibolis antarctica*, *Zostera nigricaulis* and *Halophila australis*;
- A variety, but unknown biomass, of intertidal seagrass *Zostera muelleri* and intertidal seaweed.
- Many different types of sediment epibiota communities including *Caulerpa* beds, ascidian and mussel beds, sponge clump, seapen and stalked ascidian biotopes;
- 'Living fossil' brachiopod lamp shell bed in North Arm;
- Breeding areas for elephant fish and school shark; and
- High abundance of squid and fishes.

The ecosystem in Westernport functions quite differently to other embayments in Victoria, although the level of knowledge is presently limited. The extensive intertidal sediment flats are likely to be the main primary production component of Westernport, with microalgae on the sediment surface and stands of intertidal seagrass. The intertidal seagrass is grazed by swans, particularly the buried rhizomes which contain storage sugars. The microalgae form a thin biofilm on unvegetated sediments. Intertidal microalgae are particularly productive because they use nutrients within the sediments and the increased light supply at low tides. Some of this production enters the sediments and drives the secondary production of burrowing invertebrates (infauna) and bacterial cycles. Some of this production is suspended into the water column, as plankton, and is washed into the subtidal environment with the tides. A relatively recent discovery is that a significant proportion is also consumed directly by guilds of small migratory birds, such as sand pipers.

Tidal currents are an important ecological feature, providing linkage between the intertidal and subtidal environments and transport of sediments, plankton and particulate organic matter. Current flows and sediment dynamics are important in the structuring of sediment geoforms, in conjunction with vegetation stands, such as saltmarsh, mangroves and seagrass. Microalgae also contribute to sediment stability, through the secretion of biogels. Although vegetation influences sediment geoforms, it is also sensitive to pressures affecting sediment dynamics, such as vessel wake.

The strong tidal flows and high plankton loading provides food supply to the variety of different subtidal filter feeding biotopes. This includes the Crawfish Rock sponge garden, lamp shell bed, ascidian beds and bryozoan reefs.

The waters of Westernport are generally turbid through a high suspended sediment loading. This turbidity affects primary production in the plankton and on the seabed, however there are still substantial stands of seagrass beds around the channel fringes and larger areas of green seaweed *Caulerpa* mats, of different species. The primary production contribution of phytoplankton and the benthic vegetation is unknown. A considerable portion of the vegetation production, such as seagrass leaf litter, is transported around Westernport by tidal currents, with particulate plant matter being deposited into both intertidal and subtidal sediments. The supply back to intertidal sediments provides nutrients for bacterial and microalgal components: subtidal production can influence intertidal production.

The subtidal benthic habitats provide habitat for resident fishes. For example, seagrass supports large populations of pipe fishes and sponge clump habitats support populations of cowfish, toadfish and globefish. The benthic biological structures also provide feeding and stepping-stone habitats for more widely roaming demersal fishes and squid, followed by their predators. The subtidal bare sediment habitats support different types of burrowing invertebrate communities, which are an important food source for guilds of demersal fishes. The more widely roaming fishes are an important ecosystem linkage component and fish passages are often linear and constricted in accordance to preferred depths and biotopes within the channels.

While fishes make up the higher trophic levels of the foodweb in the subtidal environment, birds make up the higher trophic levels of the foodweb in the intertidal and coastal environment. A significant portion of the wetland and migratory birds use the intertidal sediment flats, seagrass and saltmarsh environments. These birds can be compartmentalised into different trophic guilds with different roles in the ecosystem. Little is known of the bird ecosystem compartments in Westernport. The high biomass and high energy requirements of birds means that a substantial portion of the

Westernport matter and energy flow is through the wetland bird guilds. Much of the energy and matter flow is from the sediment microalgae and sediment invertebrates. The bird feeding guilds include partitions for feeding on:

- Intertidal seagrass and epiphyte seaweed (swans and some ducks);
- surface microalgae (adapted bills and tongues);
- soft-bodied invertebrates in top sediments (short-billed birds)
- deeper burrowing and hard-bodied invertebrates (probing-billed birds);
- surface hard-bodied invertebrates (robust bills, e.g. oyster catchers);
- shallow fishes (wading birds, e.g. herons);
- deeper fishes (types of diving birds including cormorants and some terns); and
- raptors (hawks, eagles).

The varying types of predation by the bird guilds have top-down structuring pressures of prey populations, including the density and size structure of sediment infauna. Top-down pressures on intertidal seagrass from swan grazing and sandpiper feeding on microalgae are unknown. Sediment prey availability and quality have a significant affect on the energetics of wetland birds. Wetland birds feed using a network of feeding areas across Westernport, with the selection of feeding area influenced by tide conditions, wind and weather and the quality of available food. Feeding is generally required continuously (day and night) to provide energy needs, interspersed by periods of roosting to digest the food. Wetland birds are sensitive to impacts that affect the energy budget, leading to reduced breeding success or migration survival. Wetland birds are therefore sensitive to behavioural disturbances that incur an energy cost, such as reduced accessibility to higher quality feeding grounds or flight to a different area.

In summary, Westernport supports significant, unique and special biological features, but also has significant features of high biomass, area and productivity. All coastal, intertidal and subtidal habitats and food web components are intricately linked with linkages over large proportions of the Embayment. Any impact assessment in Westernport needs to consider not only the specific features of conservation concern but the linkages through the ecosystem and wider spatial implications.

2.2 Actual or Likely Impacts

Actual or likely impacts on marine ecology and marine biodiversity arising from the project.

The EES did not make specific biological impact predictions. This issue was addressed in Section 3.4. Types of potential impacts based on evidence in the literature was reviewed in Section 4. A proper evaluation of impacts remains to be completed.

The prediction of impacts is presently limited by some key knowledge gaps – gaps that could have been filled by EES studies. The first is that there are not many case studies of environmental impacts of FSRU operations elsewhere. As such, there is a requirement to measure, examine and observe impacts elsewhere to better understand potential impacts in Westernport. There is also an opportunity to fill key knowledge gaps around impact pressures and pathways through local experiments and laboratory tests to provide local relevance. Secondly, working ecosystem models for Westernport are not presently in a state for properly assessing impacts, however there are various researchers working on this. The EES should have stimulated effort to provide working biological models for impact prediction. Some key parameters require field observation and measurement and the EES process could have provided such information. There was effort applied for physical modelling but not for biological modelling.

Given the limited available information, actual or likely marine impacts could include:

- Contamination of water column and sediment habitats and biotopes with brominated toxicants up to 10 km from the FSRU site;
- Bioaccumulation of brominated contaminants in food webs and potential toxicological disruptions on populations and trophic guilds in the food web – and by extension human health;
- Changes to the condition and types of seabed biotopes in the vicinity of the FSRU from effects of temperature, seabed scouring, turbidity, entrainment and toxicants – including impacts on lamp shell populations restricted to that area;
- Potential movement and behavioural energetics effects associated with effects on mobile subtidal fishes, sharks and squid moving up and down North Arm, including effects of noise, vibration, visual presence, odour, turbidity, biological cues and biotope/habitat stepping stones for movement;
- Potential for disturbance to the energetics of some wetland bird species.

There are variable sensitivities of wetland bird species to direct and indirect effects on energetics and population dynamics. Relatively small changes to prey accessibility, prey quality or behavioural disruptions that affect their energy budget can have significant impacts on survivability of migratory species. There is high uncertainty as to whether the FSRU operation could affect such energetics through direct disturbance (noise, visual presence, light, *etc.*) or through indirect trophic and habitat changes.

In addition to certain or likely impacts, there are low likelihood but certainly high consequence impacts that should form the calculus of any planning decision. These include major oil spills, LNG releases and fire events and introduction of invasive pests. There is the potential for oil spills and marine pests to have larger area, long term impacts. It is certain that any increased shipping activity will lead to an increased level of environmental risk. An understanding of catastrophic impacts is important for appropriate resourcing for preventing catastrophic incidences.

2.3 Effectiveness of Mitigation Measures

Describe the effectiveness of any ameliorative or compensatory measures proposed to account for the environmental effects arising from the project.

Mitigation Measures were reviewed in detail in Section 3.6.

Most of the proposed mitigation measures were existing standard practices that were not tailored to specific impacts. Some of these were proposed to reduce risks, such as for oil spills and marine pests, but the empirical evidence does not support the assumed mitigations within the EES. The mitigation measures are compromised by the same issues associated with the risk assessment, and the lack of any biological impact prediction modelling. There was no supporting evidence to provide assurance of their efficacy.

The proposed environmental management framework relied solely on the presumption that input controls (mitigation measures) would be appropriate for the 20-year life of the project. This is not a sensible approach. There was no consideration of uncertainties of impact prediction and ecosystem responses.

2.4 Qualification to Impact Findings

Provide appropriate qualifications or conditions that should be attached to findings or conclusions, such as uncertainties or gravity of threats or impacts.

The impact findings of the GIJPP EES were primarily determined through a risk assessment process. The risk assessment was based on what appeared to be a subjective opinion-based method that could not be considered scientific. None of the risk assessment findings can be independently verified.

The subjectivity of the risk assessment meant there was arbitrary selection of impact pathways and the analysis was ‘dumbed-down’ to just 30 generalised biological features. The inclusion or exclusion of an impact pathway was not based on any empirical evidence or learnings from similar cases elsewhere. Some important impact processes were excluded based on presumption and opinion – such as contamination by brominated toxicants and high risk shipping incidents.

There was no identification of specific wetland or marine biological features that would be sensitive to the project-related pressures and disturbances. There was no specific modelling or prediction of biological impacts, such as types of responses, magnitudes of change and spatial extents. Physical pressures were modelled, but there was no corresponding effort for the biology. The EES did not inform on any specific Ramsar ecosystem features, species of conservation concern, listed species or migratory birds. There was no ecosystem modelling to discover any critical ecosystem impacts or predict cumulative impacts.

The EES did not address uncertainties, gaps in knowledge, degrees of confidence in applied knowledge and degrees of confidence in the predictions. It did not corroborate the findings with any supporting evidence. There was an assumption that all proposed mitigation measures would ensure desirable environmental outcomes.

The subjective risk assessment method, lack of biological modelling and lack of supporting evidence make the findings of the EES highly contestable.

The use of high-level assessment categories meant there was no precise information on critical issues of concern, such as sensitive trophic pathways, faunal movements and energetics of migratory species.

There are some known threats with considerable gravity for the whole ecosystem, particularly contamination by brominated pollutants. There is considerable potential for more subtle, indirect ecosystem processes that could lead to significant impacts on species of high conservation value, such as particular migratory bird species. This is because the ecosystem is tightly and intricately linked between subtidal and littoral processes. Sophisticated biological modelling and impact prediction is required to account for intricacies in the ecosystem and provide information on specific values.

2.5 EES Marine Ecology Documents

Review the EES documents as relevant to marine ecology.

The structure, methods and validity of the EES was examined in Section 3 and the types of potential impacts were examined in Section 4. The review focused on marine ecology impacts, including intertidal wetland and subtidal environments.

There was considerable overlap and repetition of information among the EES documents. The biological information for wetland and marine environments was mostly drawn from the technical reports for marine biodiversity impact assessment, terrestrial and freshwater impact assessment and matters of national significance (Technical Reports A, B and Attachment I).

A considerable bulk of information was provided in the existing conditions sections. Very little of the provided existing conditions information was to applied to impact or risk assessment. There was some information in the existing conditions that should have been applied, such as: criteria for significant biological impact responses; and listed species and migratory birds requiring specific attention.

The biological impact reports were supported by appendices with information on field surveys, airborne noise, underwater noise, chlorine chemistry, physical modelling and safety hazards (Technical Reports H and K; Annexures A-A to A-J). The marine field surveys for benthic biotope and species distributions (Annexure A-D) was not combined with existing biotope mapping for North Arm to provide a map of natural values in the area. There was no interpretation of the ecological significance of the benthic surveys, especially for lamp shell beds which are a species of concern. Although the Churchill Island Marine National Park was established partly for this species, its only known extant distribution is in the vicinity of Cribb Point. Only some plankton information from the field surveys made it through to the risk/impact assessment (Annexures A-B, A-C, A-H). It was evident that the survey methods for plankton were not well designed for impact assessment, given the assessment made many assumptions about stratified depth distributions and the monitoring integrated sampling across the whole water column. The field surveys attempted to detect the rare and listed ghost shrimp *Michelea mirophylla* (Annexure A-F). This species is known only from one specimen in North Arm, collected in 1965. No extant specimens were found by the EES surveys. It should be accepted that knowledge of this species is an ongoing knowledge gap. Instead, the EES makes an extraordinary claim that there is some other population somewhere else to minimise any conservation concern.

The chlorine chemistry report (Annexure A-A) was highly ambiguous in its language as to whether it is dealing with only chlorine products, immediate brominated oxidants or all of the numerous toxicants that can be formed by chlorine in seawater. The report was only concerned with acute toxicity from selected studies and arrived at a guideline value that was well above that set for Canada. It was assumed all compounds were transient and the existing evidence for the existence and toxicology of various types in brominated contaminants in marine environments was ignored. The modelling of chlorine dispersal was cut off at 2 µg/L (Annexure A-H) but the mapping should have been represented to well below 0.5 µg/L (the Canadian guideline value). The marine biology assessment also disregarded all literature evidence on brominated contaminant release. In fact, it dismissed any concern by claiming only bromoform would be produced and it would evaporate out of the environment. There is evidence that 10s to 100s of types of toxicants can be released and bromoform itself can be dispersed up to 10 km from an FSRU discharge, with accumulation in sediments and in fishes. Recent modelling indicated some Australian ports could already have discharges of brominated contaminants above safe levels. Environmental contamination by the FSRU was not addressed properly in the EES.

Modelling of physical effects was for initial chlorine dilution, temperature/density plumes and particulate entrainment (Annexure A-H). None of the physical modelling was related to maps of benthic species or biotopes. There was no modelling or prediction of seabed scouring and turbidity effects. The particulate modelling indicated a net supply direction from the FSRU to the northern part of North Arm. Although the model was only run for 28 days, it indicated potential for a recruitment shadow to the north. More importantly, it showed that the FSRU is environmentally linked by tidal currents to the wider environment and habitats, including the large areas of littoral sediment flats in the region. Anything associated with suspended particulates can be transported to most of the key biotic features in the North Arm and northern mudflats. The potential for wider spatial impacts from the FSRU cannot be dismissed without biological modelling.

The underwater noise report (Annexure A-I) did not make any field measurements of the existing sound scape at Cribb Point. The modelled scenario of FSRU and carrier operational noise showed behavioural impact thresholds were exceeded across the width of the channel. This indicated the possibility for behavioural effects on movement and energetics of marine biota in North Arm. The report noted the consequences are unknown. An understanding of cumulative effects on top of the existing sound scape needs assessing.

The noise and vibration report (Technical Report H) assessed noise impacts for human receptors and not ecological receptors. The report directs to the marine and terrestrial reports for faunal impacts, however these reports circle back to Technical Report H. For physical noise prediction. The population dynamics of various guilds of birds are sensitive to noise effects leading to a concern for the large and various populations of wetland birds. Key feeding and roosting habitats are in direct line of sight of the proposed FSRU facility. There was no reporting in the EES of the existing air-borne sound scape in Westernport associated with sensitive species and locations. The EES did not make use of information on noise impacts from FSRU impacts elsewhere. The findings of the human noise impact assessment did not find excessive areas of high noise levels, but notes that the introduction of the new noise source to the area may impact existing tranquility values on French Island. This implies potential for faunal impacts on significant feeding and roosting areas as well.

The effects of noise on wetland birds was approached in the terrestrial biodiversity impact report. This report introduces some preliminary empirical measurements of local noise levels from April 2020, as a personal communication. The wetland bird assessment in Section 7.2.1.3 claims noise would attenuate to inaudible levels at adjacent roost and feeding areas, however this was inconsistent with the human noise impact assessment, which predicted auditable noise to affect French Island, passing through significant faunal habitat areas. The wetland bird noise assessment also uses logic that is incompatible with the population biology of wetland birds. The EES claims the existence of wetland bird populations on feeding grounds exposed to higher noise levels is an indication for reducing levels of concern. In reality, wetland birds are at close to carrying capacity for the wetland environment and must make use of a network of all available feeding and roosting areas to maximise energy intake and digestion according to the tides and weather conditions. There is no ‘spare’ capacity in the energetics of the system for birds to go to other areas in the feeding-roosting network if noise levels are too high. The signal for noise impacts on wetland birds would not be on the location of biomass, but in population dynamics such as breeding success, storages and survivability. There is ample evidence and modelling to show wetland birds cannot move away from most feeding and roosting sites – they need them to survive.

The safety and hazard report (Technical Report K) had some evaluation of some incident type risks associated with LNG release incidents. This had a human focus and potential effects on wetland fauna were not specifically addressed. Notably absent were other shipping incident risks that could have catastrophic effects on the ecosystem. This includes major oil spills, given the potential to interact with cargo vessels traversing to the terminal at Long Island Point, and the introduction of invasive marine pests. These risks were summarily dismissed in the EES.

None of the EES biological impact assessments identified important impact pathways, sensitive species or ecosystem processes. There was no prediction of biological impacts for any wetland and marine features. There was no population modelling for behavioural and energetics-related impacts. There was no ecosystem-level modelling for wholistic impact assessments. There was no inclusion of supporting data, evidence or case studies for the impact assessment. Most citations in the EES ecology sections were for existing conditions and unrelated to impact assessment. There were no learnings of FSRU environmental impacts elsewhere.

The bulk of the EES analysis resided in a risk assessment. The risk assessment detailed impact criteria for application to the risk assessment. All risks were registered in the risk report. The risk assessment used subjective opinion to determine the impact pathways to be assessed and the assignment of likelihood and consequence ratings. The risk assessment was not independently and objectively repeatable. The assessment was for 30 broad, general biological features and did not consider species or specific features of high sensitivity to impacts.

The risk assessment included designated residual risk assumed from the application of mitigation measures. The efficacy of the proposed mitigation measures was not addressed, either by impact modelling or by supporting empirical evidence. Most of the proposed mitigation measures were existing practices, hence there would be no changes to ‘business-as-usual’ and there should not have been changes to the residual risk ratings.

The Environmental Management Framework was presented in Chapter 25. This framework was inconsistent with most other environmental management strategies and frameworks, including not having any continual improvement cycle and not having an objective and process for achieving good environmental outcomes. Instead, the framework was focused on achieving approvals on the basis of input controls alone, as represented by the mitigation measures. The framework relies solely on the risk register and mitigation measures for environmental management. As noted above, the information represented in the risk assessment and mitigation measures is not robust or reliable.

The accuracy of the EES was not established, with no documentation of knowledge gaps, uncertainties or degrees of confidence in any of the provided information (excepting some sections of the terrestrial biodiversity impact assessment). The assessment of broad groupings rather than specific features meant the precision of the assessment was diminished. The EES has major omissions, including for bromine toxicant effects and wholistic ecosystem level effects.

2.6 Best Practice Marine Impact Assessment

Review the EES documents against the best practice marine impact assessment criteria and overarching standards.

The validity of the methods applied to the GIJPP EES was reviewed in detail in Section 3.

A long-standard expectation of impact assessments is the use of the scientific method to provide objective, accurate and reliable information. Scientific principles provide some assurances of the reliability of findings by being transparent and repeatable: the same result should be achieved if repeated by someone else. The bulk of the EES findings did not use scientifically repeatable methods. The EES was centered around the results of a risk assessment method that was subjective and opinion based. The process and findings were not scientifically repeatable, not based on evidence from the literature and had no controls on errors and biases.

Ecological impact assessment requires the prediction of biological responses, including how the biota respond, to what magnitude and over what area. The significance of those impacts is then assessed to determine the level of concern and need for intervention. The prediction phase needs the development of an ecological model and the application of physical and chemical pressures associated with the project. The EES had physical but no biological impact modelling and prediction. Both the modelling method and results require the use of evidence and rationale. Very little of the EES was based on scientific evidence. Evidence was applied to the description of existing conditions, but that description was not applied to impact assessment. As with any type of modelling and prediction, there are uncertainties and varying degrees of confidence. This was not provided in the EES.

There have been substantial advances in the last decade in the sophistication of ecological impact assessment, to match the sophistication of natural systems. This has included mechanistic models and wholistic ecosystem-based assessments. Contemporary practices are for ecosystem-based management and ecologically sustainable development, both of which require ecosystem-level methods of assessment. Various approaches have become increasingly standardised, particularly in northern America, European Union and United Kingdom. A central feature is the use of a socio-ecological model that encompasses aspects of activities, drivers, pressures, ecosystem status, ecosystem services and management responses. There has also been development of ecological classification systems that facilitate identification of values and functions in the models. Ecosystem and wholistic assessments are principles of the Marine and Coastal Act, but were not addressed in the EES.

2.7 State Environment Protection Policy (Waters)

Review of the EES documents against the State Environment Protection Policy (Waters).

The State Environmental Protection Policy for Waters (SEPP) applies directly to the GIJPP with respect to wastewater discharge. The wastewater consists of heater exchange waters with biocides and contaminants and any increased in turbidity from seabed disturbance.

The SEPP has objectives to protect and improve environmental quality for general areas and water segments and areas of high conservation value. Westernport meets multiple criteria for the SEPP definition of as of high conservation area:

- Ramsar wetland;
- Migratory bird species area including agreements with China, Republic of Korea and Japan and in accordance with the Bonn Convention; and
- FFG Act where the discharge of waste may create a barrier to the passage of migratory species.

