Review of Vopak Victoria Energy Terminal EES

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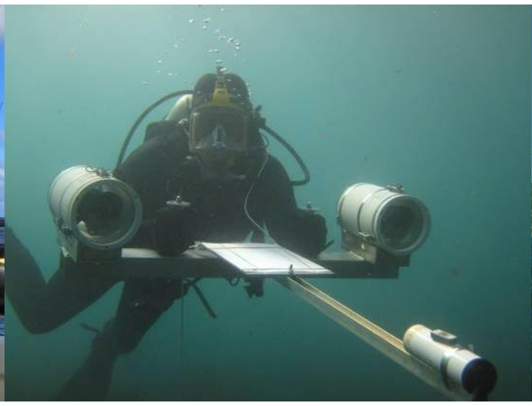

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Review of Vopak Victoria Energy Terminal EES

Document Control Sheet

Description

This document reviews the Environmental Effects Statement for the proposed Victoria Energy Terminal in Port Phillip Bay. The potential impacts include a proposed gas import jetty, floating storage, regassification, subsea pipeline, subsea electrical cable, disinfection chemical discharges and shipping movements. The scope of the review focusses on scientific validity of the marine ecology, including potential impacts on features of conservation concern, features of high ecological importance and ecosystem-level processes. The review was in the context of best practice scientific standards and ecosystem-based management.

Keywords

Geelong Arm, Werribee, Phillip Basin, Port Phillip Bay, Port Phillip Heads, sublittoral sediment, sublittoral rock, littoral sediment, , Corio Inner Segment, Port Phillip Bay Biounit, supralittoral zone, littoral zone, sublittoral fringe, sublittoral zone, littoral sediment, littoral rock, sublittoral sediment, sublittoral rock, saltmarsh, wetland, littoral seagrass, sublittoral bank, sublittoral seagrass, bare sediments, littoral gravel, swans, teals, demersal fishes, Ramsar, migratory birds, *Atriplex cinerea*, *Zostera nigricaulis*, *Zostera muelleri*, *Halophila australis*, desktop, field survey, existing conditions, ecological features, gas import facility, floating storage and regassification unit, FSRU, ecological impact assessment, environmental effects statement, EES, ecological sustainability, sensitivity analysis, peer review, suspended sediments, sedimentation, light climate, burial, scouring, light attenuation, temperature, marine pests, contaminants, toxicants, noise, light, scientific standards.

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Summary

Approach

The marine ecology component of the Victorian Energy Terminal EES was reviewed in accordance with scientific principles and contemporary best practice for ecological management. This included consideration of existing legislation and policies. Not all aspects could be reviewed within the available time-frame.

Summary of Issues

General Issues

There were general issues with the framework and methodology of the EES assessment. The assessment and considerable selection bias and was not to an appropriate biological resolution. The assessment was not transparent or use an independently repeatable method. The EES did not incorporate the existing body of knowledge and this neglected to consider the existing deleterious state of the ecosystem. This meant the EES conclusions of no significant impact were unsound.

Turtles, Whales and Seals

The marine ecology assessment contributed 110 pages to species not present in the ecosystem, including turtles, whales and seals. This was at the expense of considering important aspects, such as species of conservation concern that are known in the area.

Features of Concern

The EES did not address key species and features of concern. There was no attempt to address knowledge gaps and potential impacts for southern hooded shrimp or school shark – key species of conservation concern. There was no impact assessment on areas identified as having ecological importance – mapped as Key Ecological Feature areas. The assessment excluded large areas of potential impact, including The Rip at Port Phillip Heads and the Phillip Basin area.

Seabed Impacts

The greatest pressures and ecological concern are for the seabed biota and associated ecosystem functions. The EES did not integrate the full body of knowledge on the seabed system and failed to identify the contraction and depauperate states of existing seabed components.

The EES field studies were incomplete and incompetent – as evidenced by misclassifications of obvious biotope classes, such as scallops and seaweed eutrophication. The seabed studies grouped the biota into coarse categories that did not have the biological resolution to properly predict impacts and recovery.

The seabed impact assessments were atomised and scattered through the EES. There was effort to model and map physical pressures but there was no effort to model and map biological impacts and recovery.

The impact predictions were generally in the form of a subjective narrative with assumptions not supported, or contrary to, existing evidence.

Electromagnetic Disturbance

There is considerable potential for movement barrier and feeding disruption caused by the proposed two subsea power cables. This effect was poorly addressed in the EES. This disturbance is highly significant for migrating school shark pups, but potentially also for a large suite of demersal fishes, eels, sharks, skates and rays.

Contaminant Discharges

The FSRU would release disinfection by-products as part of the disinfection process of the heat exchangers, used to gassify the LNG. The discharge would be as a lower-temperature density plume on the seabed. This density plume would be into the Werribee relict paleochannel. The potential dispersal of the plume was not adequately addressed. The disinfection by-products can include highly toxic substances that can bioaccumulate. The EES omitted addressing the contamination issue.

Ecosystem Assessment

The EES did not properly address ecosystem level properties and potential impacts. The EES ecosystem assessment was subjective and not based on any ecosystem description or model from the project area.

Cumulative Impact Assessment

The EES did not implement any process to combine and integrate existing and project pressures into a cumulative impact assessment. The EES assessment was subjective, brief and approached by a narrative that assumed potential impacts away based on activities alone.

The actual potential for cumulative impacts is significant. The present ecosystem is in a deleterious state and declining. Added, cumulative impacts may tip the system into an unrecoverable state.

Environmental Management Framework

The EES environmental management framework was incapable of meeting any of the principles of modern ecosystem-based management. These principles are embodied in the Marine and Coastal Act and Policies. The framework did not include any outcomes-based approach that would ensure ecologically sustainable development.

Conclusions

In general, the EES marine ecology assessment did not meet the standards of contemporary, best practice assessments. The assessment was selectively biased and had an uneven treatment of different ecosystem components. This uneven treatment extended to assessing iconic, flagship species that do not occur in the project area. Most of the assessment was on grouped biotic components, such that it did not have the biological resolution to detect and understand impacts. There was incompetence in the fieldwork, with an inability to recognise existing impact conditions and common, easily recognisable biotopes. The EES did not build on the existing body of knowledge or adequately fill key knowledge gaps.

The impact assessment was not well supported by evidence and did not follow a transparent and independently repeatable method. The EES predicted there would be no significant impacts. Most of these predictions were based on assumptions rather than evidence. Some important areas of impact were omitted, including contamination effects of disinfection by-products and ecosystem chain effects.

The proposed project has the potential for considerable, ecosystem-level impacts, across a diverse range of habitats. These impacts include seabed disturbances to habitats that may take a long time to recover, barrier effects on demersal fish movements, including school shark and removal of fragmented, relict populations that are in decline.

The existing knowledge indicates Geelong Arm and Werribee biogeographical segments are presently in very poor ecological condition and in decline. The additional pressures of the proposed project may exacerbate this decline or, worse, tip the ecosystem into an unrecoverable state (known as hysteresis).

The poor standard of the marine ecology assessment means the information is unreliable for planning decisions and management. There is potential for the proposed project to cause considerable ecosystem-level harm. The full scope of potential impacts should be clearly incorporated into the environmental decision process.

The present level of evidence and knowledge indicates the proposed project would not be ecologically sustainable.

Contents

1 Qualifications and Experience

1.1 Qualifications and Experience

I have the following qualifications in marine ecology:

- Bachelor of Science (Hons), Marine, Freshwater and Antarctic Biology, First Class, University of Tasmania
- Doctor of Philosophy, Zoology, University of Tasmania

1.2 Relevant Expertise

My primary areas of expertise is in the areas of:

- Temperate marine ecology, community and population dynamics;
- Monitoring, impact and condition assessment;
- Habitat mapping;
- Numerical ecology;
- Ecological modelling and prediction; and
- Ecosystem-based management.

I have particular knowledge and experience in Port Phillip Bay ecosystems, with over 30 years of studies in Port Phillip Bay. This work included:

- Long term monitoring programs;
- Mapping bathymetry and topography 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; and
- Assessing, mapping and monitoring of ecosystem status and condition throughout the bay.

More recently, I have been compiling and mapping ecological inventories, including in the proposed project area, informing on how ecosystems are structured, their functioning, their condition and changes over time. This information was highly pertinent to the EES project assessment. I have also been developing standardised approaches and software tools for efficient implementation of ecosystem-based management and cumulative impact assessment.

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

- Development of environmental decision support systems for EPA, DEECA, Melbourne Water and community groups for the Port Phillip Bay EMP;
- Viva Energy Gas Import Project Supplementary EES inquiry (expert witness including inquiry hearings);
- Viva Energy Gas Import Project EES inquiry (expert witness including inquiry hearings);
- AGL Cribb Point Gas Import Project EES inquiry (expert witness including inquiry hearings);
- Port of Melbourne Corporation - Channel Deepening Project, EES and Supplementary EES inquiries (expert witness including inquiry hearings);
- AquaSure - Victorian Desalination Project (expert reviewer);
- 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);
- Parliamentary Inquiry into Ecosystem Decline (expert submission); and
- DELWP Sea Floor Integrity Project – Review of ecological condition survey requirements.

2 Review Approach

2.1 Information for Decisions

The purpose of the EES is to provide information on potential impacts for supporting decisions and approvals. There is an expectation that the EES information is accurate and precise and, if not, the limitations and uncertainties of the information is made known to the regulatory authorities. The EES should be evidence-based, unbiased and reliable for decision-making.

There are a set of principles for ensuring that EES information is fit for purpose, including being accurate and reliable for planning decisions. These include the scientific method and best practices for ecosystem management. The Victorian Energy Terminal (EES) was reviewed in accordance with these principles.

2.2 Scientific Principles

The assessment of the evidence provided in the EES was in accordance with scientific principles:

- Complete and transparent reporting;
- Independently repeatable methods;
- Evidence-based;
- Builds on existing knowledge;
- Measurements are taken to fill knowledge gaps; and
- Objective and unbiased, particularly with respect to selection bias and omissions.