The GIJPP EES acknowledged that the site is a Ramsar wetland and an important area for migratory birds covered by international agreements and conventions. The EES did not consider potential impacts on the of migratory species, including fish and other animal movements up and down North Arm. The SEPP precludes any new wastewater discharges into Westernport unless it can be satisfied that the wastewater provides an environmental benefit (Clauses 22 and 25, Schedule 5). There was no conceivable situation of how there could be an environmental benefit and the GIJPP EES did not attempt to make any such case.

In addition to the conservation area clause, the GIJPP does not comply with the general provisions of the SEPP either. Two applicable general provisions are the protection of beneficial uses and properties of mixing zones.

Beneficial uses to be protected include:

- Water dependent ecosystems and species;
- Maintenance of fish passage;
- Human consumption – suitable for use by Wonthaggi desalination plant (water from Westernport flows eastward past the plant);
- Human consumption of aquatic foods – safe from contamination; and
- 99 % level of protection for the largely unmodified aquatic ecosystem.

The mixing zone compliance requires evaluation of:

- Acute lethality at the point of discharge (such as from un-neutralised oxidants);

- Chronic toxicity outside the mixing zone (such as from dispersed brominated compounds);
- Risks to beneficial uses at the boundary of the mixing zone (such as to benthic and pelagic communities);
- Harm to humans (via bioaccumulation in squid and fishes); and
- Harm to plants and animals (both nearby benthic communities and the wider ecosystem, including species of conservation concern).

The EES did not explicitly address any of these criteria. In general, there was little biological information in the EES to provide any assurance that any of the SEPP criteria would be met. In particular:

- There was no direct measurement of ecotoxicology and the contaminants that would be released;
- There was no biological prediction of impacts on benthic communities with direct and diluted exposure to the wastewater, nor any specific species of conservation concern;
- There was no consideration of the types and dispersion of chemical contaminants into the wider environment, no consideration of environmental and bioaccumulation and no consideration of chronic ecotoxicology (physical modelling was censored);
- There was no ecosystem evaluation with any level of detail that could accurately inform on impacts on ecosystems;
- There was no evidence basis to the predictions of the EES; and
- Evidence from similar cases elsewhere was omitted from the EES.

Evidence from elsewhere indicates there would be a variety of toxicants released with the potential to pervade ecosystems at distances in the order of 10 km from the source (Section 4.2 of this review). This evidence indicates the GIJPP would be non-compliant with the SEPP.

In summary, the Ramsar listing of Westernport prohibits the approval of new wastewater discharges in accordance with the SEPP. The GIJPP EES did not provide assurance that any other provisions of the SEPP would be met.

2.8 Other Matters

Any other matters identified which are considered relevant within the limits of expertise.

There were no other matters additional to provided scope.

2.9 Key Issues and Gaps

In addition to a detailed synthesis of the conditions, issues and gaps, include a high-level summary of the key issues.

A high-level summary was provided in the Executive Summary.

Key issues and gaps in the GIJPP EES were:

- The framework was not well structured to provide the appropriate and relevant information – the Statement was not systematic or comprehensive;
- Key impact pathways and receptors were not assessed, including toxicants, dispersal, ecosystem integrity and species of conservation concern.
- The impact assessments were not in accordance with contemporary methods and best practice;
- There was little to no biological impact provision
- There was no adequate ecological resolution to the assessment – impacts on species, biotopes and ecosystem functions were not directly assessed;
- Most findings were based on a subjective and opinion-based risk assessment and were not scientifically robust;
- There was no evaluation of levels of knowledge and certainty and confidence in the impact predictions; and
- Evidence from elsewhere, omitted from the EES, indicates the potential for wide-spread and long-lasting impacts from FSRU operations.

3 Scientific Approach and Validity

3.1 EES Framework

3.1.1 EES Framework Requirements

The purpose of a framework to the EES is to provide a structure and flow of information that supports decisions with respect to environmental management. The structure should provide a synthesis of information from the multiple disciplines involved and arrive at wholistic consideration of the project. The information should support decisions for approvals and consents and for ongoing management.

The presentation and flow of information in the EES, and its development into knowledge, should be transparent (auditable) and scientific. The scientific method, including principles of objectivity, repeatability and evidence-basis provides assurances that the information is accurate and reliable. It is expected and indeed a requirement that a proponent promotes its proposed project as best it possibly can from a business perspective. This can lead to intentional and unintentional motivations, advocacy and biases in assessing the environmental aspects of a project. Scientific validity is therefore essential for robust environmental decisions.

There have been considerable developments in the science behind frameworks for environmental management in the last two decades. A key change has been the recognition for managing at the ecosystem level, not atomised components of the ecosystem, and matching the complexity of ecosystems with sophisticated science. These changes are reflected in contemporary best practices and in regulation, including the Victorian Marine and Coastal Act, which embodies principles of ecosystem-based management and ecologically sustainable development.

3.1.2 Environmental Frameworks and Best Practice

There have been clear approaches and standards to environmental assessment and management frameworks for decades. The common approach has been to describe the potential physical effects of a proposed activity, determine where the physical effects intersect with biological components, model biological responses and changes given the physical changes and then assess implications of predicted biological changes, in accordance with the existing knowledge and levels of uncertainty (Treweek 1999). This approach has developed into more sophisticated and effective assessment frameworks over the last two decades. The generic framework for assessing and managing environmental impacts involves the linkages between activity drivers (D), physical and chemical pressures (P), ecological status (S) and management responses (R). This generic, conceptual framework has many variants, such addition of ecosystem services, goodness of environmental status indicators and human needs, but can be conveniently abbreviated to the DPSER chain for communication (*e.g.* Figures 3.1 and 3.2).

The advancements to implementing the DPSER framework have been through the application of socio-ecological models with standard categories, nodes and linkages. This approach has produced a common framework for progressive improvement researchers and comparable outcomes for regulation and assessment. Examples of frameworks with comparable structures and components include ReefLink (US EPA), ODEMM / DEVOTES / KNOWSEAS (EU), HELCOM (Baltic region), FeAST (Scotland) and EcoNet (Victoria).

The development and alignment of environmental assessment frameworks has arisen from a nexus of requirements associated wholistic, ecosystem-based management. These include:

- More sophisticated ecological modelling for precision and accuracy;
- Protect ecosystem services and natural capital;
- Assess cumulative and incremental impacts;
- Marine spatial planning and multi-use of the environment;
- Centralised knowledge base with open access and transparency;
- Decision and research support tools; and
- Compliance with absolute environmental condition standards.

Regulation has both driven and responded to the development of best-practice environmental assessment frameworks. The EU Marine Strategy Framework Directive is a common basis to the EU and UK frameworks and the Victorian Marine and Coastal Act and Policy also has commonalities.

In summary, there is considerable documentation of best practice environmental assessment frameworks. Most have a common DPSER structure and align with legislation and regulation. The GIJPP EES should be validated against such best practices, which are also principles of the Marine and Coastal Act.

Examples of frameworks and the degree of sophistication that should have guided ecosystem-based approaches in the EES include (but not limited to):

Clarke Murray *et al.* (2014). Cumulative effects in marine ecosystems: scientific perspectives on its challenges and solutions.

De Piper *et al.* (2017). Operationalizing integrated ecosystem assessments within a multidisciplinary team: lessons learned from a worked example.

Harvey *et al.* (2014). Implementing the IEA: using integrated ecosystem assessment frameworks, programs, and applications in support of operationalizing ecosystem-based management.

Korpinen and Andersen (2016) A global review of cumulative pressure and impact assessments in marine environments.

Levin *et al.* (2009) Integrated ecosystem assessments: developing the scientific basis for ecosystem-based management of the ocean.

Levin *et al.* (2013) Guidance for implementation of integrated ecosystem assessments: a US perspective.

Long *et al.* (2015) Key principles of marine ecosystem-based management.

NOAA (2008) Integrated Ecosystem Assessments.

Rosellon-Druker *et al.* (2019) Development of social-ecological conceptual models as the basis for an integrated ecosystem assessment framework in Southeast Alaska.

Samhouri *et al.* (2014) Lessons learned from developing integrated ecosystem assessments to inform marine ecosystem-based management in the USA. *ICES Journal of Marine Science* **71**, 1205-1215.

Tam *et al.* (2017) Towards ecosystem-based management: identifying operational food-web indicators for marine ecosystems.

Townsend *et al.* (2019) Progress on implementing ecosystem-based fisheries management in the United States through the use of ecosystem models and analysis.

3.1.3 EES Framework was Non-Standard

The GIJPP EES presented two of its own frameworks for environmental assessment, represented by two flow diagrams (Figures 3.3 and 3.4 below). One had a feedback cycle between risk assessment, impact assessment and environmental management (Figure 3.3). The other approach had parallel feed-back loops with an impact assessment loop separate from the risk assessment loop (Figure 3.4). The loops in the first diagram revised environmental management with each cycle while the second diagram updated the project description with each cycle.

There was no narrative or rationale as to why the EES frameworks were structured this way. The EES does not make any reference to any precedents or contemporary practice. A consequence of the non-standard approach is that the EES had major gaps in information required to understand potential impacts, particularly at the ecosystem level.

3.1.4 EES Framework was Confused

The two frameworks presented in the EES conflicted with each other and did not represent the actual process of the EES. The perceived structure of the EES based on the documents is represented in Figure 3.5.

There were odd weightings and flows of information in the EES. A large bulk of text was existing conditions, but little of this was applicable to the impact assessments. This was largely because of a dumbing down of specifics into general categories in the assessment. Most of the EES assessment was comprised of risk assessments and mitigation. The EES structure had very little content on describing and prediction of biological impact responses.

Where biological impacts were predicted, this was presented ***after*** the risk assessment. A risk assessment is an abstraction of impact assessment with predictions of changes being translated into some type of index of concern. Any impact predictions feeding into the risk assessment were not provided, devolving the risk assessment into subjective opinion.

There was no structure in the framework for the scoping and focus of impact pathways. This was clearly evident in the disconnection of the existing conditions information from any of the EES analyses. The impact pathways in the EES appeared to have been arbitrarily and subjectively selected during the risk assessment process.

In summary, there were inconsistencies between the described and applied frameworks. There was no clearly defined, overarching methodology and the described approach did not match the structure of the bulk of the EES. The implication is a lack of discipline in ensuring the appropriate information was provided for understanding impacts.

3.1.5 Key Issues of the EES Approach

Major Concerns

There are major issues with the methodology of the EES, as it was applied (Figure 3.5). These concerns include:

- Lack of formal structure;
- Superfluous and repeated information (padding);
- Poor information synthesis;
- Missing impact considerations;
- Poor attention to ecological impact prediction – few impact types considered and poor inclusion of empirical and modelled information;
- Risk assessment was not valid – the method was non-transparent, subjective, selective and error-prone;
- Mitigation measures not valid – no description of the mechanism for reducing impact levels, most were obviously inappropriate; and
- No environmental management – the proposed environmental management framework had no management component, only preapproval project design elements in the form of 'mitigation measures'.

Poor Information Synthesis

For the marine ecology section in particular, there was little synthesis of information into suitable forms for the EES. Information was presented from the literature, or field survey results were presented, but neither were produced into a combined map for assessing spatial impact of mapping. The field work was not evaluated for the significance of the findings, such as the high component of resuspended benthic algae in the plankton or the conservation significance of the lamp shells being only present in the Cribb Point region.

Other areas of poor synthesis included not overlaying maps of physical effects, such as temperature, resuspension or toxicant dispersal over maps of ecological features. Although there was a high degree of repetition of existing conditions and risk assessment results, there was no overall synthesis or appreciation provided for whole ecosystem interconnections and impacts. For example, wetland birds, Ramsar features and marine ecology were separate considerations in the EES, ignoring the fact that the wetland birds, Ramsar values, littoral and sublittoral marine ecosystems are very tightly connected in Westernport.

There was very little absolute context provided across the set of technical fields, resulting in disparate or non-comparable findings between them. For example, short-term terrestrial construction noise out-ranked all other marine impact findings.

The application of the information within an overarching socio-ecological model structure would have solved many of these problems.

Missing Considerations

The EES has considerable gaps in expected information. Following from a lack of standard structure, there is little explanation or rationale as to why some pressures or ecological receptors were selected and not others. There was a lack of consideration of wholistic ecosystem impacts, particularly pathways that may affect sensitive and protected components. There was no real cumulative and incremental impact assessment. There was no integration of supporting evidence or findings from elsewhere. The provision of evidence from the literature was depauperate.

No Ecosystem-Based Assessment

The Westernport environment and supporting ecosystem has strong ecological linkages between the coastal, littoral and sublittoral regions. Much of the area is comprised of littoral sediments and ecological processes in this habitat drive much of the ecological character of Westernport, but is also sensitive to external impact pressures. For example, much of Westernport's carbon and nutrient cycling is centered around microalgal primary production on the littoral sediments, with plant production driven by nutrients from the sediments. Microalgae supports sediment invertebrates, including surface snails and buried molluscs, worms, crabs and shrimps. Guilds of wetland birds form critical parts of the foodweb. Some, such as sandpipers, feed directly on sediment biofilms, some specialise on the surface fauna while others specialise in burrowing fauna. Grazing birds such as swans have a linkages with littoral seagrasses. The littoral sediment flats are highly influenced by tidal hydrographic conditions and geoforms and coastal formations structured by saltmarshes and mangroves. Subtidal biotopes are influenced by the carbon and nutrients supplied by the high littoral productivity and turbidity of water drained from the intertidal zone. In turn, subtidal productivity, such as seagrass leaf production, returns particulate organic matter to the littoral sediments. These are but a few examples of the tight ecosystem linkages and potential impact susceptibilities across the Westernport region.

It should be noted that ecosystem functioning and condition are a core consideration of the Westernport Ramsar Management Plan. Ecosystem and wholistic-based assessments are also principles of the Marine and Coastal Act.

Key information criteria of ecosystem models needed for the GIJPP impact assessment include:

- An appropriate resolution of ecosystem components, processes and linkages.
- Inclusion of drivers and sensitivities that relate to activity pressures;
- Encompass appropriate scales of dispersion, including sediment and water quality transport, movements of fauna that link components some distance from Cribb Point.

Example ecosystem-level processes and issues that need to be examined include:

- The potential for sediment-adhered contaminants to be transported some distance by tidal currents, settle on mudflats and enter or affect the food chain.
- The potential for increased sediment resuspension from vessel propeller scour and vessel wake to affect sediment microtopography, shore vegetation and erosion, primary productivity and particulate production;
- Potential effect of bird disturbance at Cribb Point affecting the usage and carrying capacity of the network of feeding and roosting sites across Westernport.
- Cumulative impacts in conjunction with other activity and pressures in the area.
- Implications of ecosystem impacts for 'good environmental status', ecosystem services and natural capital.

Of great concern is the general presumption that all mitigation measures are predicted to address all types of impacts perfectly. This is addressed in following sections.

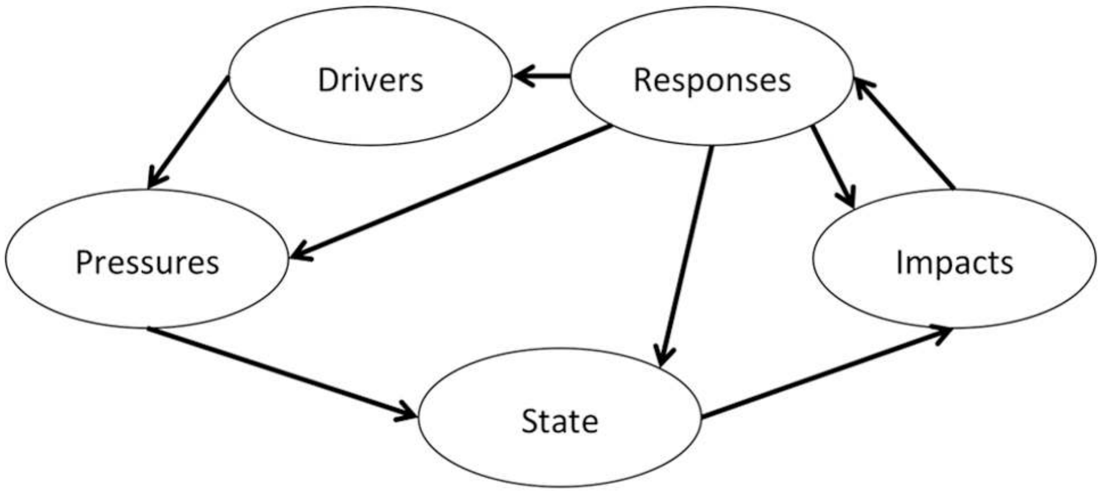

Figure 3.1. Generic DPSER structure for ecosystem-based management (from Kelble *et al.* 2013).

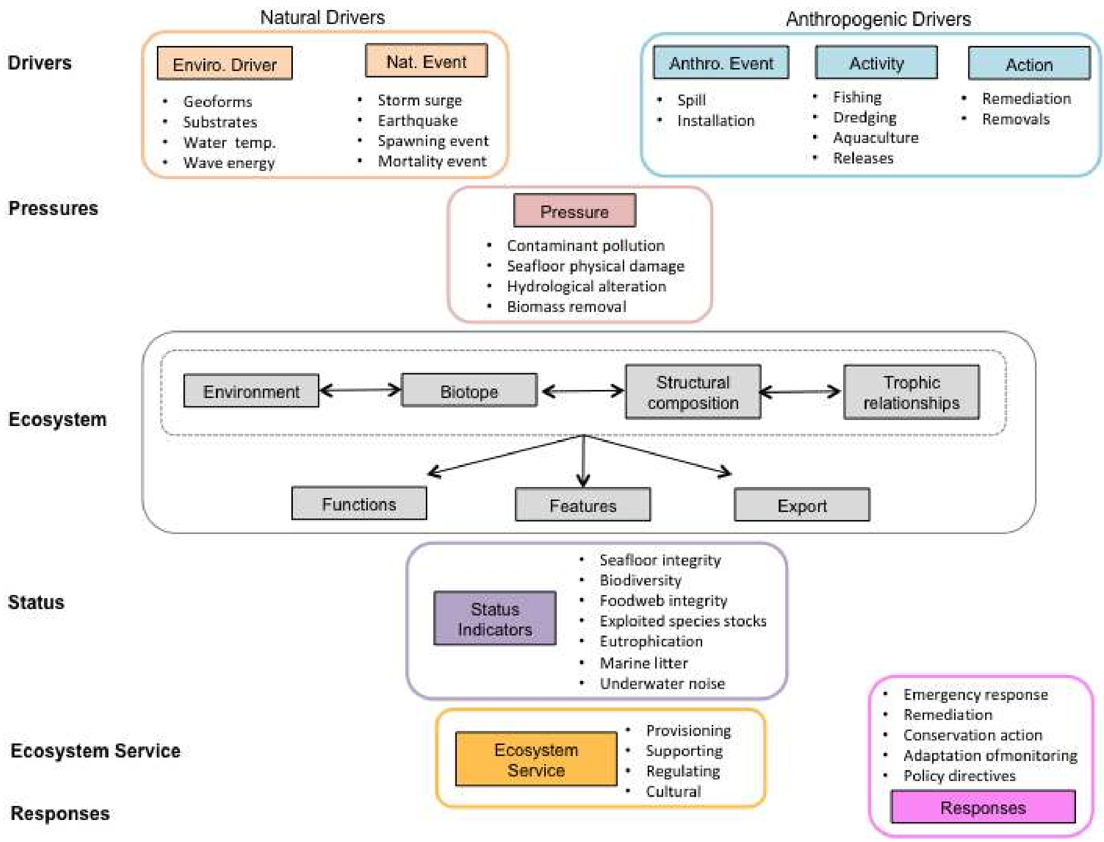

Figure 3.2. Extract of EcoNet DPSER chain for ecosystem-based management, as applied in Victoria and elsewhere (Australian Marine Ecology, Fathom Pacific, Department of Environment, Land and Water).

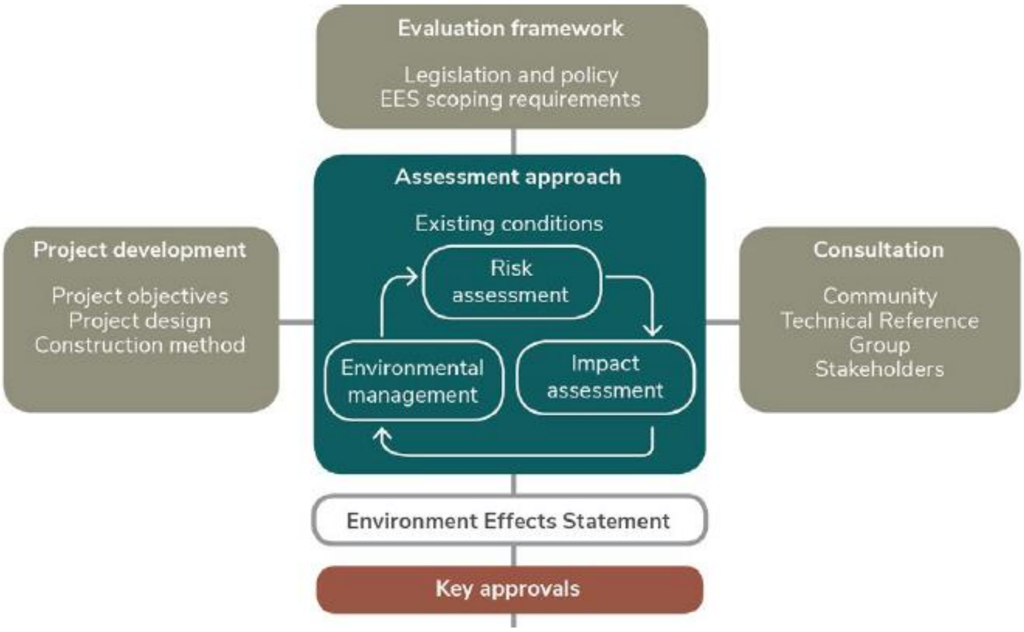

Figure 3.3. First proposed EES assessment framework (Figure 5-1, p 5-1, GIJPP EES Chapter 5).