2.3 Best Practices for Decisions and Management

There are a set of well recognised, contemporary best practices for environmental and ecological management. These include:

- Ensuring ecologically sustainable development (ESD);
- Wholistic and integrated ecosystem management;
- Ecosystem-based management (EBM), which has its own set of principles, including:
    - Maintaining the integrity of ecosystems;
    - Maximising the social benefits derived from the ecosystem features; and
    - Combining scientific, community and indigenous knowledge;
- Outcomes-based management, ensuring integrity and sustainability;
- Cumulative and incremental impact assessment (also known as integrated impact assessment, EIA);

- Adaptive management, including Monitoring-Evaluation-Reporting-Improvement (MERI) or the Plan-Do-Check-Act (PDCA) cycle (Figure 2.1); and
- The Precautionary Principle.

2.4 Policies and Environmental Decisions

2.4.1 Environment Protection Act

The present Environment Protection Act (2018) is relatively weak with respect to reflecting contemporary environmental management. The Act has a principle for integrated environmental, social and economic consideration and a principle for protection of biological diversity and ecological integrity. It does not provide mechanisms for meeting those principles. The revised Act introduced the concept of General Environmental Duty (GED), but does not put in place the contemporary practices for oversight of GED, particularly the MERI approach. The Environment Protection Act has Environmental Reference Standards (ERS), but these pertain only to water quality parameters. Some of these parameters are arbitrary and disconnected from maintaining ecological integrity, for example water column light attenuation is set too high to ensuring adequate light dosage for primary production in Port Phillip Bay. The ERS should not be used as a surrogate for maintaining ecosystem integrity.

The real-world implementation of the Act has been based around outdated approaches of regulating inputs (activities and pressures) with an assumption or implication that this will produce desirable outcomes. Those outcomes are assumed without any consideration of the reliability of those assumptions or real-word situations (*i.e.* ‘set and forget approach’).

Managing ecosystems by regulating activities and input levels has been proven to be an unsafe and ineffective form of environmental management. This includes for Port Phillip Bay where there has been few to no ongoing outcomes-based assessments. Ecosystems have deteriorated substantially in Port Phillip Bay, including in the area covered by this EES. There were no mechanisms for detection and response to these changes, even though input controls may have been met. Planning decisions based on arbitrary activity and pressure regulations, particularly adherence to codes of conduct and settings to physical disturbances and dilutions and chemical concentrations are no guarantees for protecting ecosystem integrity.

2.4.2 Marine and Coastal Act and Policy

The Marine and Coastal Act and associated Marine and Coastal Policy embody the best practice ecosystem management principles described above. They supersede the paradigm of the Environment Protection Act. The Marine and Coastal Act and Policy emphasises an wholistic, ecosystem-based approach. This approach comes with an alternative paradigm of decision-making that is based on outcomes: a decision is not based on whether pressures are mitigated or minimised to some arbitrary level, but rather whether the ecosystem will maintain its integrity and be sustained into the future. This also has implications for ecosystem services and social benefits arising from the ecosystem, which should also be a transparent component of the decisions. This change in emphasis for planning decisions is illustrated in Australian Marine Ecology's socio-ecological model in Figure 2.1 and is being applied in Port Phillip Bay and elsewhere. Ecosystem and habitat management are also central to the Fisheries Act and the Port Phillip Bay EMP.

This is the fourth EES process for gas import facilities in recent years. There were incidences during prior EES processes where the proponent has down-weighted or argued against ecosystem-based approaches and ESD. This is incorrect: it is clearly required under the Marine and Coast Act and Policy, as well as subordinate and local management plans. Decisions for the Victorian Energy Terminal would be best served in having a best-practice, ecological outcomes-based approach, which is in accordance with the Marine and Coast Act and policies.

2.4.3 Information Requirements for ESD Decisions

There are particular information requirements to support ecosystem-based decisions and ensuring ecologically sustainable development. These were considered as part of this review and include:

Biological resolution - the relevant ecosystem features, including species, guilds, biotopes and ecosystem functions are understood to a required level of biological resolution. Past EESs pooled or grouped features such that important aspects were confounded and no impact would be found;

Biological responses – the relevant biological responses and interactions to environmental and proposed activity-pressures need to be understood to model and predict impact responses, over and above natural patterns and changes. Past EESs assumed physical modelling was a surrogate for biological responses. This is not biologically valid;

Ecosystem impact chains – a direct biological response to activity-pressures should be modelled and predicted. This then may have further, secondary and tertiary impacts through other ecosystem interactions. These further chains of impacts may be more significant than the primary impact response. Assessing ecosystem impact chains requires a base model of ecosystem interactions. Past EESs have excluded explicit biological impacts and ecosystem-level impact chains.

Ecosystem model – an ecosystem model that relates abiotic and biotic interactions is essential for best practice management, including predictions for ecologically sustainable development. The model needs to be comprehensive enough to understand potential consequences to ecological status, and also ecosystem services and social benefits from ecosystems.

Biological evidence and knowledge building – There is real-world evidence to support the information requirements listed above. This evidence is expected to come from comprehensive review of the literature, incorporation of existing data from the study area (knowledge building), field surveys to describe present biological values and conditions, temporal monitoring to understand patterns and relationships and targeted studies to fill important biological knowledge gaps.

2.5 Limitations of this Review

This review focussed on the marine ecological aspects of the EES and the matters pertaining to ensuring and maintaining ecosystem integrity.

This review was prepared under limited time availability for the submissions and does not include all aspects and issues.

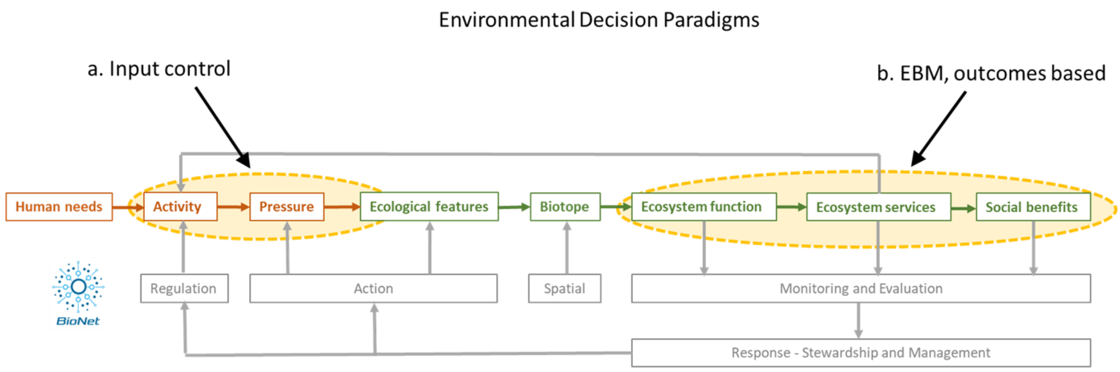

Figure 2.1. EcoNet model framework (BioNet, Australian Marine Ecology) with highlighted areas that inform on different environmental decision paradigms: (a) Input control management; and (b) Outcomes-based management and EBM decisions.

3 General Issues

There were major systematic and general issues in how the marine ecology impact assessment was implemented.

Systematic Approach
There were some aspects in implementing a systematic approach, such as having well described criteria for impact conclusions. Regardless, the EES did not progress through a framework that was objective, complete and transparent, as per the following comments.

Selectivity and Completeness
The EES did not attempt to provide a complete inventory of ecological features to consider and assess. Instead, it has a selective focus, including a strong focus on species that do not inhabit the area, such as turtles. The field surveys were not to a high biological resolution, with many groups lumped broad categories that were likely to obscure detection of impacts (detailed in following sections). The EES did not address key ecological feature areas or species of conservation concern. The biological resolution was not to species and Level 5 biotopes for all habitat areas.

There were large areas of potentially impacted areas that were not assessed, including from shipping movements across the Phillip Basin

Building on Existing Knowledge
The EES did not use or integrated the existing knowledge of the biota and ecosystem in the project area. The EES provided some existing conditions information but this was not brought forward into the impact assessment. The EES failed recognise the deleterious conditions and declining trends, potential tipping points and the implications of this for causing irreparable ecosystem harm from the project. The EES did not fill key knowledge gaps, such as the presence of the FFG listed southern hooded shrimp within the project area.

Incompetence of the Field Surveys
The EES did benthic field surveys using low quality methods (towed imagery) and there was a lack of competence in the data extraction from the imagery. This included an inability to recognising existing impact states and obvious biotopes, for example the small bivalves Electroma were mistaken for scallops.

Transparency and Evidence of Predictions
The EES did not use an objective, quantitative or semi-quantitative approach to biological predictions. There was quantitative modelling and mapping of some of the

physical pressures, but there was not an equivalent effort applied to the biology. The assessment used a subjective narrative approach that was not supported by a transparent chain of evidence. The narratives were full of assumptions that were unsupported by evidence, and often contradictory to existing evidence that was excluded from the EES. Most predictions assumed recovery was possible much faster than actual observations in Port Phillip Bay.

There was no mapping of biological impact areas, despite considerable effort to map existing habitat groups.

The predictions were opinion-based and did not use an independently repeatable scientific method (i.e. not objective).

Ecosystem Assessment

The EES assessment was atomised into separate assessment components and there was no effort to assess ecosystem-level impacts, or chains of impact process that may occur through the ecosystem. The project area fulfils many important ecosystem functions and roles and these were not identified and assessed in the EES. To do an ecosystem level assessment, there is a requirement to establish a descriptive model that identifies the nature and magnitude of different relationships between ecological units (species, guild, biotopes, processes, habitats, natural drivers, *etc.*). The EES did not apply any effort towards an ecosystem level of assessment.