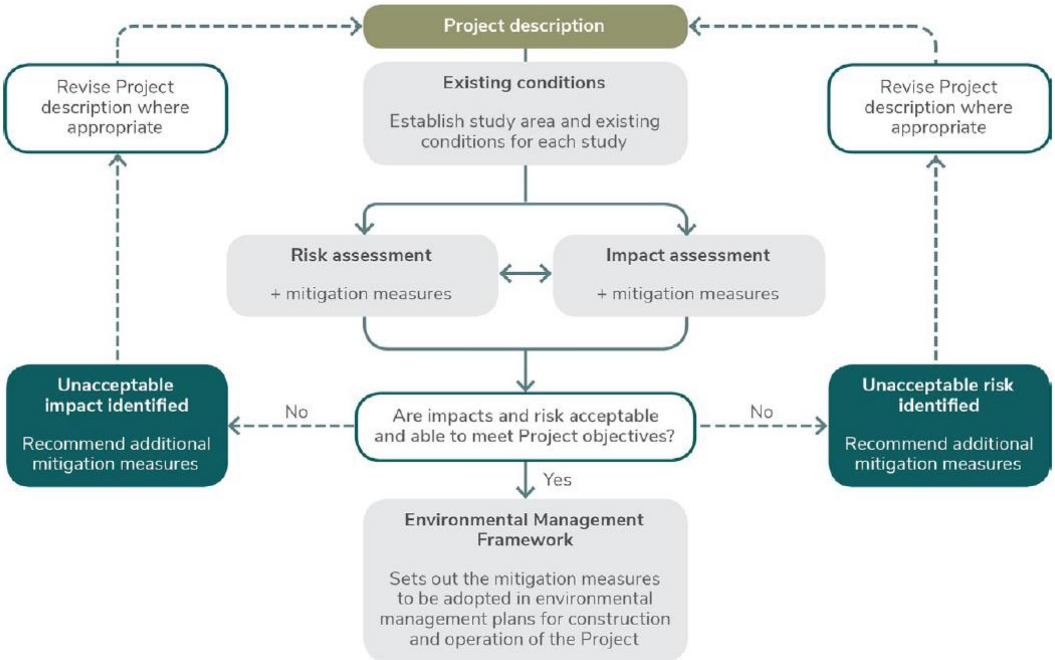

Figure 3.4. Second proposed EES approach (Figure 5-3, p 5-10 EES Chapter 5; Figure 1, p 2, Attachment III).

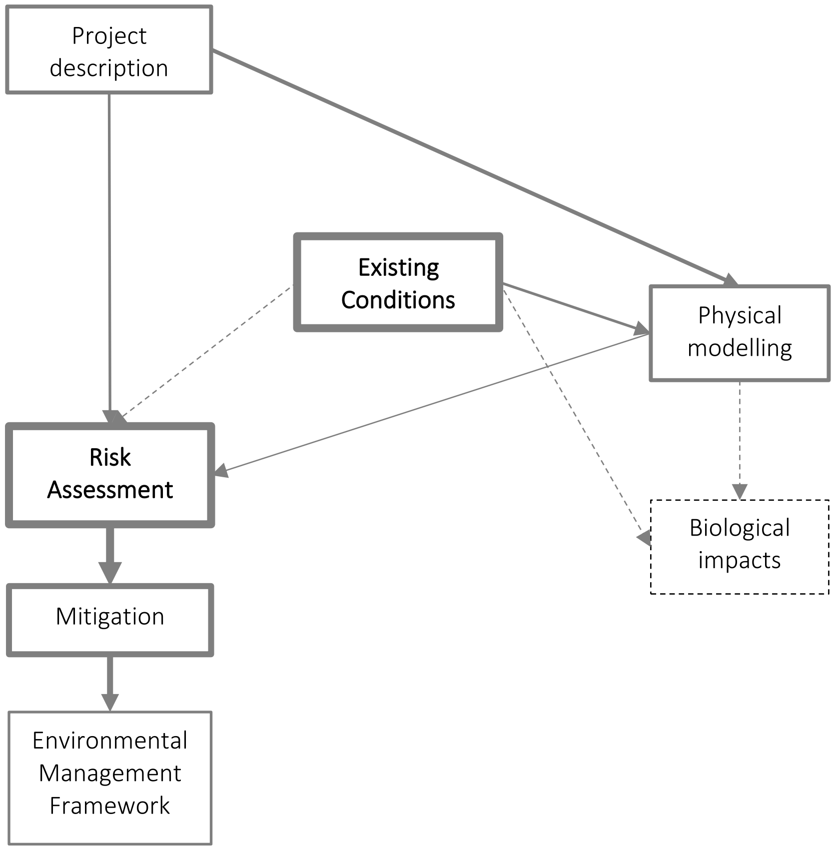

Figure 3.5. Actual EES information flow, as perceived from the EES documents (EES Chapters, Technical Appendices, Attachments). The line thickness represents the weighting of information presented.

3.2 Supporting Evidence

3.2.1 Disconnection of Existing Conditions Evidence

Approximately half of the biological information in the EES was provided in the existing conditions sections and nearly all sources of information were referenced to the existing conditions chapters. In general, nearly all cited sources of information related to the existing conditions and this information is not carried through to the EES analyses.

Matters of National Significance

The Matters of National Environmental Significance report had 28 pages of existing conditions and cites five sources of supporting evidence. Much of this information was repeated from the marine and terrestrial technical reports. The existing conditions sections mostly pertain to describing listed species, communities and wetland sites. None of these specific attributes were traced through to the risk assessment. The impact assessment did have some linkage to the existing conditions section, but only where some environmental pressures may intersect with some of the listed species. There was no attempt to predict magnitudes of biological impact on the species and features listed in the existing conditions sections.

The risk assessment was presented before the impact assessment, yet the risk assessment had defined consequence criteria pertaining to magnitudes of changes in species populations and areas of cover. None of the existing conditions features were placed in context with those criteria. Much of the narrative in the impact assessments skipped over consideration of existing biological features by jumping from a description of abiotic pressures directly to mitigation measures.

Marine Biodiversity

There was a more obvious divide for existing conditions of the Marine Biodiversity Impact Assessment. The existing conditions sections contributed 191 pages and included references to sources of information (*i.e.* supporting evidence). Very little of the biological information presented in the existing conditions was used for assessment of environmental effects. This included seabed biodiversity, plankton biodiversity, habitat mapping and fishery species.

The EES had a field sampling program, with reports on:

- Phytoplankton sampling program;
- Zooplankton sampling program;
- Ichtyoplankton sampling program;
- Subtidal benthic habitat and biodiversity; and
- Threatened ghost shrimp survey.

These works had little input to the impact assessment and for the most part the findings were disregarded. For example, none of the species or biodiversity information carried through to the risk / impact assessments because the assessments were on high level categories. All zooplankton, phytoplankton and benthic fauna were treated as if all members in those categories had the same sensitivity to impact effects. None of the species mapped or monitored from the EES field program were specifically addressed in the risk, impact and mitigation sections. Modelling of physical and chemical impact pressures, such as temperature, toxicants and noise, was ***not*** assessed with respect to maps of sensitive species, communities or ecosystem features. There was no level of effort for modelling and predicting biological impacts as there was for modelling physical effects.

The field studies did not have design features that related to impact prediction. For example, field studies integrated plankton surveys across the water column (AGL Gas Import Jetty Project: Ichthyoplankton Sampling Program) but impact assessments relied on assumptions on vertical stratification, such as:

> *Pelagic eggs are usually buoyant. Hence, if the seawater intake on the FSRU is at least 2 m below the water surface (even at low tide) the relative risk of entraining floating eggs is reduced. This mitigation measure has been recommended for incorporation in the FSRU, as described in Section 7.5.1 and would reduce the rate of entrainment for some species* (page 337. Technical Report A: Marine Biodiversity Impact Assessment).

There were some findings in the field studies, including directly near the FSRU site, that should have triggered conservation concerns in the EES impact assessments. Lamp shells *Magellania flavescens* have populations only in the vicinity of Cribb Point and qualifies for listing under the FFG Act. The surveys for ghost shrimps found considerable populations of common ghost shrimp species and are an important group in food webs, but such ecosystem components were not addressed.

Terrestrial Biodiversity

The terrestrial existing conditions assessment was highly detailed, succinct and targeted and sources of evidence was clearly defined. There were long lists of key features and species and vegetation of conservation concern. This included the wetland birds of the Ramsar site. The terrestrial assessment defers impacts on the wetlands to the marine studies, with the exception of noise. There was no assessment of wetland ecosystems and the impacts on birds in any of the reports.

The terrestrial biology assessment used information from the existing conditions for the impact assessment, through the intersection of key species and impact pressures. As with the other biological studies, there was no explicit tracing of the existing condition components through the risk assessment and none of the components were treated to prediction of biological impact responses with respect to the consequence criteria. There was little lineage of the existing information to estimates of population change, population viability, changes in ecosystem function. There was information on some habitat area changes.

3.2.2 No Supporting Evidence for Impact Prediction

The prediction of biological impacts requires the development of a model using existing evidence on processes, states and variations. Predicted outcomes are assessed for their plausibility against empirical evidence and case studies. Supporting evidence is applied to understand the implications and consequences of predicted outcomes. The application of supporting evidence provides a measure of confidence in the results, particularly if there is evidence of concordance in similar cases.

For many of the terrestrial pressures, the impact processes are discrete with binary outcomes, making predictions obvious and straightforward (*e.g.* a patch of habitat is removed). For the wetland and marine components, there are considerable knowledge gaps. Pressures can extend across large areas through tidal flows and animal movements and there are intricate ecosystem linkages. The impact of the GIJPP requires sophisticated approaches to the impact assessment and a large amount of supporting evidence is required to construct the prediction model and have any confidence in the outcomes.

Supporting evidence was mostly absent in the GIJPP EES for the wetland and marine biological impact assessment. None of the citations in the existing conditions sections were applicable and only a handful of citations were provided in impact assessment sections.

There was no supporting evidence or lessons learned from other FSRU installations.

The EES as a whole had no explicit reference to case studies for any other FSRU installation, or installations with similar pressures. Some citations had useful empirical observation, but that evidence was not applied in the EES. For example, Boudjellaba *et al.* (2016) was cited but the evidence in that citation on ecosystem contamination from chlorination by-products was not reported in the EES. The evidence in Boudjellaba *et al.* (2016) was contrary to the EES conclusions, indicating FSRU toxicants could contaminate the environment 10 km away.

The wetland and marine parts of the EES had no review of any types of impacts that could occur or has been observed to occur in the past. There was no review of biological sensitivities and responses to pressures, nor was there ancillary information for modelling responses to both natural and activity-related drivers. The terrestrial component did apply some supporting evidence.

There was no observation or experimentation to feed into impact prediction related to an FSRU in Westernport. Given there were field studies for the EES, there was opportunity to gather predictive information pertinent to Westernport, such as:

- Experimental measurement of temperature and toxicant effects on each of the types and species of benthic fauna;
- Sensitivity of wetland bird guilds and probably bats to noise, light spill, visual disturbance, odours*, etc.*;
- Types of secondary disinfection product toxicants under the various types of water quality conditions at Cribb Point (this varies with types of nutrients and organic content);
- Ecotoxicity, bioaccumulation, bioconcentration, particle attachment, transport and pooling of expected toxicants with respect to ecosystem components and foodweb;
- Processes that could cause faunal movement barriers in North Arm, including combinations of noise, vibration, odour, light, physical presence and migration routes; and
- Local ecosystem components, status, linkages, sensitivity and ecosystem services.

The matters of national significance report had no citations associated with the impact assessment, although this was presumed to have been supported by the marine assessment. The marine biodiversity impact assessment only had a smattering of supporting citations for only some types of impacts:

- Shipping and whale strikes – 2 citations (DoEE 2016; Peel *et al.* 2016);
- Mechanical effect of entrainment – 3 citations (Michels 2010; Ramirez-Duque 2012; Wang and Lan 2018);
- Discharge of chlorination by-products – 3 citations (Boudjellaba *et al.* 2016; Saeed *et al.* 2019; Taylor 2006).

3.2.3 No Evidence for Risk, Mitigation and Management

No supporting evidence was applied to the risk assessment, mitigation or management framework sections. This is discussed further in sections below.

3.3 Uncertainty and Knowledge Gaps

3.3.1 Uncertainty in Biology

The biological assessments of the GIJPP EES did not identify key knowledge gaps, uncertainties or confidence levels. Addressing uncertainties in the biology was largely avoided through:

- Not describing explicit biological impact responses;
- Substituting biological responses with physical effects as a surrogate;
- Making no predictions of biological responses;
- Using over generalised categories in the assessments;
- Not matching inputs to predictions with evidence from elsewhere, such as literature, observation or case studies; and
- Not discussing variations and uncertainty.

3.3.2 Knowledge Gaps filled by Speculation

In places, the EES attempts to mask knowledge gaps through speculation. A clear example was for the surveys of the listed and rare species of ghost shrimp *Michelea microphylla* This species is known only from one specimen collected in the North Arm region in 1965. This single sighting 55 years ago means there is no knowledge of any present populations. The EES down weighted any impact concerns by inventing populations existing outside Westernport:

> *While it is considered rare, it is likely that individuals in Western Port are part of a population or populations that are distributed at similar depth (≥~20 m) and habitats as Lower North Arm that are found elsewhere in Southeastern Australian coastal waters* (page 12; AGL Gas Import Jetty Project: Threatened Ghost Shrimp Survey).

Such speculations were baseless and indicated a tendency in the EES to mask biological issues with subjective opinion.

This approach of the EES is not consistent with the application of the Precautionary Principle.

3.3.3 Uncertainty in Predictions

The EES did not indicate levels of confidence, precision or accuracy about its predictions for impacts or operation of mitigation measures. There was no appreciation for the consequences of being wrong in the predictions.

Assurances should have been provided around predictions through the use of objective and transparent methods with well described assumptions and limitations. Results could then be checked against corroborating evidence and other case studies. The opposite was true of this EES – there was a reliance on risk assessment methods that were not driven by evidence or rationale. All findings were presented as if they perfectly reflect the real world

3.3.4 Uncertainty in Management

Real-world ecological responses have a component of uncertainty with respect to the knowledge around the biology and predictive modelling tools. This is uncertainty is exacerbated by natural stochastic and dynamical variations. This means outcomes will never be exactly as predicted and environmental management systems must have a component of knowledge building and measurement of actual outcomes.

This over-confidence of the impact assessment extended to the environmental management. This had a ‘set-and-forget’ approach rather than a focus on good outcomes.

3.4 Biological Impact Assessment

3.4.1 Weak Impact Assessment

Biological assessment is central to any environmental and ecological impact assessment. Nearly all critical environmental concerns are associated with the impacts that pressures have on biota, associated ecosystem affects, changes to ecosystem services and then to humans.

The EES made few explicit biological predictions such as types of changes, magnitudes and spatial extents. There was considerable effort for physical modelling predictions but there was no biological modelling effort.

Biological impact predictions were confined to just 10s of pages in the EES. Clear predictions are difficult to find in the marine biological impact assessment report, consisting of ad hoc statements and narratives interspersed among the risk assessment narrative. The matters of national significance assessment made no specific biological impact predictions, with the impact assessment mainly discussing mitigation measures for physical effects. The terrestrial impact assessment was more specific for a selection of species, however impact responses were not clearly stated.

The impact assessment was overshadowed by the risk assessment. Curiously, the risk assessment methods listed impact prediction criteria for input to the risk assessment. None of the impact assessments reported against those criteria. Example impact criteria included:

- Measurable changes to ecosystem components;
- Detectable impact over up to 45 ha around FSRU;
- Loss of area of threatened ecological community 0.05-0.5 ha;
- Detectable population changes with reduction in population viability that is significant at a bioregion level (Appendix A, Environmental Risk Report).

3.4.2 No Wholistic Ecosystem Assessment

Best practice impact assessments include wholistic ecosystem assessments, particularly with regard to ecologically sustainable development and cumulative impact assessment.

The GIJPP EES had brief descriptions of some ecosystem interactions in the marine biodiversity reports, however these were either incomplete or decades out of date. Both the terrestrial and marine impact assessment reports summarily dismiss the potential for impacts on wetland birds and Ramsar ecosystem feature. Both reports do this without any appraisal of ecosystem linkages, food web and trophic guilds. The terrestrial report goes so far to claim it was considered in the marine report:

> *"Trophic impacts that might affect waterbirds are considered to be unlikely (CEE 2020)"* (page 179, EES Technical Report B, Terrestrial and Freshwater Biodiversity Impact Assessment).

The CEE report did not consider trophic-related impacts for any ecosystem guild, in either the risk or impact assessments. The word trophic is not even used. The only apparent ecosystem components in the impact assessment were at broad habitat levels, such as mangroves and saltmarsh, or over-generalised and confounded entities, such as 'water birds' and 'marine invertebrates' (*e.g.* page 443, EES technical Report A, Marine Biodiversity Impact Assessment).

A generic, coarse-level conceptual ecosystem model was provided in Figure 7-3 of some marine components (Figure 4.3, from p 307, Technical Report A). A more detailed food web was provided for sublittoral seagrass in Figure 4-3 (p 27, Technical Report A). This figure was illegible, not updated since inception 36 years ago (1984) and not accompanied with equivalent models for the other key habitats. These two figures appear to be the only ecosystem models put forward in the whole EES. As with most of the existing conditions information, the models were not applied in the impact assessment. The coarse nature of the subtidal model in Figure 7-3 precluded its use for impact prediction. There were no models in the EES representative of key ecosystem components and interactions, including wetland bird food web guilds.

The principles of ecosystem-based management (EBM) and ecologically sustainable development (ESD) are part of the Marine and Coastal Act. For the GIJPP EES to address ecological sustainability, it requires a wholistic ecosystem approach that includes important linkages between ecosystem components and secondary implications. There are few excuses as to why this could not have been attempted in the GIJPP EES. There is a plethora of techniques in the literature. Some examples from the literature are provided in the framework section. It is a reasonable expectation for the EES to have reviewed best practices. The EES preparation phase included considerable field survey effort. That time and budget could have been applied to filling the required knowledge gaps for a wholistic ecosystem evaluation.

3.4.3 No Cumulative and Incremental Impact Assessment

The GIJPP EES does have various sections attempting to address cumulative impacts, however most make poor excuses for excluding this aspect or that it was not possible to do. This can be considered to even a preliminary level using ecosystem modelling and concerted effort to combine information multiple sources. The effort to do this was poor, with not even consideration of the extant literature and existing practices. Where attempted, only a few select considerations are combined, without any systematic consideration or scoping of sensitive ecosystem features. Neither are the overlap of activities and pressures in the region considered in any systematic or comprehensive manner.

The cumulative impact assessment in the marine report (Section 8.5) was particularly selective and was presented primarily as conjecture without supporting evidence or modelling. This included statements such as:

> *Shading is expected to be a significant stress, as it would reduce the light in the water column and also reduce the biota in the water column occupied by the vessels, thereby potentially reducing the food supply to infauna in the seabed below the vessels. This would be compensated (to the east of the FSRU) by the extra food supply from the effects of plankton damaged in travel through the heat exchangers.* (page 446, Technical Report A, Marine Biology Impact Assessment).

The EES is full of statements such as this, not supported by evidence and actually conflicting in logic. Instead of trying to invent explanations, the EES should have concerned itself with the collection of evidence to discover processes that are expected in real-world settings.

There is an essential requirement for a wholistic ecosystem-based model to examine cumulative impacts on wetland birds and the Ramsar wetland site is critical for the proper assessment of the GIJPP.

3.4.4 Assessment Spatially Limited

The biological impact assessment for the FSRU was spatially limited to just the region around the FSRU, as mapped by physical plume modelling. There was little consideration of ecological processes and linkages that can extent impacts over a larger area. This includes the transport of particulates by tidal currents. The EES itself models particulates with respect to entrainment and that modelling showed there could be ecosystem linkages to the north and connecting with the large areas of littoral sediment habitats. The EES was conflicted in stating that none of the littoral habitats were close enough to be impacted, when the physical modelling clearly showed they were. There were also statements that major oil spill could also be transported to those habitats, yet this was also ignored in stating the spatial extent of potential impacts. Wetland birds and marine fauna, particular fishes and squid, move widely between their habitat patches in Westernport. These faunal movements also considerably increase spatial scale that FSRU effects could be manifested at. This issue pertains to the issue of not having a wholistic ecosystem assessment approach and not systematically evaluating all potential impact pathways.

3.4.5 Biological Impacts Dumbed Down

A point emphasised many times in this review is that the GIJPP EES ‘dumbed down’ most biological impact considerations. Biological features were combined into a small number of general groups for impact assessment. The most concerning aggregations were the grouping of wetland birds and sediment invertebrates. Both of these categories have guilds of animals with vastly different sensitivities, connections through food webs, influences on habitat structure and conservation status.

3.5 Risk Assesment

3.5.1 Expectations from a Risk Assessment

Risk assessments serve to abstract various types of predicted impacts to measures of ***concern*** for decision makers. Risk assessments represent a translation of predicted environmental impacts into some measure of exposure to harm or loss. Environmental risk assessments require the input of impact predictions and the quality of risk assessments is predicated on the quality of the input information. Although risk assessments take impact assessments as their input, they are not a substitute or surrogate for environmental impact assessment. The results from a risk assessment are abstract from impact descriptions and do not contain information about the nature impacts. As such, risk assessments have to be reported in the context of the impact predictions, including biological responses: EIA risk assessments are dependent on modelling biological impact responses.