Cumulative Impacts

The proposed project has a footprint that covers many different ecosystem habitats and components, including The Rip at Port Phillip Heads, Phillip Basin, Geelong Arm and Werribee biogeographical segments. There are many different existing activities and pressures that the proposed project would interact with to cause increased cumulative pressures on the ecosystems. The EES did not apply any contemporary methods to assess cumulative impacts. There was a cursory narrative on existing activities and then a (biased) assumption of no cumulative impacts without development of any supporting evidence. The existing body of knowledge indicates the reverse is true – there is a serious risk of tipping the present deleterious states into unrecoverable states. The need to assess for hysteresis effects in the project area was identified in the 1990s by the CSIRO Environmental Study.

Environmental Management

The environmental management framework presents an environmental management mindset for the 1970s – a ‘set and forget’ approach – and bears no resemblance to modern, contemporary practices. Contemporary practices are also principles of the Marine and Coastal Act and the EES is non-compliant. The EES framework provides no assurance for maintaining the integrity of ecosystems and ecologically sustainable development.

4 Prioritisation of Turtles, Whales and Seals

4.1 EES Prioritisation

The EES Marine Ecology Technical Assessment identified key faunal receptors for impact assessment on pages ii and in Table 6-18 on page 170. Stakeholder identified features of concern were listed on page 29. Among these prioritised receptors were turtles, baleen whales, phocid seals and otariid (eared) seals. These groups were prioritised for assessment in the EES over all other species and ecosystem components, addressed over approximately 110 pages of the 620 page assessment: *i.e.* one sixth of the assessment.

The issue with this prioritisation is that these faunal groups are mostly transient or vagrant visitors to the project area. The potential for impact interactions is extremely low given the low to very rare presence and there is no substantive reliance or interaction with the project area ecosystem. Eared seals are common in Port Phillip Bay, and do occasionally visit the area and may feed in the area, but the area is essentially incidental with respect to overall habitat usage and foraging range. The natural habitat of phocid seals is in Subantarctic and Antarctic waters, recognising there was a former elephant seal colony on Phillip Island.

The heavy focus of the EES marine assessment on species of little to no concern, *i.e.* turtles, baleen whales and seals, is a form of bias and is misleading. The excessive volume of pages attributed to these components of no consequence obscured the consideration of more important impacts.

Sections of the marine ecology assessment that should be disregarded include:

Turtles
Sections 8.1.3, 8.2.3, 8.3.3, 9.1.6, 9.2.3, 10.1.3, 10.2.3
Pages: 221-228, 284-285, 342-342, 407-408, 467-468, 502-503, 520-523

Baleen Whales
Sections: 8.1.4, 8.2.4, 8.3.4, 9.1.7, 9.2.4, 10.1.4, 10.2.4
Pages: 229-243, 285-293, 343-347, 408-411, 469-473, 504-507, 524-528

Seals
Sections: 8.1.6, 8.1.7, 8.2.6, 8.3.6, 8.3.7, 9.1.9, 9.2.6, 9.2.7, 10.1.6, 10.1.7, 10.2.6
Pages: 248-260, 295-299, 351-356, 415-418, 477-481, 511-515, 533-540

General
Section 10.3.2, pages 544-548

4.2 Priority Features not Considered

The focus on species that do not inhabit the project area was at the expense of other features conservation concern, information to an adequate biological resolution and critical ecosystem processes. For example, the ecosystem impact assessment in Chapter 12 was very brief and inadequate, covering just six pages (pages 590-595).

Priority aspects that were neglected in the EES included (but not limited to):

- Survey and documentation of seabed species, guilds and biotopes – only a few biotopes were mapped with the rest lumped into habitat groups – biodiversity was not described to adequate resolution;
- Improved understanding of ecological relationships and linkages between water column, seabed epibiota and sediment
- Surveys in reference or control areas to support temporal monitoring design and spatial comparison;
- Implications of placing the FSRU site over the Werribee paleochannel;
- Assessment for the presence of southern hooded shrimp *Athanopsis australis* – the field survey methods were not applicable to this species;
- Assessment for impacts on school shark – particularly EMF impacts during migrations;
- Assessment on intermediate sediment biotopes which are particularly sensitive to impacts, including *Botryocladia* drift algal mats, scallop and *Pyura* range of biotopes.
- Assessment of habitat use by demersal fishes, sharks and rays, with a particular focus on school shark and pup migration;
- Impact assessment, with design options, for EMF impacts on seabed biota;
- Impact assessment of disinfection by-products
- Assessment of shipping movement impacts, including through the Port Phillip Heads and Phillip Basin Key Ecological Feature areas;
- Construction of a working ecosystem model to trace impact pathways, evaluate ecosystem level impacts and design monitoring programs;
- Implement a proper cumulative impact assessment that includes mapping of ecosystem features, pressure levels and resulting integrated sensitivity or impact response – including incorporation of present impact status and thresholds for ecosystem collapse;
- Design a management framework and monitoring program with an outcomes-based management paradigm.

4.3 Conclusions and Recommendations

The EES was heavily biased by impact assessments of species not relevant to the project area ecosystem. There were many priority aspects that were not addressed by the EES.

Recommendations include:

- Disregard the assessments for turtles, baleen whales and seals;
- Re-evaluate the priority ecosystem features and information required for impact assessment and planning decisions;
- Address key knowledge gaps, as listed above.