Risk assessments cannot be used as a substitute or surrogate for biological impact assessments because there is a significant loss of information. They can be useful for assessing environmental tradeoffs and prioritising management interventions. If risk assessments are to be used in the such decision processes, it is vital that the risk results are fit for such purposes.

There are many types of calculations and expressions of risk. For environmental impact assessment, risk is often expressed as the degree of potential for a hazard or threat to cause harm. This is calculated as some measure of environmental or ecological consequence and the level of consequence is often weighted as a measure of likelihood of occurrence. Measures of consequence and likelihood are derived from the outputs of impact modelling and prediction for some times of risk assessments. Other methods avoid likelihood concepts and use biological resilience and recovery as indicators of risk.

The choice and implementation of a risk assessment method has a substantial influence on the type of information in the results and how it can be used in any decision framework. Substantial issues were identified in both the risk assessment method and how it was applied to the EES.

3.5.2 Risk Assessment is not a Surrogate for Impacts

The GIJPP EES places a heavy emphasis on the risk assessment as an indication of environmental effect levels. The EES essentially uses risk levels as a substitute or surrogate for proper biological impact assessment. This includes:

- Little to no biological impact prediction;
- No demonstrated input of impact assessment results into the risk assessment;
- Dominance of the reporting around risk assessment results.

The intention of the EES was clear that the environmental effects statement should be appraised primarily through the risk assessment results.

3.5.3 Risk Method not Fit for Purpose

The risk assessment method selected for the GIJPP EES was a basic, qualitative method derived from processes for rapid screening of well-defined safety and project hazards in the workplace. This method has crept into use for environmental management via integrated management systems that assess healthy and safety risks in conjunction with project and environmental risks. The method was not designed to be the primary input into major environmental planning decisions.

The EES risk method involved selecting hazards or threats to assess and choosing a single category of likelihood and consequence for each hazard, with categories of risk defined for each likelihood and consequence category. This method works well for initial screening of health, safety and economic type risks where there is information from previous experiences and events are discrete with respect to categories of likelihood and consequence.

It is well documented that this method is difficult to apply for environmental risks. In particular, environmental impacts can be rarely categorised as discrete event. The type of information for biological response modelling is usually not translatable into likelihood and consequence categories. Lastly, that type of representation of risk is not consistent with best practice approaches for ecosystem-based management and DPSER-style management frameworks. Instead, contemporary methods typically express levels of risk in terms of biological sensitivity, such as functions of

- susceptibility to threats and pressures (resistance or resilience); and
- ability to restore and recover to natural conditions from disturbance or change (recovery).

There are other types of value and consequence inputs that may be appropriate evaluating environmental risk. Not least of these is the level of knowledge and uncertainty. Where there are high levels of uncertainty then this usually triggers a high level of management concern, with management action stimulated in accordance with the Precautionary Principle.

The GIJPP EES risk assessment method takes on none of the best-practice developments and concepts implemented the last decade. Some of the newer quantitative approaches make the risk assessment process simpler, easier and more transparent to implement. Given the scale of this project, it would be reasonable to expected the application of more robust ecological risk assessment methods. There was no review or rationale in defense of the chosen risk assessment method.

The risk assessment, as presented in the EES, had no supporting information on how and why is impact pathway was chosen and likelihood and consequence levels were chosen. All aspects of the risk assessment are presented as subjective opinion. There was no transparent, supporting evidence for an independent person to reach the same or similar finding: it was unscientific.

Qualitative risk assessments with opinion-based inputs are routinely used as means of eliciting information, as a precursor to scientific processes. These inputs have well documented issues. Common short comings that have to be accounted for include non-transparency, uncertainties and poor supporting information, vagueness, under-specificity and failure to identify important risks. Cognitive biases are common in risk assessments, including optimism, inside view, anchoring and ambiguity biases.

Of particular concern is that subjective risk assessments can be easily manipulated for advocacy and influence of particular outcomes. Such issues require explicit attention if the results of such assessments are to have any credibility or used in major environmental decisions. Examples of literature outlining issues and structured approaches to ecological risk assessments include: Mostert (1996), US EPA (1998, 2003), Levin *et al.* (2008), Burgman *et al.* (2011), Martin *et al.* (2012), Burgman (2013), Game *et al.* (2013), Fletcher (2015), Stelzenmuller *et al.* (2015), MacGillivray (2017), DAF (2018), Enriquez de Salamanca (2018) and Probert *et al.* (2019).

The GIJPP EES risk assessment method was highly vulnerable to bias and manipulation and did not acknowledge methodological issues. The EES did not offer supporting evidence for the findings or indicate any controls to guard against subjectivity and bias. The risk assessment method used in the EES was not fit for purpose. There was considerable evidence that the methods were applied in subjective manner that skews the results to favourable outcomes, as explained below.

3.5.4 Selectivity of Threats and Biological Components

There was no systematic approach to the identification and screening of the biological components and threats that should be considered in either the impact assessment or the risk assessment. Items in the risk assessment had no explanation of how they got there and do not trace explicitly to information in the Existing Conditions descriptions. There was considerable bias in what components were assessed in the risk assessment. These were addressed in more detail in Section 4. In summary these included:

- Selective exclusions - key threats and marine features were arbitrarily excluded – particularly those with high risks such as marine pests and major oil spills;
- Confounding and dumbing-down of inputs - sensitive impact pathways were buried by combining into super-groups;
- Dilution and filtering - severe threats were merged with less severe threats.

3.5.5 Risk Profiles Hidden

The GIJPP EES defined the risk assessment as a function of likelihood and consequence. This function is actually continuous: risk levels for a particular event or hazard occur as a distribution across the range of likelihoods and consequences. In many cases, this risk profile can have a peak at a particular combination of likelihood and consequence. Where this peak is distinct, it can be taken as a measure of the concern about an event. The risk profile does not always have a clearly defined peak, in which case the maximum risk value may be used. For assessment of environmental risks, there is usually not enough information to calculate the full risk profile accurately, so it is quantised into ordinal categories, with distinct jumps in values. The GIJPP EES used quantised categories to represent risk distributions.

The GIJPP EES only selects a risk level for one part of the risk profile. This selection process revolves around choosing only one likelihood category and only one consequence category. There was no rationale or evidence as to why only one part of the risk profile was selected, particularly where there was no underlying model and impact prediction results. The selection of parts of the risk profile appears to be biased towards presenting a favourable outlook for the GIJPP.

There are obvious empirical cases where the risk profile includes effects that can have lasting and widespread (catastrophic) impacts, but may also have frequent and low consequence impacts, such as marine pests and toxicants. Using marine pests and toxicants as an example, the EES assigned consequences and likelihoods to these as minor-unlikely and negligible-certain respectively. This is despite the known existence of severe cases and catastrophic consequences in Victoria and elsewhere.

The selection of only part of a risk profile for reporting in the EES can be considered a form of bias.

3.5.6 Risk Results not Comparable

The EES claimed in Chapter 5 and the Environmental Risk Report that the risk assessment was used to provide a common assessment across disciplines and ecological compartments. This was clearly not the case, with risk results mismatched with levels of hazard across the disciplines. The EES reports only one elevated marine risk, of oil and chemical spills, and ranks this at the same level as risks of noise from temporary construction works. The level of environmental concern (risk) of temporary noise is obviously not equivocal to the concern associated with an oil spill event. The ranking or prioritisation of environmental concerns from the EES risk assessment is not sensible.

3.5.7 Arbitrary Consequence Levels

The GIJPP EES determined its own consequence criteria for the risk assessment (Appendix A of Environmental Risk Report). The language of these criteria was vague and subjective. For example, the categories of consequence for a Ramsar site are in the language of minor, moderate, major or extreme change in ecological character. There is no information of what ecological character is indicated by and what constitutes a major vs extreme change. Some criteria have arbitrary values to define a consequence category, such as "Detectable impact over up to 250 ha around FSRU". The source of these thresholds should be questioned, along with how it could be applied. What is the meaning of "detectable impact"?

There criteria for impacts on threated species and waders and waterbirds were not different between the levels. For this category, the language was for detectable population change with a reduction in population viability that is significant at local, regional, state or national levels. This does not make sense in that all species are listed because of State, national and international concern: any changes in population at the local level is of national or global significance for nearly all the species of concern. Categories of consequence in the risk assessment were vague in definition and open to subjective interpretation.

Apart from issues in defining the consequence criteria, the criteria were not applied in the EES. There was no impact assessment that predicted results for use in the impact assessment. Instead, it was apparent consequence levels were selected by subjective opinion.

3.5.8 Arbitrary Likelihood Ratings

The likelihood categories were defined around the likelihood or expectation of some event occurring: rare, unlikely, possible, likely, certain. There was not any objectivity or guidance to ensure independent results would be the same. The likelihood assignment was a subjective process. Person-to-person variations in the choice of likelihood could lead to markedly different risk results.

Based on the narrative in the EES, it was apparent that many of the likelihood choices were more on consequence levels that some event probability, such as where mitigation measures that affect only consequence had a change in likelihood assigned as well. There were also impact pathways where an impact pathway was guaranteed to occur so the likelihood should have been certain by default. For example, chlorine related impacts are certain, which was the likelihood assigned for benthic invertebrates but not for other things such as the Ramsar site. Contamination of food chains is rated as ‘possible’ but only ‘rare’ for Ramsar values (which is the same ecosystem).

There were also inconsistences in the likelihood judgements with respect to residual risk, following mitigation measures. In some cases, mitigation measures were applied that would have happened in the base case anyway. For example, for contamination spills from vessel (ME 43), mitigation from compliance with the operational environment management plan, regulations and policies reduces likelihood from *unlikely* to *rare*. Given the EES claims to apply existing plans and regulation (referring to Port of Hastings operations) and does not describe any new procedure to mitigate likelihood, this likelihood change appears to be false. For the risk hazard of entrainment of pelagic and demersal fish into the FSRU, it is proposed to mitigate it by reducing intake and discharge flows in spring. Entrainment would still occur but the consequence from the magnitude of impacts would reduce, yet the mitigated risk level includes a drop in likelihood from *likely* to *possible* – how does the change in magnitude of an impact change the likelihood? There are many other examples of such arbitrary likelihood ratings.

3.5.9 Risk Assessment Unreliable

The GIJPP EES risk assessment used a method with known issues and flaws with respect to gauging environmental concerns. The chosen evaluation method was not aligned with present best practices.

The risk assessment was applied without any transparency, supporting evidence or rationale, making the assessment subjective, not independently repeatable and not scientific. There was clear evidence of subjective judgement and bias, both in the framing of the risk pathways to be assessed and the selection of likelihoods and consequences. The risk assessment was not anchored by the existing conditions information of risk assessment or any other points of truth form the literature.

Despite it being the bulk of the assessment of environmental effects, it was clear the findings do not provide reliable information to support environmental decisions.

3.6 Mitigation Measures

3.6.1 Base Case vs Mitigation Case

The mitigation measures are confounded with measures that are existing practices and would be expected as part of a base-case design. It is not made clear what would be implemented specifically to the nature of the environment and the proposed project. Items listed as mitigation measures but are already part of normal, base case or regulated operations included:

- Vessel speed restrictions and Master watches for whales;
- Appropriate antifoul, cleaned and inspected in accordance with regulations;
- Compliance with the environment management plan, regulations or policies;
- Port of Hastings Handbook;
- Design of intake, velocity and screening grilles;
- Operation waste management;
- Acid sulfate soil management plan;
- Contaminated soils;
- Emergency response plans;
- Monitoring of chemical and fuel storage facilities;
- Dangerous goods;
- Refuelling of vehicles and machinery;
- Spills prevention management;
- Fuel and chemical storage;
- Contractor awareness.

Such standard, base-case management measures were applied to reduce the residual risk. For example, “compliance with the operational environmental management plan, regulations or policies” reduced the hull and prop cleaning risk (ME 44) likelihood from *possible* to *unlikely*. Why was the project designed outside existing standards?

The base-case mitigation items are important to any environmental management plan, but they are not valid mitigations to apply for calculation of mitigated, residual risk levels. Such actions should be applied regardless as part of existing regulation, codes of practice and good environmental stewardship.

3.6.2 Uncertainties and Knowledge Gaps

A common theme throughout the EES is the lack of consideration for uncertainty and gaps in knowledge and the ability to understand and manage impacts. The mitigation measures must take this into account, but there is no mention of this in the EES.

3.6.3 Mitigation only for Broad Categories

The mitigation measures identify the need for specific measures to address specific risks to sensitive species and habitats. However, specific measures were only identified for terrestrial flora and fauna, such as for the growling grass frog, river swamp wallaby grass and Merran's sun orchid. This specificity was not extended to wetland, migratory and marine flora and fauna. This is despite there being known species and communities sensitive to impacts and / or requiring mitigation actions determined specific to them.

As a whole, the mitigation measures described in the EES refer to broad, generalised groups or impact pathways. The over-generalisation issue was applicable to both the pressures and ecological receptors. Migratory birds are treated as a single group and marine pests were treated as if they are all the same and have the same mitigation measures. For example, there are many types of marine pests with particular translocation vectors and invasion properties. Some of these can be effectively managed through targeted mitigation. For example, construction vessels that have long residence times in infested waters have caused the spread and infestation of *Undaria* kelp between ports and this should be accounted for during works at Cribb Point. Particular vessels coming from particular ports will have be more likely to translocate particular pest species and additional protection measures can be specified accordingly. For example, construction or service vessels should be excluded coming from Portland or Geelong Ports to reduce risks of translocating *Undaria pinnatifida* and *Caulerpa racemosa* var *cylindrocarpa*.

3.6.4 Mitigation by Assumption

The proposed mitigation measures were presented with a degree of certainty in their efficacy. This is on the basis that the EES neglects to present the mechanisms of how the mitigations would work. Ideally, mitigation mechanisms would be an extension of biological impact modelling. The apparent confidence of the predicted mitigation outcomes was not matched by any analysis or supporting empirical information.

There is evidence that some of the mitigations would be not as effective as perceived. A clear example are the controls around translocations of marine pests and the EES statement claims that marine pests would be mitigated by existing practices. Port Phillip Bay, Apollo Bay Harbour and Port of Portland show that this would not be the case, with examples of ongoing translocation, establishment and spread of marine pests. A similar leap of faith was applied to mitigation of oil spills with mitigation measures including safety plans and emergency response plans, particularly in the Matters of National Significance Report. Although the assessment of major incidences such as oil spills, ship collisions and gas explosions (or all three together) were not specifically addressed in the EES, it is worth noting that none of the proposed mitigation measures could change the impact consequences.

None of the mitigation measures presented in the EES should be accepted as valid and effective without an explanation and supporting evidence. Just because a proposed mitigation is an existing practice, it does not mean it would be effective with respect to the proposed project.

3.6.5 Mitigation tied to Risk Assessment

The mitigation measures were tied to the risk assessment and, given the biases of the risk assessment, they suffer from similar biases.

As noted above, mitigation measures should have been assessed as part of biological impact modelling, where outcomes of mitigation measures could be tested and optimised. This would provide a biological rationale and justification for the mitigation measures.

3.7 Environmental Management

3.7.1 EMF has no Environmental Objective

The GIJPP proposed an environmental management framework (EMF; Chapter 25 Environmental Management Framework. The EMF had no objective for maintaining good environmental condition. Instead, the stated objectives were activity-based and administrative:

- Set out mitigation measures developed in the EES;
- Identify relevant statutory approvals that give effect to the measures;
- Identify lines of accountability; and
- Monitoring the implementation of statutory approvals.

These objectives related only to input controls, *i.e.* management of activities and drivers only. The wording of the EMF indicated there is not an actual concern for assuring environmental sustainability of the project, just concern around meeting particular project approvals. The irony is that the Marine and Coastal Act, and to some extent the EPA Act, require management to good outcomes.

3.7.2 Focus on Obtaining Consents

The structure for environmental management of the EMF was mostly geared towards gaining consent and initiation of the project. The contents are confined to:

- Objectives;
- EES scoping requirements;
- Regulatory pathways for gaining consent for the project;
- Roles and responsibilities for obtaining consents and approvals;
- Risk assessment register; and
- Mitigations measures register.

3.7.3 EMF not Best Practice

No Adaptive Management

There have been considerable developments and improvements to environmental management systems over the last few decades. Central to all of them is the concept of building knowledge and improvements through adaptive management. The proposed EMF implements no concept of continual improvement. Instead it is static and assumes all input controls are perfectly adequate.

Assumes Perfect Knowledge

The prediction of impacts and how to manage them has a high degree of uncertainty. For wetland and marine habitats, there is very little evidence on existing conditions, ecosystem process and responses to impact pressures that can be input into prediction models. For Westernport, there are major ecological discoveries still occurring and key ecosystem processes are still be elucidated. For example, the extent of the intertidal sediment habitat has only recently been mapped and the delineation of seagrass in the intertidal zone has never been determined. It was only recently determined that sediment microalgae is a major driver ecosystem process throughout the bay, including food for a large biomass of migratory birds.

Added to the uncertainties in existing knowledge are the uncertainties of impact predictions. Any model used for prediction has particular assumptions, limitations and confidence bounds. The development of the models requires input of particular ecological processes, which are scarcely known. On top of those uncertainties are stochastic and dynamical processes in the real world, such that unforeseen events occur despite even the most perfect of prediction modelling (actually models predict this should be the case).

The EES is completely silent on knowledge gaps and uncertainties for predicting impacts and informing environmental management. This absence of consideration implies and assumption of good status of knowledge and this assumption is also implied in the confidence projected in the mitigation measures. The overarching claim of the EES is that any and all environmental issues will be controlled by the proposed mitigation measures. Such perfect knowledge does not exist and the management system must account for that.

No Outcomes Basis or Continual Improvement

Various forms of adaptive management cycles are implemented as a central component of best-practice environmental management systems or frameworks. The cycle consists of obtaining information on outcomes and filling knowledge gaps, improving management practices and then assessing outcomes again.

The EMF proposed input controls only with no adaptation according to outcomes.

No Evidence Basis

A strong evidence basis is important for robust decision making in environmental management. The EMF relied solely on the risk assessment of the EES. The issues of the risk assessment therefore extend to the EMF.

Not to Standard

The EES claimed the proponent applies the ISO 14001 standard for environmental management systems (EES Chapter 1 Introduction, page 1-2). This standard has adaptive management and continual improvement at its core. The EMF described in Chapter 25 is non-compliant with ISO 14001 and the proponent’s own environmental management system.

3.7.4 No Ecosystem Based Management

There is considerable literature on contemporary expectations for environmental management systems. Many of the key principles are defined in the Marine and Coastal Act. These include ecosystem-based management (EBM), ecologically-sustainable development (ESD), the Precautionary Principle and marine spatial planning (MSP). Approaches to apply these principles have been cited above.

The siting of the FSRU is in an environment with highly connected sublittoral, littoral and coastal ecosystem components. The connections extend across a large spatial area with clear impact pathways between Cribb Point, North Arm, northern dendritic channels with vase areas of sediment flats and the network of bird usage areas throughout the bay.

It is critical impact assessment and management is ecosystem-based and includes the wider spatial linkages.

3.8 Synthesis of EES Validity

3.8.1 Reliability

Approvals and consents for the GIJPP should be based on reliable and robust information to provide assurance that the development is ecologically sustainable and that ecosystem services and natural assets are not unduly harmed. The validity of the information provided in the GIJPP EES must therefore be established before the findings can contribute to decisions.

The nature of the information presented in the EES has some major issues that impinge on its robustness and reliability. The worst of these were:

- No ecosystem-based framework or structure and no reflection of contemporary best practices.
- Existing conditions information was padding in the EES – few specifics in these sections connect into effects on biota and ecosystems (except for some terrestrial species but not wetland birds, Ramsar or any marine components).
- Poor evidence basis: impact, risk and mitigation sections had effectively no supporting evidence from literature, empirical or modelling sources with respect to biological or ecosystem responses.
- No consideration of uncertainty, including gaps in knowledge of impacts, impact processes, biological responses and efficacy of mitigation;
- *Ad hoc* selection of issues: no overarching standardisation or process for identifying sensitive ecological components, screening of threats and hazards or predicting biological impacts;
- Biological impact responses predicted only for only a small selection of issues.
- Impact prediction did not inform the risk assessment (risk does not describe impacts);
- Risk assessment method subjective, non-transparent, non-repeatable with inconsistent results;
- Risk assessment for only a selective set of issues and on dumbed-down, overgeneralised ecological components;
- Mitigation measures not transparent or rationalised;
- Environmental management framework designed for approvals, not for good environmental outcomes.

The structure and implementation of the EES lacked a systematic framework within the context of contemporary expectations and information requirements. The was a large bulk of information in the existing conditions section and nearly all of this was ignored for assessment of effects. The bulk of the EES relied on a risk assessment process that was subjective, biased and avoided addressing specific impact issues. The poor implementation of the EES lead to major, obvious errors of omission and accuracy, with levels of precision and uncertainty of predictions not addressed at all.

The lack of scientific rigour means EES findings should be treated with a high degree of skepticism or disqualified for decision making.

3.8.2 Potential for Environmental Harm

The lack of rigour in the structure and implementation of the EES lead to some major potential impacts being overlooked or discounted. Whole swathes of issues and concerns were excluded or avoided, including by dumbing the assessments down into meaningless categories. The EES also avoided evidence of serious issues in the literature. The EES makes little reference to supporting evidence in the literature or empirical observation in determining biological sensitivities and impact responses.

Examples of the major environmental issues the EES failed to properly address included:

- Release of toxicants;
- Marine pests;
- Seabed alteration;
- Sensitive marine species and communities;
- Barrier effects in North Arm;
- Major incidences, such as ship collisions, oil spills and gas explosions;
- Cumulative impacts;
- Ecosystem and ecosystem services assessments; and
- Uncertainties, monitoring and maintenance of good environmental status.

Some of these issues are discussed in the following section.

4 Potential for Harmful Impacts

4.1 Pressures, Sensitivity and Impact Scoping

4.1.1 Information for Impact Assessment Scoping

A critical part of impact assessment is the initial scoping of the environmental pressures, biological features and responses of consequence that are relevant to the project. Scoping has the benefits of ensuring there is appropriate levels of attention to the relevant and most important issues, ecologically and socially, without diverting effort to non-relevant concerns. It is also important to ensure that all appropriate combinations of types of activity-pressures are considered with the various combinations of potentially sensitive biological features. This should be the primary purpose of existing conditions information, to identify and screen the important information that feeds into the impact assessment. The screening process also identifies key areas of uncertainty and these have to be addressed through EES-related research and/or The Precautionary Principle.

This process requires an initial evaluation of the types of environmental pressures and biological sensitivity for every type of reasonable possibility. There are a variety of systematic and transparent approaches to achieve the initial screening, as per the references cited in Section 3 of this review. It was noted that some scoping was provided by the scoping directive of the EES and by existing management policies. For example, wetland birds, migratory species and Ramsar ecosystem features (‘ecological character’) require specific focus in the impact assessment. The Marine and Coastal Act makes it clear there should be wholistic ecosystem assessment with respect to ecosystem-based management and ecologically sustainable development. This means ecosystem-level processes and linkages need to be considered as much as particular species sensitive to particular pressures. Moreover, the policy of the Act defines categories for Good Environmental Status and if the GIJPP so it is important for the EES to determine the potential to affect each these criteria.

Aspects with poor knowledge, uncertain responses or poor confidence in the existing knowledge are retained rather than screened from the assessment, such that implications of any uncertainties can be addressed in more detail.

4.1.2 Selection Bias, Transparency and the Precautionary Principle

Any EIA or EES process can be easily biased or manipulated for a ‘favourable’ outcome for the proponent through initial impact assessment screening. This includes through the omission of relevant considerations (selection/omission bias), higher weighting or focus on less important aspects (diversion or misdirection) and using inappropriate definition of biological units, classes and mechanisms for impact assessment (misrepresentation). The guards against such biases include the use of a systematic and comprehensive approach with transparent and independently repeatable methods. There are standard approaches and methods that have proven capability and confidence in providing the appropriate information. Regardless of the methods used for impact screening, there is a requirement to justify those methods and provide assurances that they have been applied appropriately. Transparency in the methods and results, addressing levels of confidence in the applied information and the clear application of the Precautionary Principle are also important assurances for the reliability and robustness of the impact assessment. The development and communication of models greatly assists in the provision of transparency to the impact process (*e.g.* Figure 4.2).

4.1.3 Policy, Regulations and Plans

The impact assessment scoping requires the inclusion of regulated, policy or other environmental management planning. These include listed species and communities, special management areas and the like (*e.g.* Figure 4.1).

4.1.4 Impact Scoping in the EES

Scoping of Pressures

The GIJPP EES did not provide a systematic approach to the selection and definition of impact effects and pressures. Chapter 4 of the EES describes the project construction, operation and decommissioning activity, but does not detail the environmental pressures. There is a scattering of information on the physical effects of the project within the marine, terrestrial and matters of national significance assessments. The marine biodiversity assessment introduces a partial list in the introduction (Section 1.3.1, page 8). The methods of the marine assessment identified the need to review impact pathways:

> *"Detailed review of previous studies and relevant scientific literature to define the characteristics in impact pathways (existing conditions, see to Section 5)"* (page 47, Technical Report A).

However, any consideration of environmental pressures did not occur until the hydrodynamic modelling and risk assessment assessments of the terrestrial, marine and matters of national significance assessments. Some impact processes appear randomly through the assessment, such as marine pests, some processes are raised and summarily dismissed in the impact assessment, such as contaminants and lighting, while other processes are ignored, such as movement barriers and habitat changes.

Scoping of Sensitive Biological Features

The EES did not systematically address the potential scope of the impact assessment with respect to sensitive biological features. Notably absent was any aspect associated with ecosystem linkages, particularly trophic and habitat-related pathways. The marine and wetland existing conditions sections of the EES did not identify any particular biological sensitivities or vulnerabilities to impacts.

Scoping of Regulated and Planning Features

The GIJPP EES did identify the need to include things like listed species, migratory birds and Ramsar ecological values. For example, from the marine biodiversity assessment report:

"…Significant impact judgements must be made on a case-by-case basis and with consideration for the context of the action. The potential for a significant impact on migratory shorebird species will depend on the:

> *o timing, intensity, duration, magnitude and geographic extent of the impact*
> *o sensitivity, value and quality of the environment within and around the area*
> *o combined effects of impacts within and outside the area, direct and indirect impacts, as well as cumulative impacts already sustained*
> *o presence of this and other matters of national environmental significance."*
> (page 207, Marine Biodiversity Impact Assessment).

The matters of national significance report and the terrestrial biodiversity impact assessment provide specific lists of species for consideration. Despite the identification of scoping requirements for listed species, migratory birds and Ramsar sites, none of these considerations were actually addressed in the wetland and marine sections of the EES. There was no specific information on sensitivities and impact pathways and there was explicit impact analysis.

Listed species and Ramsar features were recognised, but not scoped into the EES assessment.

4.1.5 Actual Scope of the EES

The GIJPP EES considered 30 biological features for impacts on the wetland and marine environments (Table 4.1). These were identified from the risk assessment and narratives in the impact assessment sections. Most were high level groupings, such as seagrass, plankton, Ramsar area, food chain. There was no explicit treatment of listed and migratory species for all potential pathways. They were all treated as a group. There were no descriptions of predictive relationships between pressures, species and ecological networks.

The biological categories used in in the impact assessment for wetland and marine environments were not representative of the important sensitive species or ecosystem components.

4.1.6 Summary

An impact assessment requires a clear justification of the biological features and impact pathways to be included in the assessment. The scope should consider aspects of most significance, importance and concern. The scope of the GIJPP EES for the wetland and marine environments encompassed 30 generalised biological features. There were few specific considerations of species and ecosystem processes of concern.

Table 4.1. Audit of wetland and marine biological features used in the impact assessment of the GIJPP EES.

Biological feature	Pressure	Source
Mangrove and saltmarsh Seeds, community	• Entrainment (ME 1) • Cold water (ME 10) • Warm water (ME 20) • Chlorinated seawater (ME 30)	• Risk register
Intertidal mudflat invertebrates Larvae, community	• Entrainment (ME 2) • Cold water (ME 11) • Warm water (ME 21) • Chlorinated seawater (ME 31)	• Risk register
Seagrass seeds and propagules community	• Entrainment (ME 3) • Cold water (ME 12) • Warm water (ME 22) • Chlorinated seawater (ME 32)	• Risk register
Benthic subtidal invertebrates Eggs and larvae	• Entrainment (ME 4) • Cold water (ME 13) • Warm water (ME 23) • Chlorinated seawater (ME 33)	• Risk register
Pelagic and demersal fish	• Entrainment (ME 5) • Cold water (ME 14) • Warm water (ME 24) • Chlorinated seawater (ME 34)	• Risk register
King George Whiting Larvae	• Entrainment	• Marine biodiversity assessment
Syngnathid fishes Larvae	• Entrainment	• Marine biodiversity assessment
Ghost shrimp *Eucalliax tooradin*	• Entrainment	• Marine biodiversity assessment
Ghost shrimp *Michelea microphylla*	• Entrainment	• Marine biodiversity assessment
Jetty biota	• Entrainment	• Marine biodiversity assessment
Plankton	• Entrainment (ME 6) • Cold water (ME 15) • Warm water (ME 25) • Chlorinated seawater (ME 35) • Chlorine concentration	• Risk register • Marine biodiversity assessment
Subtidal reef	• Cold water (ME 16) • Warm water (ME 26) • Chlorinated seawater (ME 36)	• Risk register
Ramsar protected area	• Entrainment (ME 7) • Cold water (ME 17) • Warm water (ME 27) • Chlorinated seawater (ME 37)	• Risk register
Other protected area	• Entrainment (ME 8)	• Risk register

Biological feature	Pressure	Source
	• Cold water (ME 18) • Warm water (ME 28) • Chlorinated seawater (ME 39)	
Protected species	• Entrainment (ME 9) • Cold water (ME 19) • Warm water (ME 29) • Chlorinated seawater (ME 39)	• Risk register
Food chain Bioaccumulation	• Chlorine produced contaminants bioaccumulation (ME 40)	• Risk register
Shallow habitats and communities	• Vessel grounding (ME 47)	• Risk register
Aggregated marine biota	• Food supply and light causes unnatural aggregation (ME 51)	• Risk register
Whales	• Whale strike (ME 52)	• Risk register
Marine biota	• Noise injury or disturbance (ME 53)	• Risk register
Ecological character	• FSRU operational activities (FF 06) • Pipeline works operational activities (FF 07) • Harmful introduced pest (Table 26)	• Risk register • Matters of National Significance
Waders and waterbirds	• Construction activities (FF 18) • Operational activities including noise and lighting (FF 01) • Light pollution	• Risk register • Terrestrial biodiversity assessment
Habitat or lifecycle of native species	• Likelihood of impact (Table 26)	• Matters of National Significance
Migratory species	• Destroy or isolate important habitat (Table 27) • Invasive species in important habitat (Table 27) • Disrupt life cycle of ecologically important species [not identified] (Table 27)	• Matters of National Significance
Migratory birds	• Chlorine concentration	• Marine biodiversity assessment
Seabirds	• Chlorine concentration	• Marine biodiversity assessment
Penguins and seals	• Chlorine concentration	• Marine biodiversity assessment
Fish	• Chlorine concentration	• Marine biodiversity assessment
Zooplankton	• Chlorine concentration	• Marine biodiversity assessment
Turtles	• Light pollution	• Marine biodiversity assessment

4.2 Environmental Contamination

4.2.1 Release of Disinfection Secondary Products

The proposed FSRU would use chlorine dosing to prevent biofouling within the heater exchanges. The chemistry of this process means the chlorine will be deactivated relatively quickly, however the chlorine is substituted by bromine in seawater, resulting in predominantly brominated compounds released into the environment. The types of brominated chemical compounds that are produced is highly variable and this variation is related to changes in water quality parameters at the intake, including the salinity, temperature, pH and concentrations of ammonia and organic compounds (Saeed *et al.* 2015; Zhang *et al.* 2015; Boudjellaba *et al.* 2016). This suite of chemicals arising from chlorine dosing is termed disinfection secondary products (DSPs)

Commonly produced DSPs are carcinogenic, mutagenic or have long-term toxicity. Some, such as bromoform, are endocrine disrupters and cause depression of nervous systems. Some products are transient, with eventual release to the atmosphere, while others are environmentally persistent and bioaccumulating. Commonly produced DSPs are halogenated methanes, hydrocarbons, acetonitriles, amines, phenols and acetic acides (Werschkun *et al.* 2014; Menasfi *et al.* 2019; Summerson *et al.* 2019). Up to 462 brominated DSPs can be generated from electrochemical disinfection in seawater (Gonsior *et al.* 2015).

A large proportion of chlorine-dosing DSP production is known to consist of bromoform, which is volatile and evaporates into the atmosphere over periods of days, to weeks. Other products are relatively unstable and degrade over weeks to months (Mass *et al.* 2019). The production rates of bromoform at major shipping ports is considered non-trivial and high enough to raise concerns over potential contribution to ozone layer depletion (Mass *et al.* 2019). The volatile and short half-life of some brominated compounds in the marine environment has been used as an excuse to not consider DSPs as a threatening process. Bromoform can be produced by some biota naturally in the environment and this natural production has also been used as an excuse to exclude it from consideration. Neither excuse is valid based on the empirical evidence, with naturally produced concentrations of bromoform tending to be produced in quantities of nanograms per gram and occurs in concentrations of nanograms per litre (Fogelqvist and Krysell 1991; Goodwin *et al.* 1997). This is thousands of times less than FSRU discharged amounts, which are in the order of 10s micrograms per litre, some 3-4 orders of magnitude difference in concentration (*e.g.* Boudjellaba *et al.* 2016). The emission of brominated DSPs can be at a rate such that elevated concentrations of even volatile substances are elevated throughout components of ecosystems. This evidence is based on empirical observation (*e.g.* Boudjellaba *et al.* 2016) and modelling (*e.g.* Summerson *et al.* 2019).

Although there is common usage of chlorination in seawater, including for ship ballast water treatment and FSRU systems, there has been little attention on actual environmental and human health impacts (Werschkun *et al.* 2014). This is despite the known toxicants and a high degree of uncertainty about the many types of brominated organic compounds discharged. One case study is the Gulf of Fos in France, which has multiple industrial facilities releasing chlorine-dosed waters, including two FSRUs. The two FSRUs produce DSPs above and below that planned for the GIJPP and there was a measured plume concentration of DSPs of 18.6 µg/L and detections of bromoform in the water column up to 10 km away in concentrations from 0.5 to 2.2 µg/L (Boudjellaba *et al.* 2016; Manasfi *et al.* 2019). Put in context, the Canadian guideline value is 0.5 µg/L and the Gulf of Fos study determined seven (7) compound concentrations were above safe levels to the local environment. Considerable concentrations were also detected in sediments and benthic fishes, indicating a pervasive dispersal into bay-wide environments and ecosystems. There was bioaccumulation of 2,4,6-Tribromophenol in conger eels, with a bioconcentration factor of 25 (Boudjellaba *et al.* 2016). The composition of DSPs was different according to the industry, with halophenols more prominent in power station discharges.

The environmental contamination of DSPs from treated ballast water was modelled for selected Australian ports, including the enclosed ports of Melbourne and Geelong and the open area of Port Phillip Bay (Summerson *et al.* 2019). Although the modelling was highly constrained by limited data, the modelling indicated exceedances of guideline limits within enclosed ports for dibromoacetonitrile, monochloroacetic acid and dibromoacetic acid: DSP concentrations are already likely to be at concerning levels in Victorian enclosed ports. The findings for the open waters of Port Phillip Bay were above the established guideline value, indicating this would also be the case for the tidal waters of Westernport. Nevertheless, the modelling showed that DSP discharges are not a trivial matter in Australian waters and this is an issue that needs to transparently addressed in the GIJPP. The modelling only considered existing plausible ballast water discharges and did not include cumulative discharges such as from heated waters from power generators and oil refineries in these ports. The establishment of an FSRU terminal would add to existing DSP discharges in Westernport, including other shipping and the Long Island Point oil refinery.

Direct measurements of acute and chronic toxicity yielded a mixture of findings, depending on the biota and the settings. Toxicity effects are not necessarily related to residual free oxidant levels (*e.g.* Delacroix *et al.* 2013), which means some guideline values may be inaccurate if expressed only the reactive suite of contaminants.

Based on the empirical and modelling evidence, it is reasonable that DSPs can have ecotoxicological effects to raise the potential for DSP contamination as a threat of major concern for Westernport. Although there may be differences in rates and position of production, the Westernport discharges would be into tidal currents for wider dispersal.

The empirical evidence for deposition in sediments indicates toxicants are a risk to the large areas of intertidal mudflats to the north, where there are direct trophic linkages with sediment infauna, surface biofilms and various wetland and migratory bird feeding guilds. The particulate modelling in the GIJPP EES established there are mechanisms for particulate matter to be transported considerable distances from the FSRU (EES Technical Report A, Annexure H Hydrodynamics Modelling Report). Other hydrodynamic modelling indicates water bodies can be transported considerable distances over several tidal cycles, well within the half-life of the volatile and unstable forms of brominated DSPs. This includes models of surface water transport for assessing oil spills and various types of water quality and sediment transport models (Zapata and Langtry 2013; review by Cardno 2013). Another form of ecosystem-wide dispersal is within flora and fauna, including locally migrating squid and fishes, but also from the resuspension and transport of sediment microalgae (tidal suspension of littoral microalgae is a major flow of carbon and energy in Westernport). The other concern for DSP discharges is bioaccumulation and bioconcentration in the food web. There is potential for apex predators to be vulnerable, including higher order feeding guilds of wetland birds, penguins, seals and dolphins.

There is a major knowledge gap about chronic impacts of brominated DSPs in the marine environment and what constitute safe levels, for both the ecosystem and humans. There is very limited information on even acute toxicity with no suitable information from Australia. Recent attempts at establishing safe limits by Summerson *et al.* (2019) were reliant on Northern Hemisphere data. It is recognised there is considerable potential for ecological harm in Canada, and a precautionary guideline value was set at 0.5 µg/L (CCME 1999). The guideline levels of the Australian ballast water modelling used predicted no effect concentrations (PNEC) in the range of 0.0012 to 20 ug/L, depending on the type of DSP compound (Summerson *et al.* 2019) but clearly stated these highly tenuous given the depauperate knowledge. Other major uncertainties and knowledge gaps include the types and concentrations of toxicants produced under varying water quality conditions, including levels of ammonia and organics (*e.g.* Zhang *et al.* 2015). Levels of persistence and biological implications are mostly unknown, however Boudjellaba *et al.* (2016) provided clear empirical evidence of bioaccumulation.

There is adequate empirical and modelled evidence to indicate DSPs discharged from an FSRU would be of high concern to the Westernport ecosystems. The paucity of knowledge increases the degree of concern. Contaminant releases have the potential to affect large areas of Westernport and pervade all components of the ecosystems. Once released, impacts would be irreversible and unmanageable. Impacts could be incremental over time and there is likelihood of synergistic, ‘cocktail effects’. This may include associated effects with other emerging trace contaminants of concern, including pharmaceuticals, antibiotics, endocrine disruptors and plastics. Given the capacity for incremental, irreversible and ecosystem-wide impacts, this is a high consequence issue that deserves considerable attention in any approvals and environmental management process.

4.2.2 EES Consideration of Contaminants

The EES assessment of DSP contaminants modelled the initial discharge and dilution, but was generally dismissive of any subsequent environmental impact. The assessment was confused and patchy in the approach to this issue. On the one hand, any secondary disinfection products were summarily dismissed by claiming the bulk of it would be bromoform. It was claimed bromoform would be non-persistent and non-harmful because it is a naturally occurring substance. This was not supported by evidence, such as that presented in the previous section. The EES presented no corroborating evidence for its assumptions and merely speculates lack of impacts. Despite having made such claims, bioaccumulation was a consideration in the risk assessment, however the risk assessment process was not scientifically valid either. The method was subjective and not scientifically repeatable and there was no rationale or supporting evidence. Much of the dismissal of contaminant impacts was based on the development of an inflated guideline value and truncated modelling and disregard for real-world case studies.

The assessment commenced by establishing a guideline value for environmental concern (EES Technical Report A, Annexure A, Behaviour and regulation of chlorine in waters associated with the AGL Gas Import Jetty Project). This report is very difficult to interpret because of its loose and interchanged reference to potential toxicants and whether some terms are surrogates for others. These include total residual chlorine TRCs, total residual oxidants TROs, chlorine-produced oxidants CPOs, chlorination reaction products. There is no mention of non-oxidative toxicants. The report is also unclear in the language around chlorine guideline values and the degree that the developed guideline value (GV) includes reaction products. Mostly, it refers to the guideline value of chlorine, which is unclear because most ecotoxicity will be caused by brominated compounds. This loose language requires clarification, however the gist of the report appears to be confined to short-term oxidative toxicity, within a mixing zone, and is not concerned with ecosystem contamination.

The chlorine behaviour and regulation report is extremely confined in consideration, it is desktop based and selective with supporting evidence. Also disturbing was the focus on short-term values that are more related to spill or pulse exposures (paragraph 1, page 10), without any consideration for the real-world case of continual, press and chronic type contaminant exposures. It was primarily concerned with mixing zone considerations and measurement of any proscribed mixing zone requirement. This implies the toxicants effects are mitigated or eliminated by dilution and chemical degradation. If toxicants are environmentally persistent or worse, there is bioaccumulation and bioconcentration, then mixing zones are a poor form of environmental management of this issue: management should be around magnitudes and rates of release of brominated compounds (which requires chemical modelling with input of monitored water quality parameters) and environmental condition status (measurement of contaminants in the ecosystem components).

It was concluded that the guideline value (GV) developed for chlorine, of 6 μg/L was not applicable as a threshold for protection against ecosystem contamination impacts. It is noted that the Canadian guideline value was much more conservative, of 0.5 μg/L, with the supporting rationale recognizing ecosystem risks and that there is a complex of toxicants involved with different properties. The modelling by Summerson *et al.* (2019) also recognised that different brominated compounds have greatly different toxicity, albeit from limited information.

The next step of the EES was to use a hydrodynamic model to predict dispersal of 'chlorine' (EES Technical Report A, Annexure H, Hydrodynamic modelling report). The language is vague about whether it is modelling chlorine, residual chlorine, bromine or chlorine produced oxidants. This needs to be clarified because the language could be interpreted as levels of 'chlorine', 'chlorine concentration' and 'chlorine discharge' being a collective term for all chlorine produced oxidants (CPOs) and that this is also a surrogate for all resulting toxicants. Alternatively, the language could be interpreted literally, meaning the modelling results only predict residual chlorinated compounds and not brominated compounds. The differences in environmental consequences between these two interpretations of the language are vast.