5 Conservation and Ecological Features

5.1 Species of Conservation Concern

5.1.1 Southern Hooded Shrimp

The southern hooded shrimp *Athanopsis australis* is an FFG listed species and is extremely rare. It was last observed in the eastern Point Wilson region in 2012 (MacArthur *et al.* 2011; Edmunds 2012).

The EES recounts the existing information (page 137), but did not attempt to field surveys to establish any presence in and near the project disturbance areas. The infaunal surveys of the EES used a Van Veen grab sampling method which is not appropriate for this species, or its host burrow former by the echiuran *Anelassorhynchus porcellus*.

The EES claims the southern hooded shrimp is not expected within the FSRU envelope (page 258). This claim was based on the depth distribution of known specimens, however there are only 12 known sightings and this is not enough to establish a depth-distribution or habitat range. There have been no targeted surveys in the proposed FSRU envelope or along the pipe and power cable disturbance area. The EES has no supporting evidence to assume hooded shrimp do not occur in the proposed disturbance areas.

In the absence of explicit field data, it should be assumed that the intermediate sediment crossing of the power cables and gas pipeline may include southern hooded shrimp habitat. This is based on similar habitats occurring there as observed where they have been collected near Point Wilson (*pers. obs.*). There is no evidence to indicate whether or not they occur within the offshore FSRU envelope.

It should be assumed that they may occur until evidence shows otherwise. This is in accordance with the Precautionary Principle.

5.1.2 School Shark

School shark Galeorhinus galeus (EPBC listed) were recognised as a species of conservation concern in the EES, but the significant features were not represented. The Corio Inner and Corio Outer areas of Port Phillip Bay is a significant pupping ground and nursery area. Pups then migrate through the Geelong Arm and Werribee area, generally following intermediate sediments area that typically have epibiota habitats (Olsen 1954, 1984; Stevens and West 1993). The nursery area is one of only a few in southeastern Australia and the migratory route is through the project area.

The subsea power cables, pipeline and associated construction and operation pressures present potential migration barriers. The habitats along the alignment are also likely important feeding grounds. There are implications for population recruitment and recovery.

The EES concluded there would be no impact on school shark because seagrass habitats would not be affected (Table 13-1, page 597). This conclusion ignored the habitat use, feeding and migratory routes on non-seagrass habitats: it is not a conclusion supported by the evidence in the literature.

Until there is further evidence, it should be assumed that the project area contains important feeding grounds and migratory routes for school shark pups, following the Precautionary Principle.

5.1.3 Sublittoral seagrass *Zostera nigricaulis*

The sublittoral seagrass *Zostera nigricaulis* is FFG listed. It is relatively common, but highly vulnerable to impacts and its present abundance is much reduced since the Millenium Drought. Its abundance in the Kirk Point region appears to have reduced substantially over recent decades and Kirk Point east and west are the main remnant stands within the northern Geelong Arm segment.

The under-shore directional drilling will minimise physical impacts, however there may be increased pressures from suspended sediments and drilling muds during the construction phase. Drilling mud releases can smother and change sediment and reef habitats, as observed for the Victorian Desalination Project pilot drilling works (Pers. Obs.). Such impacts were not addressed objectively in the EES. Smothering from drilling muds does not appear to been addressed. There was no calculation of light reduction impacts from suspended and settling sediments. Impacts in the EES were assumed to not occur based on a subjective narrative and a few generalised literature references (page 316). There was no direct impact assessment specific to the Kirk Point population and predicted pressure levels.

5.1.4 Southern Right Whale

Table 6-10 (page 188) lists the southern right whale Eubalaena australis as a likely occurring species in Port Phillip Bay. Although this species does enter the Bay, its presence is incidental and such records should be treated as vagrant sighting. The project area is not of ecological importance to the southern right whale. As such, any impact consideration in the EES should not be at the expense of high priority species and ecosystem features that rely on the project area ecosystem. Disproportionate attention to lesser priority features is a form of bias and misdirection in understanding impact consequences.

5.2 Key Ecological Feature Areas

5.2.1 Significance of KEF Areas

Key ecological feature areas were recently identified and mapped in accordance with range importance criteria (Edmunds 2024; Ferns *et al.* 2025). This work followed from the Marine Asset Areas mapped by Kent and Jenkins (2012).

The KEF areas each have particular special values that require additional consideration for any assessment of impacts or disturbances.

5.2.2 EES KEF Impact Assessment

The EES recognised the proximity or overlay of two KEFs within the project envelope:

- k.260 - drift algal beds; and
- k.261 - Werribee River paleochannel (Figure 6-56, page 190).

The EES omitted impact assessments on any of the potentially affected KEFs. Understanding KEF impacts should be a requirement for environmental planning and decisions.

5.2.3 Werribee River Relict Channel

The proposed FSRU envelope is directly over the unique geomorphological structure of the Werribee River relict channel (Figure 6-56, page 190). There is presently little knowledge of this ecosystem feature and the EES should be required to fill relevant knowledge gaps.