The 'chlorine' dispersion modelling results were truncated. The mapped results do not display findings less than 2 μg/L of 'chlorine' (Figures 4.1, 4.2, 4.5, 4.6), with Figure 4.2 not mapping extents below 4 μg/L (the map was truncated).

The dispersion of chlorine-produced oxidants (CPOs), and indeed all potential disinfection secondary products (DSPs) should have been mapped to a range below 0.5 μg/L (the Canadian guideline value) to provide an appreciation of distribution patterns at acute to medium-term toxicity levels and trajectories of exposure to ecosystem components. The mapping should have also been overlaid on maps of biotopes with sensitive features, such as the lamp shell beds which are only found in the Cribb Point region. The modelling results were presented in isolation of biological results, noting there was no identification or maps of sensitive sublittoral biotic features in the EES.

The remainder of the GIJPP EES did not engage further in assessing impacts of toxicant releases. It used a claim that the area above its own guideline value of 6 μg/L was relatively small and no substantial risks were considered. It also used the claim that contamination will be in the form of bromoform which dissipates/evaporates and has no environmental harm because it occurs naturally. As explained above, these assumptions are not valid and contrary to empirical evidence.

The GIJPP EES did not take the opportunity to inform itself from direct observation of brominated toxicant production in Westernport conditions, such as laboratory experimentation on toxicant generation, mesocosm tests, field trials, ecotoxicology tests and the like. There was an opportunity to take measurements and observations from existing and comparable real-world situations elsewhere and to use the existing literature. No such evidence was collected or examined.

The hydrodynamic modelling of particulates, for the entrainment assessment, found there were detectable trends in particulate transport to the northern part of Westernport (EES Technical Report A, Annexure H, Hydrodynamic modelling report). This and other modelling showed that there is potential for contaminants to be transported to large areas of the bay. Decay and dilution may be limited where transport is via sediment adhesion and up-taken by biota. For particulate transport, there is a concerning pathway for settlement onto littoral sediment flats, where much of the biological productivity occurs.

4.2.3 Summary

It was proposed to use chlorine dosing to prevent biofouling within heater exchange units of the FSRU. Oxidated chlorine compounds are changed in seawater to 10-100s of different types of brominated toxicants, many known as carcinogens, mutagens and can bioaccumulate. There is a high degree of uncertainty and paucity of knowledge on ecological impacts associated with release of toxicants from FSRU operations. Despite this, there is enough evidence to demonstrate considerable impacts can and do occur over considerable distances and can pervade the whole ecosystem.

The GIJPP EES did not reflect on existing knowledge and had a narrow focus on conditions in the immediate vicinity of the FSRU. The language and modelling results were vague and truncated. The paucity of knowledge was not improved by the EES studies. The EES concluded there were low environmental risks but the conclusions were not supported by valid science and evidence.

The issue of release of brominated contaminants should be treated as a primary issue because it has the potential to cause long-term, irreversible and ecosystem-wide impacts. The paucity of knowledge exacerbates the level of concern, along with the fact that there are a considerable number of species, communities and ecosystem features of concern with respect to conservation and ecosystem services.

4.3 Marine Pests

4.3.1 Catastrophic Impacts

Marine pests are a major environmental consideration for any shipping and port-related activity. There is a plethora of empirical cases where the introduction of marine pests caused catastrophic and large-scale changes to marine ecosystems and extensive damage to ecosystem services (Katsanevakis *et al.* 2014). Infestations with high consequences happen relatively frequently, highlighting that this issue requires serious attention and management.

Some of the most pertinent case studies are from Victoria and particularly Port Phillip Bay. The sediment communities have been transformed by high biomasses of the introduced bivalve *Corbula gibba* and the Northern Pacific seastar *Asterias amurensis* (Hewitt *et al.* 2004). In the decades following establishment, the resident demersal fish populations went into steep decline and are now but a fraction of normal abundances (Parry and Hirst 2016). The Japanese kelp *Undaria pinnatifida* established in Geelong Arm in the early 1990s and gradually spread eastward and then around Port Phillip Bay. By 2019, nearly all rocky reefs have been permanently transformed, with some patches of natural seaweed assemblages persisting along the eastern shores. The collapse of natural kelp beds and the annual die-back of *Undaria* kelp stimulated an overabundance of sea urchins, leading to a succession of over-grazed barren reefs around the Bay (Hewitt 1999). Port Phillip Bay presents a risk of translocation of pests to elsewhere in Australia and internationally.

Once a pest is detected it is usually well established, especially given there is no effective surveillance program in Victoria. Once established, there is little mitigation that can be done to prevent spread, however there is considerable mitigation that can be done to slow the spread. Attempts to mitigate *Undaria* by diver-hand harvesting at Station Pier and Apollo Bay indicated this could actually increase biomass, probably through stimulating spore release and disturbance to natural biota covering colonization surfaces. Two of the best forms of mitigation that at least slow spread of invasive species are quarantining and protecting the resilience on natural communities. For example, *Undaria* is slow to establish in natural communities until there are disturbance events. In Tasmania, large scale spread occurred following dieback of native kelps from a disease event. Quarantining vessels and equipment from translocating from invested areas to new areas can also prevent spread. It is likely construction vessels were responsible for the spread of *Undaria* to Apollo Bay Harbour during its refurbishment.

Introductions of serious marine pests are continuing to occur under the present management and regulation regime. One of these has been the introduction of *Caulerpa racemose* var *cylindrocarpa* to the Portland harbour, sometime between 2006 and 2010 (Monk *et al.* 2006; Worley Parsons 2010; Werner *et al.* 2012). Such introductions to Apollo Bay and Portland Harbours indicated existing regulations and management are not as effective as they should be, recognizing that no amount of regulation can eliminate marine pest translocation.

There are a raft of known marine pests that could cause ecosystem-wide changes to Westernport, if introduced there. Examples include *Sargassum muticum*, *Caulerpa taxifolia* and *Caulerpa racemose* (Bulleri *et al.* 2010; Salvaterra *et al.* 2013). Any pest that alters the habitat structure and food web of the littoral sediment flats would be devastating to migratory bird populations.

The proposed GIJPP would involve construction and operation activities that increase the potential for marine pest introductions. Given the potential consequences, this threat needs to be addressed comprehensively. Because there is little scope for mitigating the damage to ecosystems once particular pests are established, it is essential that decisions and approvals are cognizant and responsible for this risk.

4.3.2 EES Consideration of Marine Pests

The GIJPP EES makes no evaluation of potential marine pest consequences and prevention measures. There is no identification of potential catastrophic outcomes and does not attempt to identify vulnerabilities of Westernport to potential invasive species. For example, the vulnerability of *Caulerpa* species was not addressed. The vulnerability of Westernport to pests cannot be addressed without examining the type and distribution of existing biotopes. It is noted the existing conditions reporting was only concerned with mapping from their own surveys, and did not include any prior mapping work which included Caulerpa, biogenic reefs and epibiota that may be sensitive to marine pest invasions.

The ample empirical evidence of catastrophic ecosystem affects and ongoing introductions, including within Victoria, should have resulted in a serious level of concern within the risk rating method. That marine pest risks were rated as less of an environmental risk than short-term terrestrial construction noise is a clear example of the inadequacies of the risk assessment of the EES in general.

The GIJPP EES skips over ecological concerns of marine pests and makes the claim in several places that existing regulations and procedures mitigate this risk (pages 74 and 79, Matters on National Significance Report). This is not supported by the empirical evidence, given the ongoing introductions and the fact there is not a formal surveillance program. Additional risks introduced by the GIJPP require extraordinary attention to:

- Transparency around potential hazards and outcomes, including explicit exploration of potential outbreak species and ecosystem changes;
- Additional practices and procedures for prevention of translocation;
- Protection measures for existing natural biotopes from other types of impacts to maximise resilience to invasive species; and

- a preparedness to respond to catastrophic ecological outcomes should an event occur.

The treatment of such risks is established practice for other catastrophic hazards such as for oil spills and transport of oil and gas products. This practice should also be expected of equally catastrophic but higher likelihood events such as for marine pests.

4.3.3 Summary

Marine pests are a critical consideration for any activity involving shipping, ports and other maritime operations. There is a plethora of case studies of invasive species causing large scale and permanent ecosystem transformation and collapse. The level of environmental concern (= risk) is extremely high because of the catastrophic consequences and the frequent occurrence, as evidenced in Victoria and elsewhere.

The GIJPP EES excludes consideration of potential consequences and fails to consider learnings from the empirical evidence. The treatment of marine pests in the risk assessment highlighted failings of the EES risk assessment method in general.

Environmental decisions, approvals and ecosystem-based management should be thoroughly informed about marine pest considerations. Such information is not provided in the GIJPP EES.

4.4 Shipping Incidences

4.4.1 Catastrophic Impacts

The GIJPP project would increase the level of shipping operations in Westernport and also includes the management of dangerous goods. The project will therefore lead to an increase in the likelihood of an event occurring and there is the potential for catastrophic events to occur. The most extreme of these are a large oil spill which is transported large areas of littoral habitat and release of LNG into the environment with either a vapour pool fire or explosion.

There is considerable evidence for potential of catastrophic consequence events to occur associated with maritime incidences and major oil spills. The potential area of impact has been modelled for some scenarios in Westernport (Zapata and Langtry 2013) and the potential ecological impacts have been well documented (Chang *et al.* 2014). A major oil spill event and ecosystem impact is not an unlikely event, as evidenced by the Iron Barren spill into the Tamar estuary (ATSB 1995). Although neither the FSRU or LNG transport vessels would carry appreciable volumes of oil to spill in an incident, there is reasonable potential for them to be involved in another vessel that is carrying appreciable oil volumes. It is noted that an oil refinery is located upstream of the proposed FSRU facility, so the potential for such interaction and incidents in Westernport exists.

There are also risks around the LNG transport, transfer and storage in Westernport. Although LNG has a much better safety record than other petroleum products, it remains a dangerous product and the variety of hazards to the environment should be transparently assessed and communicated. Potential environmental risk events associated with LNG include:

- Cryogenic and asphyxiation of wildlife from a vapour pool over water to the littoral zone;
- Pool fires - zones of thermal radiation in the event of a pool fire and the type of event that could lead to impacts on littoral wildlife in the vicinity of the FSRU (for example a hole size of 5 m2 could lead to a pool of 330 m diameter with a thermal hazard radius at 5 kW/m2 of 1305 m from the FSRU – what wildlife are expected within that radius?
- Fire balls from pool fire - what would be the impact radius of a fire-ball incident?
- Detonations – although difficult to achieve what scenario could achieve it and what wildlife would be exposed to the shockwave?
- BLEVE – what situations could lead to boiling liquid expanding vapour explosion?
- Jet fires – where could these occur with respect to wildlife sites?
- How are such extreme events controlled for and what are spatial risk zones with respect to a FSRU siting in Westernport?

Regardless of risk mitigation, incidences can still occur. Minor ship groundings occur in Victoria every few years and collisions with smaller vessels are not rare. Major incidences that would be classed as rare do occur in Victoria. For example, a gale caused the anchor of the APL Sydney to start dragging in Port Phillip Bay. The vessel started dragging its anchor along the seabed towards the ethane subsea pipeline. The vessel was not permitted to start its engines and be underway without a pilot and there was not a pilot available. There was a mechanical failure in the winch so the anchor could not be lifted over the pipeline and it ruptured the pipe and caused a gas release event and seabed disturbance. The vessel could not then start its engines because of the ignition risk. Such multiple failures, including advance failure to perceive and manage potential hazards, such as having anchorages near the pipeline and not having emergency pilotage, shows there should not be any complacency around imagining and managing events at any level of likelihood (ATSB 2010).

Although it is recognised that likelihoods of serious incidences are very low, this is partly because of close attention to managing such risks and there must be assurances that such management would not become complacent. No safety officer manages risks by claiming likelihoods are too low to worry about – the consequences are the starting point. Close attention to managing such risks requires acknowledgement and understanding of potential hazards and their causes. If these are not transparently communicated then there is little assurance for the control of those risks. Such communication is expected in the GIJPP.

Decisions and approvals require deliberation of all potential incidence types and the potential consequences and responsibilities associated with accepting such risks.

4.4.2 EES Consideration of Major Incidences

The GIJPP EES has a few sentences scattered through the documents acknowledging a major oil spill could have major consequences over wider areas, but there was no proper evaluation. Major oil spills were scoped out of the assessment with a claim that neither the FSRU or LNG cargo vessels would carry appreciable volumes of oil. The assessment was negligent in that it did not foresee any interaction with other vessels, including any traversing to/from the Long Island Point oil terminal. The potential for a major oil spill was essentially ignored.

Other types of risk, such as vessels breaking from berthing moorings while transferring LNG, collisions with the FSRU at the berth were not explicitly identified and addressed, although some are indirectly, such as a jet fire starting by the FSRU suddenly parting from its berth (EES Technical Report K, Safety, hazards and risk assessments). The EES assessment of LNG release and fire incidents was brief, vague and partly illegible, such as the maps of zones of predicted thermal radiation (*e.g.* Figure 13-4, Appendix C, EES Technical Report K, Safety, hazards and risk assessments). It is notable that there was no incorporation of the research and evidence on LNG related risks and modelling of incidents.

There was no linking of LNG related incidents to the wildlife of Westernport, particularly the littoral fauna that would have unobstructed exposure to any events around the FSRU.

The GIJPP EES uses existing regulations and protocols as a mitigation measure for any oil spill, LNG spill or other maritime incident, especially in the matters of national significance report and the risk assessments. There is no explanation, or evidence, of how the likelihoods and consequences of existing practices mitigate risks to levels below other minor environmental risks, such as temporary construction noise. As with the marine pests risk assessment, major oil spills were ignored in the risk calculations of the EES.

The lack of transparency and concern for high consequence risks, regardless of likelihood, possibly reflects on a degree of complacency. As noted above, the evidence shows complacency and failure to address high consequence possibilities leads to reduced vigilance and a higher likelihood of such events occurring. The APL Sydney-ethane pipeline event is evidence of this.

4.4.3 Summary

The GIJPP was incomplete in its assessment of potential high-consequence incidences, such as major oil spills and LNG dangers. There was no clarity with respect to potential concerns for wildlife and ecosystem. There was a down weighting of concerns on the basis of existing regulations and practices, however the evidence indicates there should not be complacency in such matters.

Environmental decisions, approvals and ecosystem-based management should be thoroughly informed about major incident risks, including oil spills and LNG vapour and fire events. Such information is not provided in the GIJPP EES.

4.5 Direct Impacts on Species and Biotopes

4.5.1 Hydrographic and Seabed Disturbance

The proposed FSRU operation would create changes to the hydroforms and geoforms in the FSRU location, possibly through pressures such as:

- Changes in temperature;
- Heater exchange diffuser flows (density and kinetic);
- Seabed scouring from discharge flows, propeller scour and deflection of tidal currents;
- Resuspension of sediments and turbidity plumes.

It is expected these combined physical changes to the environment would lead to changes in the nature and distributions of biotopes on the seabed and in the water column. The North Arm channel seabed has a high diversity of sediment biotopes (Edmunds and Flynn 2018), including:

- Bare sediment with various burrowing and tube-dwelling infauna assemblages, including ghost shrimps;
- Sediment with epibiota, such as lamp shell beds, seapens and scallops;
- Sediment biogenic reef, including mussel, ascidian, sponge and bryozoan clump habitats;
- Sediment green algal Caulerpa mats of different structural types (*C. cactoides c.f. C. scalpelliformis*); and
- Seagrass beds of *Halophila australis* and *Zostera nigricaulis* on shallower banks (and *Amphibolis* to the south at Tortoise Head).

There are species of high conservation concern that need to be addressed specifically. These not only include listed species, but species with high vulnerability to threats, such as the lamp shell *Magellania flavescens*. This species is highly restricted in distribution and the only known extant population in Victoria is in the Cribb Point region. Different species and biotopes are expected to have different susceptibility and impact responses to different combinations of physical effects.

The assessment of impacts on species and biotopes require mapping of distributions, determinations of susceptibilities to pressures, comparison with mapping of predicted mapping of physical effects and a consideration of the implications of predicted impacts.

4.5.2 Recruitment Shadow

There are impact pathways for affecting the migration and recruitment of planktonic flora, fauna and larval life phases of benthic species. These pathways include barrier effects to movement of adults and planktonic life phases, the entrainment of planktonic forms into the FSRU heater exchange, and temperature and toxicant effects of secondary disinfection products released from the FSRU.

4.5.3 Movement Barrier and Behavioural Disturbance

North Arm has a high diversity of stationary species, biotopes and habitats that require consideration of direct impacts at that location. North Arm is effectively a linear channel that connect northern and southern ecosystem components and processes. One of these ecosystem connections is the movement of biomass and populations. Mobile squid, sharks and fishes traverse back and forth through this area. Such mobile fauna comprise a variety of trophic guilds in the Westernport food web. Movements do not occur randomly through the cross section of North Arm – particular species have a particular affinity for particular biotopes and geoforms. Some will prefer the deeper channels; others have an affinity for shallow fringes.

There is reasonable evidence that the FSRU could cause changed behaviour and restrictions of movements to faunal groups (*e.g.* Payne *et al.* 2015; de Jong *et al.* 2020). Any disturbance to school shark *Galeorhinus galeus* breeding females or pups would be of conservation concern as Westernport is one of only a few pupping sites. There could also be potential consequences to biomass, production, functional guilds and food-webs. Impacts to connectivity via North Arm could have ecosystem-level impacts across broad areas of Westernport (Allen and Singh 2016). There are two processes that could disrupt movement in North Arm:

- Change of benthic biotopes and habitats and cues that act as movement, foraging and safe habitat stepping stones; and
- Behavioural disruption and barriers including visual, light, noise, vibration, odour, toxicant, temperature, turbidity and other cues.

4.5.4 EES Consideration of Impacts on Marine Species and Biotopes

The GIJPP EES invested effort into a literature review of natural values and field ground truthing of the present distribution of some species of concern. It should be noted that much of the literature information was decades out of date. Little of the literature or field study information was used for the impact assessment. In addition to this, the GIJPP applied no explicit impact assessment of any species, biotopes or any other specific biotic feature.

Key failings of the biological impact assessments included:

- No coherent mapping of species and biotopes of concern that could be compared with modelled physical effects (disjointed mapping of points and lines were presented but not used);
- No examination of sensitivities of each specific biotic component that could be impacted;
- No specific prediction of impacts or changes to biotic components, except for entrainment of plankton;
- No specific evaluation of the potential consequences of potential biological impacts;
- Little to no supporting evidence or learnings from analogous case studies (there was no inclusion of information on biological impacts from the literature).

Instead, the GIJPP EES only considered ***some*** of the impact pathways described above (which was not a definitive list) and rolled all assessments up into generalised biotic groupings. Groupings such as 'Soft Substrata' and 'subtidal invertebrate fauna' were used as a surrogate category for all the diverse types of sediment assemblages in the region and assumed all had the same impact sensitivities and risk profile. Predictions of physical impacts were used as surrogates for biological responses. The EES did not discuss the ecological implications of any biological impacts.

The GIJPP EES biological assessment placed an overwhelming emphasis on the risk assessment. As discussed previously, the risk assessment was subjective, selective and unreliable. The risk results cannot be considered credible without providing specific biological impact analysis to support assignment of consequences levels. Such impact analysis was absent from this EES. Related issues to determining impacts on species and biotopes were:

- Absence of consideration of knowledge gaps and uncertainty;
- The covering of uncertainties by speculating a favourable situation to be true, such as claiming there must be populations of the rare ghost shrimp *Michelea microphylla* somewhere else.

4.5.5 Summary

There is a considerable diversity of species and biotopes in the North Arm region and each of these have differing susceptibilities to different impact pathways. Some are high priority ecological features and some are of high conservation concern.

The GIJPP EES did not have any specific biological impacts consideration, despite anything presented in the existing conditions section. Only some impact pathways were selected and considered, in isolation. The assessment was over-generalised and made few actual biological predictions. There was a reliance on the risk assessments which have been scientifically invalidated.

Without specific biological attention, there is little prospect of higher-level considerations of ecosystem-based and cumulative impact assessments. There can be no claim to ecologically sustainable development.

Environmental decisions, approvals and ecosystem-based management should be thoroughly informed about specific biological impact predictions and the potential ecological consequences. The GIJPP EES was over-generalised, selective and avoided any comprehensive and direct consideration of marine biological impacts.

4.6 Ramsar and Wetland birds

4.6.1 Ecosystem Values

The activities proposed for the GIJPP would be within the Westernport Ramsar wetland site. This site has a plethora of highly valued species and ecological features, including with respect to conservation, ecological functioning and ecosystem services (DELWP 2017; Edmunds and Flynn 2018). The multitude of values reflect the high diversity of habitats and species in addition to a high degree of uniqueness. Examples of the wide range in types of conservation and functional values include:

- Key breeding area for elephant fish *Callorinchus mulii* and school shark *Galeorhinus australis*;
- Three types of listed communities include diverse intertidal molluscs (San Remo), *Macrocystis* kelp bed (The Knobbies, but now extinct) and coastal saltmarsh (throughout Westernport);
- Non-listed communities unique to Westernport, including Rhyll basin bryozoan reefs, Cribb Point lamp shell beds, North Arm seapen beds, Rhyll rhodolith bed, Crawfish Rock sponges (North Arm), Corinella sponges, intertidal *Caulerpa* beds (northeast flats);
- Key area for migratory wetland birds, all of which are listed;
- Significant populations of resident wetland, shore and seabirds;
- Expansive littoral (intertidal) mudflat areas with high energy production by sediment microalgae and export to Victorian marine systems;
- Expansive, high production *Amphibolis* seagrass beds; and
- Harvesting, recreational and cultural ecosystem services.

It is an expectation of the GIJPP EES that each of the types of priority marine features in Westernport are examined explicitly.

4.6.2 Wetland Bird Trophic and Habitat Guilds

The wetland birds of Westernport include State and Nationally listed resident and migratory species, as well as non-listed species that are still covered by Ramsar listing. The range of wetland bird species in Westernport form a range of different guilds that are related to their size, habitat and role in the food web (Hansen *et al.* 2015). Examples of the Westernport bird guilds include:

- Coastal hens, rails and coots;
- Small shorebirds;
    - Small sandpipers - biofilm feeding, water less than 5 cm;
    - Plovers - epifauna feeding;
- Middle and large shorebirds - water up to 15 cm;
    - Large fauna;
    - Infauna guilds;
    - Molluscs;
- Dabbling ducks (30 cm deep);

    - Invertebrates and macroalgae;
- Swans – feeding to 30 cm deep;
    - Littoral seagrass and some macroalgae;
- Large waders (to 30 cm deep);
    - Piscivores;
    - Invertebrate feeders;
- Diving waterbirds;
    - Surface divers such as cormorants, grebes;
    - Aerial divers such a terns;
- Raptors;

Each of these and other guilds have different functional influences in the ecosystem (*e.g.* Piersma 1987; Moriera 1997; Liordos 2010; Hansen *et al.* 2011; van Dusen *et al.* 2012; Kuwae *et al.* 2012; Bocher *et al.* 2014; *Drouet et al.* 2015). Some have strong top-down predator and grazing influences that influence seagrass distribution and sediment invertebrate population structures. Other guilds are driven by bottom-up processes such as selection of feeding sites with increased prey accessibility and movement between feeding areas according to bathymetry, tide height, weather and food resources.

Consequently, wetland birds do not form a single entity for any conservation or environmental effects assessment. Instead, there are markedly different groups that respond differently to environmental drivers, activity-pressures and ecosystem changes. These different groups require separate consideration in the GIJP EES.

4.6.3 Ramsar Management Priorities

Much of the management is centered around the ecological integrity of the wetlands, including functioning and habitat provision (DELWP 2017). Management is from the perspective of both threats / pressures and outcomes with good environmental condition. The Ramsar Site Management Plan lists high-level threats that include pressures: pollution, invasive pests and commercial development. Priority high-level values include seagrass, mangroves, saltmarsh, sand and mudflats, rocky reefs, waterbirds and fish (Figure 4.1). The present Ramsar site management plan invokes the requirement for ecosystem-based management, management of multiple sectors and control of cumulative and synergistic impacts. This management approach was subsequently enshrined in the Marine and Coastal Act and associated Policy.

Threats and pressures associated with the GIJPP coincide with those for Ramsar ecosystem management. Both these and the identified priority values require specific evaluation within the GIJPP EES. The assessment of impacts on Ramsar values requires an ecosystem-based approach.

4.6.4 Ecological Character and Ecosystem Model

The Ramsar Convention terminology uses the term ‘ecological character’ to encompass the combination of the ecosystem components, process and benefits/services that characterise the wetlands at a given point in term. The objective is to protect against adverse alteration to ecological character, which encompasses any ecosystem component, process and/or ecosystem benefit/service. The assessment of environmental effects to Ramsar ecological character therefore requires ecosystem-based assessment of each of the potential pressures of the GIJPP against each of the potentially sensitive components of the ecosystem. This type of assessment requires at the development of an ecosystem model and then its application for ecological predictions.

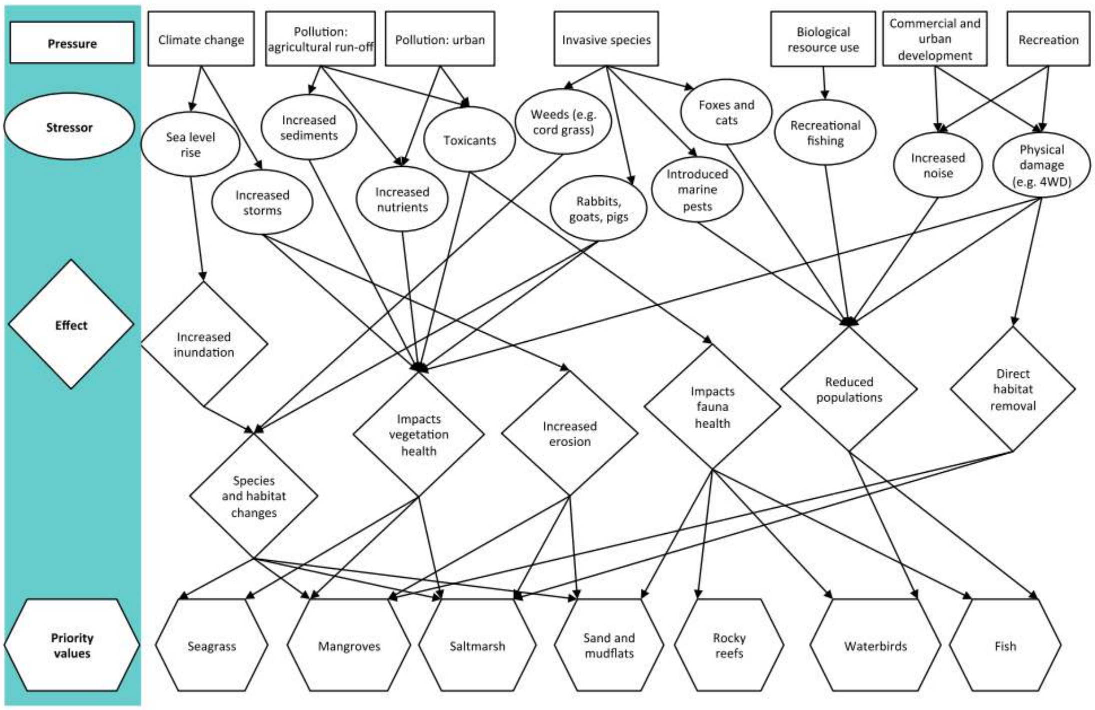

Figure 4.1. High priority components for management of the Westernport Ramsar Site (Figure 8, page 35, DELWP 2017).

4.6.5 EES Consideration of Ramsar Wetland Values

The Matters of National Significance Report provides lists of listed species and an overview of some of the Ramsar ecological values. It also lists types of changes that would be considered significant impacts (page 18). These criteria include aspects such as deterioration of quality of habitat, decrease in population size, disruption of breeding cycles, etc. Despite identifying the requirements of the effects statement, there was no direct assessment and prediction of each of the identified values. Much of the impact assessment avoided mention of any specific Ramsar values, and did not predict what impact responses might occur and how that would compare with their criteria for significant impacts.

The Marine Biodiversity Impact Assessment report acknowledged the significance of Ramsar features and went to considerable length to describe why Westernport was listed. The combined risk and impact assessment of the marine assessment reduced any specificity to a narrative of the intersection between selected pressures and broad habitat types. There was no account of sensitivity of specific biological components or any ecosystem-related effects.

The Terrestrial Biodiversity Impact Assessment report diverted much of its Ramsar site assessment to the marine assessment. Much of the information in this document (Section 7.1.5) diverted to historical ecosystem changes rather than prediction of changes associated with the GIJPP.

The GIJPP EES had no specific treatment of any of the key species, communities and ecosystem components of the Ramsar wetland. This is despite acknowledging some of key requirements in the Matters of National Significance Report. The only predictions for biological components were in the risk assessment, however this assessment rolled the features up into overly broad categories. For example (page 54):

- FF 19 - Construction activities impact on the character of Western Port Ramsar site;
- FF 07 - Operational activities impact on the character of Western Port Ramsar site;
- ME 7 - Entrainment impact on values of the Ramsar site;
- ME 37 - Chlorinated water from discharge plume impacts value of the Ramsar site.

The GIJPP EES presented no ecosystem-based modelling, prediction and assessment. Given the intricacies of the Ramsar ecological character and the many listed resident and migratory birds, a modicum of sophistication would be required to properly assess impacts on Ramsar values.

4.6.6 Summary

Westernport is a listed Ramsar site with many listed resident and migratory bird species. There is a requirement to protect both the listed species and the ‘ecological character’ of the site. These species and features encompass many aspects and functions of the ecosystem, with each component being sensitive to different aspects of the GIJPP project.

The GIJPP EES identified and listed the need to address the Ramsar wetland values and listed species, particularly the migratory birds. The EES contained no specific predictions of impacts on these species and ecosystem features. The assessment on Ramsar features was confined to some impact pressures for some high-level groupings and habitats and there was no attempt at a wholistic ecosystem assessment.

4.7 Ecosystem-Based Assessment

4.7.1 Ecosystem Assessment

It has been explained in previous section that ecologically sustainable development requires management at the ecosystem level. This is not only contemporary best practice, it also a requirement in accordance with the Marine and Coastal Act and for management of Ramsar site wetland values. Any impact assessment requires modelling to predict responses and ecosystem-level impact assessments require ecosystem-level models.

4.7.2 Socio-Ecological Model

Ecosystem-based assessment requires modelling that encompasses drivers and pressures arising from the proposed development. It also requires the information on the sensitivity and responses of the ecosystem components and the network of links and influences to key features of concern. Implications of ecosystem impacts are assessed according to indicators of good environmental status and ecosystem services. The model must be reflective of real-world conditions and have some level of predictive power for assessing impacts. The model must also account for uncertainties and knowledge gaps. There are a variety of modelling approaches to support ecosystem-based management (EBM; see example references in Section 3). There have been considerable advances in algorithms and computing tools to support EBM.

4.7.3 Ramsar Components

Given the need to address Ramsar values and the associated wetland birds, the ecosystem model should reflect the relevant species, trophic guilds, biotopes and processes that could influence Ramsar 'ecological character'. It is well documented that predicting impacts on wetland birds requires a consideration of energetics. Impacts are mostly manifested as reduced breeding success or reduced migration survival through various impacts on energy intake (foraging rates, food quality, roosting digestion, etc.) and energy expenditure (flight between foraging areas, disturbance escape, predator escape, etc.). Pressures of noise, light, visual disturbance, access to feeding areas, prey quality, habitat suitability, pests and the like can be determined through energetics models (Piersma 1987; Le V. dit Durell *et al.* 2005; Rogers *et al.* 2006). There are a variety of examples and precedents for ecosystem modelling of impacts on wetland values (*e.g.* Nelitz *et al.* 2015; Goss-Custard and Stillman 2008).

4.7.4 Cumulative, Incremental and Synergistic Impacts

One of the benefits of a wholistic ecosystem-based approach is the ability to provide insights into cumulative, incremental and integrated impacts (*e.g.* Figure 4.2). Such impacts cannot be determined from an atomised approach where different physical or chemical effects are examined separately from each other. An ecosystem-based model is required to assess combined and multiple pressures as well as secondary impacts through the ecosystem and up food chains (Westbrook and Noble 2013; Murray *et al.* 2014; Nelitz *et al.* 2015; Hammar *et al.* 2020).

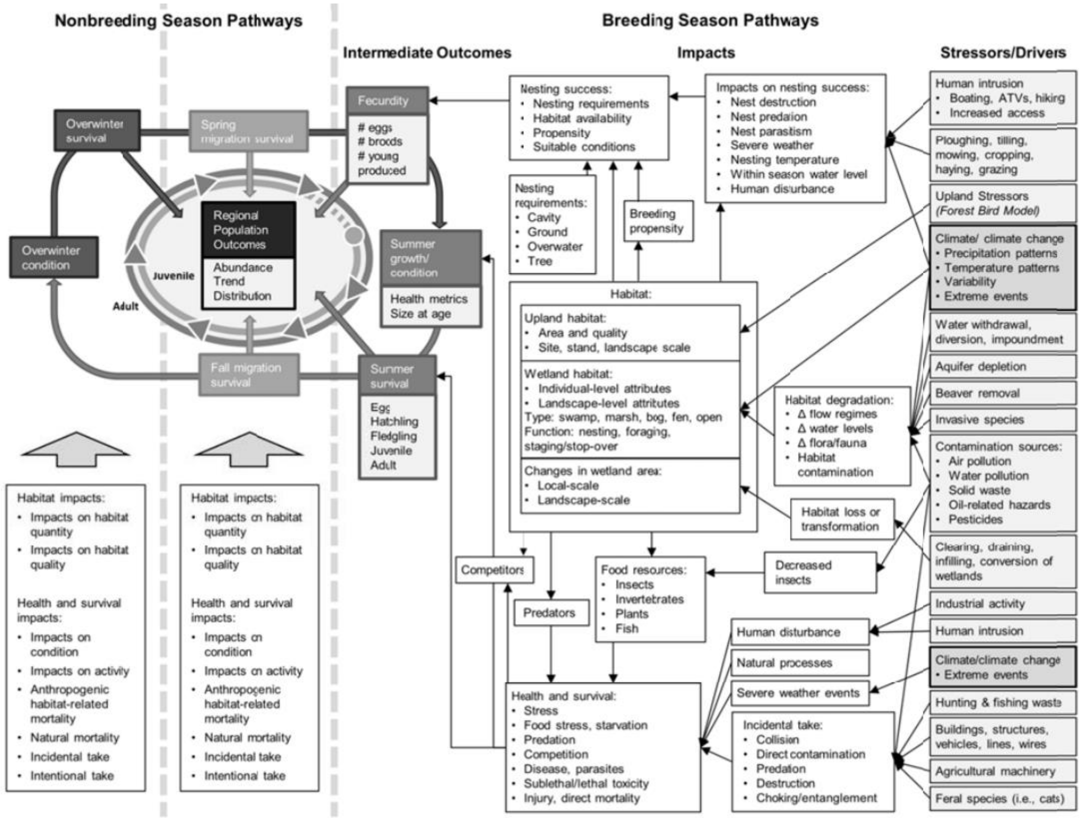

Figure 4.2. Example conceptual model combining cumulative impact pressures into a mechanistic wetland bird energetics model (Nelitz *et al.* 2015).

4.7.5 EES Ecosystem Assessment

The Matters of National Significance provided no ecosystem-level modelling, prediction and appraisal.

The Marine Biodiversity Impact Assessment report provided a brief introduction to some ecosystem components in the risk and impact assessment section (Section 7.2, Integrated Ecosystem of Western Port, page 306). This information did not connect to that provided in the existing conditions sections. A conceptual model of the ecosystem was presented with some generalised trophic pathways (Figure 4.3). The conceptual model excluded key pathways of matter and energy, particularly primary production by sediment microalgae and the large biomass and energy transfer through the bird trophic guilds. This means the conceptual model was incapable of addressing Ramsar features. Although a conceptual model was presented, it was never actually applied for impact assessment. There was no linkage of activity-pressures to the model and there was no tracing of pathways at any point in the impact assessment to examine cumulative impacts or higher-order trophic effects. Despite the conceptual model having over-generalised components, the categories of risk assessment were generalised even further into a single group of ‘benthic invertebrates’.

The GIJPP EES did not assemble a model that could be used for wholistic ecosystem-based assessment. The EES had no formal means to inform on Ramsar site values and management, address cumulative impact processes and ensure ecologically sustainable development.

There were a variety of sections within the EES that purport to address cumulative impacts. In the Marine Biodiversity Impact Assessment Report, this was predominantly in Section 8.5 (page 445) where there was a selection of some combined pressures. The five selected considerations were arbitrary and without rationale and were addressed by a subjective narrative rather than evidence-based analysis. No supporting data or empirical evidence was supplied, nor was there any structured modelling to predict potential impacts.

The Matters of National Significance Report repeated some of the marine impact report for cumulative impacts. It made no attempt to address cumulative impacts on Ramsar wetland birds. The Terrestrial Biodiversity Impact Report considered cumulative impacts on selected species (Section 7.1.6, page 181), but did not place any of the predictions or narrative in context with the overall population status and threats to these species, focusing only on some selective aspects.

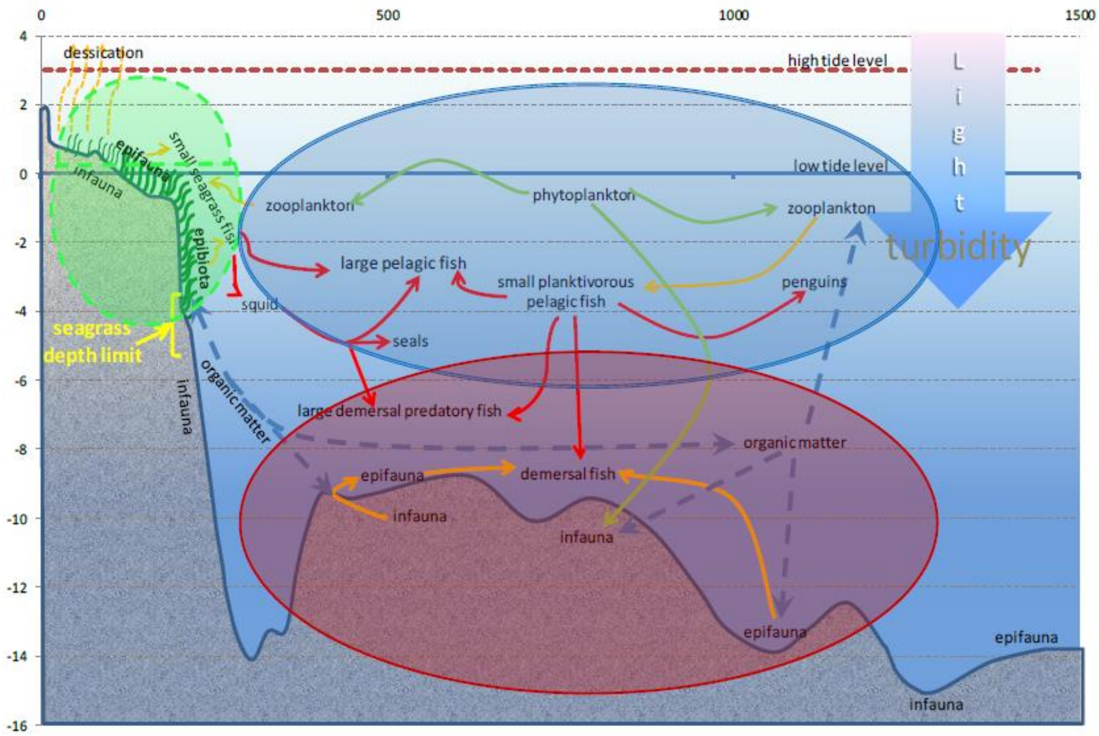

Figure 4.3. GIJPP EES ecological conceptual model proposed in the Marine Biodiversity Impact Assessment Report (Figure 7-3, page 307, Marine Biodiversity Impact Assessment).

4.7.6 Summary

Ecosystem-based modelling for impact assessment is both best practice and a present requirement in accordance with the Marine and Coastal Act and for Ramsar site management. There have been considerable advances in recent years to support ecosystem-based, wholistic environmental management.

The GIJPP EES does not address integrated or wholistic ecosystem impacts in any contemporary manner. There was no consideration of ecosystem processes that link to activity pressures and there was no rational development of an ecosystem model for use in prediction or ecologically sustainable management. The sections on cumulative impacts were not in context with ecosystem processes, a model or supporting evidence and rationale.

5 Conclusions

5.1.1 Competency of the EES

The methodology of the GIJPP EES was fundamentally flawed such that the findings cannot be considered scientifically valid. Key issues were:

- Inconsistency with contemporary best practices, including wholistic ecosystem assessment;
- No transparent structure as to how the EES scoped and selected the issues to address – there was apparent bias in the selection of impact pathways;
- The existing conditions information was not applied to the impact assessment;
- Reliance on a subjective, opinion-based risk assessment method with no impact assessment input or supporting evidence;
- Physical effects modelling was not extended to biological modelling.
- Arbitrary application of mitigation measures to reduce perceived risk, without evidence basis;
- Proposed environmental management framework with no objective or strategy for ongoing management for good environmental status; and
- No consideration of knowledge gaps, uncertainties and degrees of accuracy and confidence

The treatment of specific biological issues was particularly concerning, including:

- Avoidance of biological impact prediction in the EES, including the nature of species and community responses and the magnitudes and extents of change;
- Selectivity and ambiguity in the impact effects that were assessed;
- Dumbing-down and selectivity of the biological groupings in the assessment;
- Exclusion of existing empirical evidence for biological impacts, such as case studies on FSRU impacts elsewhere;
- No local (Westernport) studies to understand and model ecosystem-related impacts;
- No evidence-basis for predictions, with the bulk of the findings relying on the non-scientific risk assessment;
- No wholistic ecosystem approach.

The structure and implementation of the GIJPP EES had no scientific rigour and the information cannot be considered reliable for environmental decisions and management. Most of the assessment was opinion-based and without supporting evidence. The 'favourable' findings of the EES should be considered with a high degree of caution and skepticism, especially given the lack of transparency and repeatability.

5.1.2 Potential for Environmental Harm

The GIJPP has the potential to cause severe biological and ecological impacts over large areas and may be irreversible. The EES avoided addressing the most concerning impact pathways and the associated empirical evidence.