Particular knowledge gaps include:

- The nature of any existing density flows or currents specific to the geomorphology;
- The nature and uniqueness of biological and ecological features, inside and adjacent to the channel bed;
- The potential ecological benefits for a different placement of the FSRU envelope, away from the relict channel;
- The magnitude and distribution of predicted biological impacts;
- The potential for the relict channel to direct density flows from the FSRU discharges and cover larger distances along the channel.

5.2.4 Phillip Basin and Port Phillip Heads KEFs

The project operation requires frequent LNG carrier movements through Port Phillip Heads, South Channel and across the Phillip Basin areas. These movements pass over other critically important KEF areas and should also be part of the impact assessment.

Port Phillip heads is the most important marine area in Victoria, including controlling sea levels within Port Phillip Bay. Port Phillip Heads is a confined migratory route for many ecologically and socially important species, including fishes and penguins.

Shipping movements through the Heads contribute to safety risks (foundering, grounding, gas release), ship strike of the seabed, noise, faunal collisions, channel dredging and vessel wake, among other considerations.

Shipping movements occur across the shallow Phillip Basin sediments, with propellor wash and vessel wake causing sediment winnowing and turbid waters, in addition to the usual shipping movement pressures. The Phillip Basin sediments are important for primary production, sediment biogeochemical processes, demersal fish feeding and pelagic fish movements and feeding.

5.3 Sediment Epibiota

The sediments of the project area have supported a high diversity of seabed epibiota which have a variety of ecosystem functions and services. The epibiota include *Pyura* biogenic reefs, bivalve beds including scallop beds and various types of sediment seaweeds. The epibiota form different communities (biotopes) which provide habitat and feeding grounds for seabed and demersal (mobile) fishes, sharks and rays. Most of these biotopes are unique to Port Phillip Bay.

The various types of epibiota communities have been rapidly declining over recent decades and being replaced by bare sediment and unnatural (impact) biotopes. This is particularly for the Geelong Arm and Werribee biogeographical segments in the project area. All structural biotopes in the study area, including scallop beds, should be considered of both conservation concern and as important ecosystem functional features.

The EES did not do a thorough review of existing information, or field surveys to an appropriate biological resolution to properly inform of the impacts and consequences of sediment epibiota.

5.4 Conclusions and Recommendations

The EES did not directly address impacts on listed species of conservation concern and key areas of ecological significance.

It is recommended there are further field studies and integration of prior survey data to provide a better knowledge basis for assessment. There should then be specific impact assessments for each listed and key ecological feature. The assessments should investigate alternative design options, such as FSRU envelopes and shipping routes that are not over key features.

6 Seabed Impacts

6.1 Existing Data Synthesis

6.1.1 EES Data Review

There was some level of review of prior seabed surveys in *Annexure E: Benthic Communities and Habitats* (Section 2). The EES review did not compile an ecological inventory to support the EES impact assessment. Most of the Annexure E review was not brought forward into the impact assessment, with the assessment focused on the field survey data alone. The assessment was not placed in a proper context with respect to spatial distributions, changes over time and significance to ecological functioning and ecosystem services.

6.1.2 AME Data Review

A portion of the available information has been compiled by Australian Marine Ecology (Figure 6.1). Important seabed inventory information for the project area includes: Carey and Watson (1992); Chidgey and Edmunds (1997); Cohen *et al.* (2000); Blake and Ball (2001); Blake *et al.* (2012); Crockett and Keough (2014); and Jenkins (2023).

There have been a considerable number of surveys in the proposed project area over the last 70 years. Although the earlier survey data is not indicative of existing conditions, they provide a set of reference or baseline data that reflect natural and undisturbed conditions. The mid-period data provide indications of what biotopes and ecosystems should approximate as sustainable but mostly natural conditions. The latest data indicated substantial changes and impacts. The AME review indicated that the project area can have a high diversity of biotopes, but the present conditions are degraded and requires remedial and restoration actions.

The changes in seabed biotopes found in the AME studies indicated a significant potential for ecosystem-wide and cumulative impacts from the project. The EES should be built on all existing knowledge.