Key biological issues not addressed in the EES but require assessment include:

- Catastrophic consequences of shipping incidences resulting in a major oil spill and potentially LNG releases;
- Introduction of invasive marine pests, in the context of existing evidence;
- The production and release of secondary brominated contaminants from chlorine disinfection;
- Specific impacts on the variety of benthic species and biotopes in and around the FSRU facility;
- Potential for barrier effects on behaviour and movement of fauna, with implications for wider ecosystem processes;
- Specific impacts on the variety of Ramsar natural values and listed bird fauna, including attention to habitat and trophic guilds and varying types of sensitivities and linkages between guilds; and
- Wholistic, ecosystem level assessment that also facilitates cumulative impact assessment, ecosystem-based management and ecologically sustainable development.

The release of brominated contaminants is a major issue, with empirical evidence of pervasive contamination of the ecosystem over distances of up to 10 km. Given the existing evidence, there is a need to address potential toxicant impacts on flora and fauna within a considerable distance from the proposed Cribb Point FSRU.

The combined effects of the FSRU operations and discharges, including temperature changes, toxicants, sediment disturbance has the potential to affect a high diversity of different community types on the seabed. Some of these communities are unique and only documented in the Cribb Point area, such as the lamp shell beds. The combinations of noise, vibration, lighting, odour, discharges and seabed habitat changes may result in behaviour barrier effects on movement with potential larger scale ecosystem implications. These types of impacts were not considered in the EES.

The EES was clearly lacking any formal and specific consideration of ecosystem effects. This is needed to address potential impacts on Ramsar ecological values and listed species, including migratory birds. There are foreseeable impacts on these values, especially if there are impacts on bird energetics such as from noise, lighting, visual presence or even subtle changes to prey availability and accessibility. Bird trophic guilds form critical parts to the functioning of Westernport ecosystem as a whole. There are considerable wider spatial linkages in the ecosystem, such as through tidal current transport and faunal movement and migration. There are pathways for the FSRU to have broader ecosystem impacts. The EES only considered a selection of atomised impact processes in isolation of ecosystem linkages.

Given the known tight linkages in the ecosystem, wholistic ecosystem effects should be transparently assessed. This also permits an evaluation of cumulative impacts and the implementation of ecosystem-based management, neither of which were properly addressed in the EES.

5.1.3 Conclusions

In conclusion, the methodology of the EES was not scientifically valid and there was a high degree of subjectivity, selectivity and bias. The findings were not supported by empirical evidence.

The GIJPP has the potential to cause significant environmental and ecological harm however critical biological impact assessments were absent from the EES. There are considerable knowledge gaps and uncertainties that need to be addressed and this should be done using best-practice, wholistic ecosystem-based methods.

6 References

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7 Appendix A – *Curriculum Vitae*

Dr Matt Edmunds

Principal Marine Ecologist

Academic Qualifications

1987-1990	Bachelor of Science (Honours), First Class, University of Tasmania Major: Marine, Freshwater and Antarctic Biology Thesis: The Community Ecology of Fishes on Tasmanian Rocky Reefs.
1991-1995	Doctor of Philosophy, Zoology, University of Tasmania Thesis: The Ecology of the Juvenile Southern Rock Lobster, *Jasus edwardsii* (Hutton 1875) (Palinuridae).

Certifications

- AMSA Coxswains Certificate, Port Phillip Heads Local Knowledge Endorsement
- Marine Radio Operators Certificate of Proficiency
- CASA Aeronautical Radio Operator Certificate
- CASA Remote Pilots Licence
- NASDS Master Diver
- ADAS Australian Commercial Diver Part 1
- ADAS Certificate IV Occupational Diving Dive Supervisor
- CMAS International Certificate for Scientific Research Diving
- DAN First Aid and Oxygen Provider
- WorkSafe OHS Construction Induction – White Card

Employment

1999-present	Director, Australian Marine Ecology Pty Ltd
1990-1999	Marine Biologist, Consulting Environmental Engineers Pty Ltd
1990-1995	Teaching, Department of Zoology, University of Tasmania
1990-1991	Technical Officer, Tasmanian Division of Sea Fisheries
1989-1990	Technical Officer, CSIRO Division of Fisheries
1988-1989	Research Assistant, University of Cambridge

General Expertise

Dr Edmunds is a director of Australian Marine Ecology Pty Ltd. He has specialist expertise in coastal ecological investigations and he has been designing and implementing research and monitoring programs for 30 years. His work encompasses a broad range of ecological topics, including community-environment relationships, taxonomy, population dynamics and environmental impact assessment.

Dr Edmunds has substantial experience in experimental/sampling design and analysis, in addition to a strong practical background in underwater sampling techniques. He has extensive field experience, including thousands of research dives in cold and challenging conditions and implementing state of the art underwater robotics surveys. He is predominantly involved with quantitative underwater visual census and robotics imaging and acoustic surveys. He has been at the forefront of long-term monitoring and assessment of communities and ecosystems for marine protected areas, dredging and outfall-related activities. He is also actively involved in population and ecosystem dynamics modelling and implementing natural resource management systems.

His work in environmental consulting has focussed on the ecological assessment of wastewater discharges, dredging, port development and other disturbances, as well as the assessment of natural spatial and temporal variations in fished populations and reef communities. These assessments encompassed: intertidal, shallow and deep benthic biota; infauna; pulp-mill and sewage discharges; aquaculture facilities; dredging; sediment smothering; underwater rock falls; fishing impacts; before-after-control-impact designs; control charting; analyses of population abundances and community assemblages; risk assessments and ecological impact prediction and assessments. He also has considerable experience in marine protected area and conservation assessment.

Dr Edmunds presently has a variety of research collaborations with the Australian Centre for Field Robotics, Parks Victoria, Geosciences Australia, Fathom Pacific and the Victorian Department of Environment Land Water and Planning. Dr Edmunds is a co-founder and curator of the *CBiCS* habitat and biotope classification scheme, *q-Core* ecological database system and *EcoNet* system for ecological modelling and ecosystems-based management.

Field Programs

Dr Edmunds has substantial first-hand experience in marine ecological field studies. In summary, this work includes both deep and shallow coastal habitats and was predominantly in the temperate regions, but includes tropical pelagic, coral, mangrove and seagrass habitats. He has considerable expertise in temperate deep sponge garden and shallow seaweed ecosystems, but also has experience in sediment and seagrass habitats.

Dr Edmunds has been responsible for some of the largest and long-term marine monitoring programs in Victoria, including:

- Entrance Canyon rock falls, ROV monitoring (2003-20011);
- Victorian Desalination Plant Baseline Monitoring Program (2009-2014);
- Victorian Intertidal Reef Monitoring Program (2003-2015); and
- Victorian Subtidal Reef Monitoring Program (1998-2016).

Other relevant experience includes:

- Surveys and monitoring variety of sewage, pulp mill and brine wastewater outfalls around Tasmania, Victoria and New South Wales;
- Water quality, sediment and seagrass monitoring associated with dredging projects in Port Phillip Bay, Corner Inlet and Lakes Entrance;
- Surveys of marine pests and diseases presence and spread, including abalone AGV virus, Japanese kelp and Northern Pacific seastar;
- Various habitat mapping and biodiversity surveys in the Coral Sea, Scott Reef, Malaysia, Baja Mexico and along the southern temperate coast of Australia and Tasmania; and
- Population dynamics assessment and modelling of southern rock lobster, canopy seaweeds (*Ecklonia* and *Phyllospora*) and seagrasses (*Zostera*, *Amphibolis* and *Posidonia*).

Frameworks, Modelling and Analysis

Dr Edmunds has a variety of analysis, modelling and assessment skills pertinent ecological and environmental management:

- Co-development of the q-Core ecological database model and supporting software and web apps.
- Co-development of the CBiCS catalogues, atlases and universal data labelling system.
- Co-development of the EcoNet framework, database and display system for ecological and EBM networks.
- Assembly of data processing pipelines in open-source products, including PostgreSQL, R, QGIS and .Net.
- Development of bespoke algorithms for repeated analysis and reporting applications.
- Development, parameterisation and evaluation of ecological models, including concept models, deterministic and stochastic modelling, individual-based models, population dynamics models, fisheries models, eco-physiological models, plume dilution and dispersion models and environment-ecosystem models and species interaction models.
- Familiarity with environmental management planning, adaptive management and management decision frameworks.
- Familiarity with most Victorian marine studies, data, imagery and atlases.

Scientific Review and Environmental Management

Dr Edmunds has extensive experience in critical scientific reviews, submissions, expert evaluations, environmental impact assessments and environment management plans. Much of this experience has related to being a principal scientist associated with multi-disciplinary, large-scale environmental and ecological assessments. His experience encompasses listed species, conservation areas, marine protected areas, fisheries, environmental management systems and regulation. Relevant projects include:

- Channel Deepening Project EES;
- Channel Deepening Project Supplementary EES Inquiry;
- Lauderdale Quay DIIS;
- Mornington Safe Harbour;
- Inquiry into the Environmental Effects Statement Process in Victoria, Environment and Natural Resources Committee, Parliament of Victoria, Melbourne;
- Expert witness for EPA Victoria related to dumping rubbish at sea;
- Expert witness for rock lobster fishers;
- Expert reviewer for the Tasmanian Resource Planning and Development Commission (RPDC) on the Gunn's Pulp Mill IIS;
- RPDC Panel member, inquiry into establishment of marine protected areas in the Bruny Bioregion;
- Committee member, Scientific Advisory Committee for implementation of the Flora and Fauna Guarantee Act, Victoria;
- Peer reviewer for the Australian Conservation Foundation;
- Peer reviewer for the Victorian Desalination Project EES for AquaSure;
- Review of marine natural values of the Kimberley region for WWF Australia;
- Review of marine nature conservation in Victoria for Victorian National Parks Association, Melbourne; and
- Victorian Fisheries Co-Management Council – Rock Lobster Committee – member for conservation.

Selected Projects

Client / Location	Description	Key Tasks
DELWP Victoria	CoastKit online marine resources	Compilation of Victorian marine data, mapping, imagery and references into a central database and atlases with online accessibility. All data unified with CBiCS classification and q-Core database structure.
DELWP, Parks Victoria Victoria	State of the Environment Reporting	Development of state of the environment marine indictors and report systems. Includes collation of long-term data, implementation of hosting database, control charting and web-based reporting systems.
DELWP Victoria	Mapping of marine habitats in Victoria	Collation of old and new data, reanalysis and classification according to CBiCS, analysis of lidar, multibeam sonar, aerial photography and towed video data, production of government GIS and atlases.
Parks Victoria Victorian coast	Implementation of robotics for long-term reef monitoring programs.	Multifaceted project to adapt and improve existing long term monitoring programs by using recent robotics advantages that vastly improve information returns. Includes UAVs (intertidal habitats) and AUV (subtidal and deep habitats)
Australian Centre of Field Robotics	Development of precision stereo-image mapping in small form-	Development of small form-factor AUVs that are portable and affordable to survey with capabilities approaching that of the national

Client / Location	Description	Key Tasks
Testing throughout Australia	factor AUVs and automation of image classification	AUV facility AUV Sirius. Testing and implementation of man-portable AUV (AUV Phoenix) for natural resource management projects. Development of machine classification algorithms and testing.
Fathom Pacific, Australian Marine Ecology (collaboration)	Co-development of the new standardised marine habitat and biotope classification system for Australia (CBiCS)	Establishment of a universal habitat and biotope classification scheme (CBiCS). Integration of European (EUNIS) and US (CMECS) schema for biotope classification into a unified hierarchical system. Development of a new morphospecies classification system to facilitate machine image classification. Coordination with Victorian and Australian NESP reef programs. Application in Australian and international settings – coral reef to bathyl habitats.
Parks Victoria Victorian Marine Parks	Subtidal and Intertidal Reef Monitoring Programs 18 year program	Underwater visual census of reef flora and fauna throughout Victoria. Work includes use of standardised underwater survey techniques, specimen collections, database management, survey reports and status reports. Intertidal visual census of reef flora and fauna throughout central Victoria.
Fathom Pacific Papua New Guinea	Ravuvu Harbour Development Survey	Near shore habitat assessment, including fringing coral reef, seagrass and mangroves, to inform an environmental impact assessment of a new harbour development.
Fathom Pacific Baja, Mexico	Marine ecological impact assessment and baseline study	Senior scientist in biological program for a seabed phosphate deposit. ROV video habitat and biological assets mapping, bioacoustics, oceanography
Degrémont Thiess Services Joint Venture Wonthaggi Victoria	Impact Assessment of Desalination Plant Discharges	Long term monitoring and mapping of seabed biota and impacts with distance from outlets and intakes by scientific diving, ROV and AUV methods.
Parks Victoria Wilsons Promontory, Victoria	Deep reef sponge garden assessment	ROV surveys of deep reef biotopes and habitats on newly discovered reefs.
Parks Victoria Wilsons Promontory, Victoria	Northern Pacific Seastar Monitoring	Surveys in sediment habitats off Tidal River and around Wilsons Promontory using drop video and AUV video.
Port of Melbourne Corporation Port Phillip Bay, Victoria	Port Phillip Bay Channel Deepening Project: Deep Reef Impact Assessment	Quantitative monitoring program to assess impacts and recovery of rock dredging at Port Phillip Heads. Deep reef biota and assemblages in the canyon were assessed using quantitative ROV and diver video surveys.

Client / Location	Description	Key Tasks
John Kowarsky and Associates Esso Australia Corner Inlet, Victoria	Barry Beach Marine Terminal and Channel Dredging	Habitat mapping and characterisation at selected locations within Corner Inlet and offshore dredged material grounds. Habitat mapping involved towed video and divers. Quantitative monitoring program to assess impacts on light climate and seagrass beds.
VNPA Victoria	Victorian Marine Nature Conservation Review	Description and status of Victorian marine values, including status, ecosystem services, threats and status.
Boskalis and Port of Melbourne Corporation Port Phillip Bay, Victoria	Channel Deepening Project Impact Assessments, EES and Trial Dredging Assessments	Existing conditions surveys, ecological impact modelling and assessments, risk assessments, environmental effect statements, panel hearings, quantitative monitoring programs.
WWF & Applied Ecology Solutions Kimberly	Marine and Coastal Natural Values of the Kimberley	Review and synthesis of natural values of the Kimberley region, encompassing the coast, shallow marine, shelf and abyssal habitats
Department of Primary Industries Port Fairy, Victoria	Health Monitoring of Abalone Wild Stock	Monitoring the health of wild abalone on inshore reefs between Warrnambool and Portland in western Victoria. The primary objective of the monitoring is to provide information on the distribution of a virus infecting abalone populations within this region.
Department of Sustainability and Environment Apollo Bay, Victoria	Apollo Bay Harbour Marine Survey	Detailed the marine assemblages, habitats and biota of Apollo Bay. A desktop investigation of previous studies was done and combined with information gained from an underwater survey. The habitats and biota in the harbour were assessed and mapped by biological divers, taking underwater notes, photographs and video
Department of Primary Industries, Parks Victoria Discovery Bay, Warrnambool, Victoria	Independent stock assessment of southern rock lobster	Standardised fishery independent stock assessment and tag and release of rock lobsters inside and outside marine protected areas.
Government of Victoria Victoria	Scientific Advisory Committee for Flora and Fauna Guarantee Act	Committee member for marine species and communities. Included evaluation of proposals for listing species and review of conservation action plans.
Tasmanian Resource Planning and Development Commission Southeast Tas.	Panel Member Bruny Bioregion MPA Inquiry	Panel member for an inquiry to design and recommend marine protected areas in the Bruny Bioregion. Included scientific reviews, interviews, assessments of public submissions, public hearings and inquiries, site visits, MPA design, reporting and publication.

Selected Documents

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22 July 2020

Dr Matt Edmunds
Australian Marine Ecology
82 Parsons St
Kensington VIC 3031

By email only: matt@marine-ecology.com.au

Dear Dr Edmunds

AGL/APA Gas Import Jetty and Pipeline Project at Crib Point, Victoria

We act on behalf of Submitter 3088, Submitter 3129 and Submitter 3004. We write to you on behalf of Submitter 3004.

Submitter 3004 is Victoria's leading nature conservation organisation. It is an independent, non-profit, membership-based group, which exists to protect Victoria's unique natural environment and biodiversity through the establishment and effective management of national parks, conservation reserves and other measures.

We write to you as an expert on marine ecology and ecological assessment. The purpose of this letter is to seek your expert opinion on the environmental effects of the Crib Point Gas Import Jetty and Crib Point to Pakenham Pipeline project (**the project**).

We seek your preliminary opinion to be provided in a draft report by **12 August 2020.** Your preliminary opinion will inform Submitter 3004 in preparing its written submission due on 26 August 2020.

We also request your expert opinion be provided as an expert witness report to be submitted to the Inquiry and Advisory Committee (**IAC**). We request that your expert report be provided by **23 September 2020**.

References to Tab numbers in bold in this letter are to the documents in an electronic brief which we provide to you via DropBox (https://www.dropbox.com/sh/sucepsg7d9fg91n/AAAUPX_ZvKbLze5dap0d8zMLa?dl=0).

Background

1. AGL Wholesale Gas Ltd (**AGL**) and APA Transmission Pty Ltd (**APA**) propose a new facility for importing and regasifying liquefied natural gas (LNG) and supplying it to the gas transmission network. The project comprises two main components:

   a. Gas Import Jetty Works comprising a floating storage and regasification unit (**FSRU**) at Crib Point Jetty, jetty infrastructure including marine loading arms and gas piping on the jetty, and the Crib Point Receiving Facility on land adjacent to the jetty (**Gas Import Jetty Works**).

   b. Pipeline Works consisting of an underground gas transmission pipeline approximately 57 kilometres long to transport gas from the Crib Point Receiving Facility to the Victorian Transmission System east of Pakenham, and associated infrastructure (**Pipeline Works**) (see description at **Tab A.1.1**).

2. On 8 October 2018 the Minister for Planning issued a decision determining that an Environment Effects Statement (**EES**) was required for the Project due to the potential for a range of significant environmental effects. The purpose of the EES is to provide a sufficiently detailed description of the proposed project, assess its potential effects on the environment and assess alternative project layouts, designs and approaches to avoid and mitigate effects.

3. An Inquiry and Advisory Committee (**IAC**) will be appointed to review the EES and public submissions. The IAC will hold public hearings for 6 to 8 weeks, after which it will produce a report for the Minister for Planning. Following receipt of the IAC's report, the Minister for Planning will then make an assessment as to whether the likely environmental effects of the project are acceptable (**Minister's Assessment**).

4. The EES includes 27 substantive chapters and 17 technical reports addressing a range of topics. All EES documents are available online at: https://www.gasimportprojectvictoria.com.au/environment-effects-statement#view-the-ees. However, we seek your review and opinion only of the EES documents relevant to your expertise (marine ecology) to assist in informing the submissions to be made by our client.

Instructions

5. We request that you prepare a report providing your expert opinion on the following:

a. The significance and value of marine biodiversity and ecological assets within the project area (and more broadly as relevant).

b. Actual or likely impacts on marine ecology and marine biodiversity arising from the project.

c. The effectiveness of any ameliorative or compensatory measures proposed to account for the environmental effects arising from the project.

d. Any appropriate qualifications or conditions that should be attached to findings or conclusions, such as uncertainties or gravity of threats or impacts.

e. Review the following EES documents (as relevant to marine ecology):

   i. Technical Report A – Marine biodiversity (**Tab A.2.1**) and appendices.

   ii. Technical Report B – Terrestrial and freshwater biodiversity (**Tab A.2.2**)

   iii. Technical Report H – Noise and vibration (**Tab A.2.3**)

   iv. Attachment I – Matters of National Environmental Significance (**Tab A.3.1**)

   v. Attachment III – Environmental risk report (**Tab A.3.2**)

   vi. Chapter 25 – Environmental Management Framework (**Tab A.1.5**)

f. Review of the EES documents (as relevant to your expertise) against the best practice marine impact assessment criteria and overarching standards (**Tab C.2, Tab B.2**).

g. Review of the EES documents (as relevant to your expertise) against the State Environment Protection Policy (Waters) (**Tab B.1)**.

h. Any other matters you identify which you consider relevant within the limits of your expertise.

6. In addition to a detailed synthesis of the conditions, issues and gaps, we request that the report includes a high level summary of the key issues.

7. As an expert you are able to consider any such material you consider relevant to your enquiry. Please identify in your report any further materials you consult outside of the briefed materials.

Expert Witness Code of Conduct

8. We have enclosed a copy of the Guide to Expert Evidence provided by Planning Panels Victoria, which is the relevant guidance for hearings before the IAC (**Tab C.1**).

9. In preparing your final expert witness report, please ensure that you include:

   a. your name, address, qualifications, experience and area of expertise

   b. details of any other significant contributors to the report (if there are any) and their expertise

   c. all instructions that define the scope of the statement (original and supplementary and whether in writing or verbal)

   d. details and qualifications of any person who carried out any tests or experiments upon which the expert has relied in preparing the statement

   e. the following declaration:

   'I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.'

Important dates

10. We seek your preliminary opinion to be provided in a draft report by **12 August 2020.** We also request your expert witness report be provided by **23 September 2020**.

11. The IAC will conduct public hearings over a period of 6-8 weeks, commencing on **12 October 2020.** We anticipate that you will be called to give evidence before the IAC at the public hearings. Please advise of the days on which you will **not** be available to give evidence before the IAC (if required) during the period of 12 October to 30 November 2020.

Confidentiality

12. This request for an expert opinion and the subsequent report, as well as any correspondence relating to this request, is for the purposes of the Crib Point Gas Import Jetty and Crib Point to Pakenham Pipeline project EES process, including the public hearings before the IAC. It is therefore confidential and is protected by legal professional privilege.

Fees

13. We confirm that you will invoice Submitter 3004 directly for fees associated with your engagement as an expert.

14. Please contact Virginia Trescowthick if you have any questions or require further information.

Yours faithfully

Virginia Trescowthick
Lawyer