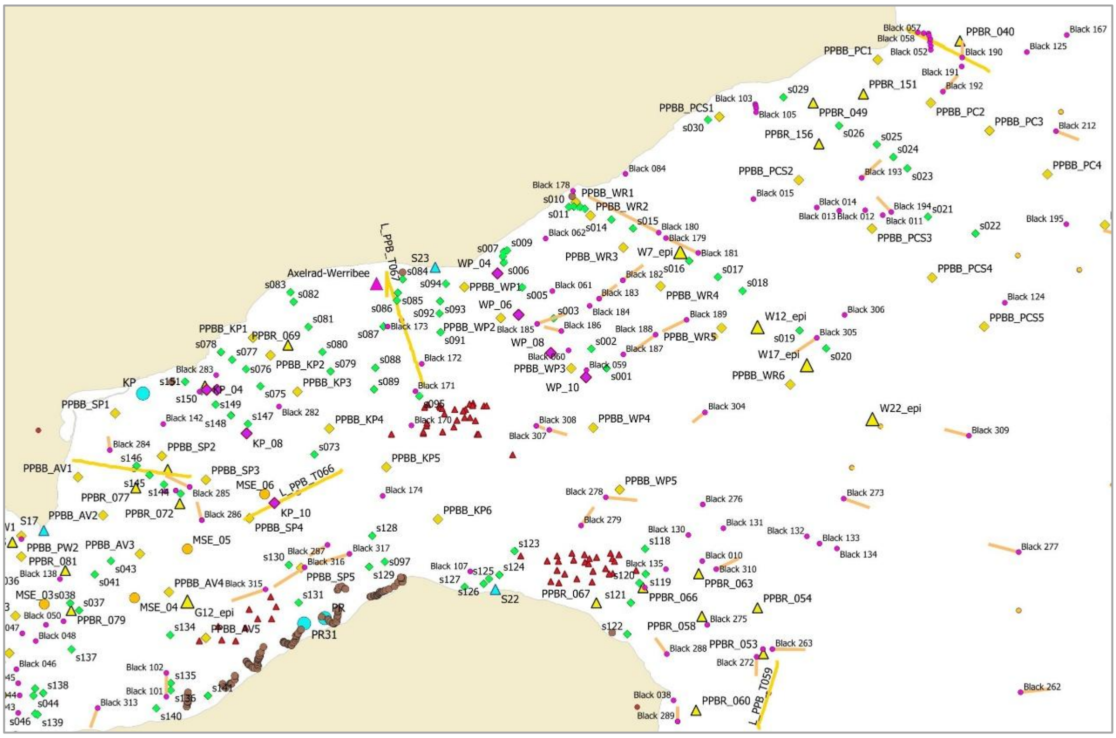

Figure 6.1. Location of scientific field surveys in the EES project area between 1957 and 2023 (Australian Marine Ecology BioNet database and DEECA CoastKit database). Much of these data were not used to inform the EES.

6.2 Seabed Field Surveys

6.2.1 Seabed Imaging

EES field surveys of seabed biota were reported in *Annexure E: Benthic Communities and Habitats*. The biotopes were surveyed using towed video at speeds of up to 3 knots (Annexure E, page 20). The AME review of the Jenkins (2023) moving ROV video indicated that towed video imagery (moving faster than an ROV) is unlikely produce imagery of adequate quality (see also Edmunds 2024b that advises against towed video methods).

The actual field survey imagery has not been reviewed to determine if it has adequate biological acuity. The Annexure E report noted at least some towed imagery was inadequate and additional drop camera imaging was used. Drop camera imagery typically produces a much higher acuity for biological discrimination. A higher reliability should be placed on the drop camera observations until the towed camera imagery has been confirmed as adequate.

The field surveys were only in the envelop area for the power cable, pipe and FSRU installation areas (Annexure E, Figure 4-1, page 35). The surveys did not include reference or control areas or general area mapping and did not appear to relate to prior survey locations. This restricted coverage prevented the surveys to be used for later baseline monitoring or to establish context for some of the biotopes. For example, the coverage and importance of the scallop biotope(s) in the impact area could not be place in context of extant distributions elsewhere. Scallop beds have been contracting over time and the presence near the FSRU site may be quite significant if there are few or discontinuous patches elsewhere.

6.2.2 Biotope Classification and Mapping Issues

Classification Hierarchy

The EES presents confusion over the definition and use of biotopes. Biotopes have a particular definition as a specific biotic community or assemblage within a defined (abiotic) habitat regime. In Victoria, the standard classification follows the CBiCS scheme, which is hierarchical and biotopes are classified at Level 5 (Edmunds *et al.* 2021; Ferns 2021). Coarser levels in this hierarchy refer to habitat classes and are not at an adequate biological resolution to assess impacts.

Pooling Biases

The EES presents mixed-level classifications and mapping, mixing levels 3, 4 and 5 in the mapping of biotopes (Table 6-14, page 116). This presents an uneven treatment of the biota on the seabed and the higher-level groups can obscure the presence of biotopes that are sensitive to impacts.

This pooling or grouping of ecological units is a form of bias: the pooling reduces the detection of impacts, favouring the proponent.

The mapping categories applied in the EES were confounded because the CBiCS classification was not applied to the biotope level. Instead, the EES mixed both parent and child categories (Annexure E, Table 4-1, page 32). For example:

- The non-reef sediment epibenthos class (Level 3, ba5.b) is a parent category of ascidian clumps (level 4, ba5.b1) and Mussels on sublittoral shell hash (level 4, ba5.b9); and *Zostera* and *Ruppia* bed (level 4, ba5.83) is a parent category of Zostera and Caulerpa mix (level 5, ba5.832);
- Sublittoral sand and muddy sand (level 3, ba5.2) is a parent class to flat muddy sand (level 5, ba5.248);
- Sublittoral seaweed on sediment (level 3, ba5.7) is a parent class to *Caulerpa* beds on sediment (level 4, ba5.71), mixed seaweed with sponges (level 4, ba5.73) and mixed seaweeds with sparse sponges (level 5, ba5.731).

This non-standard application of the CBiCS classification scheme means the results cannot be replicated by an independent observer: there was no rationale for using both child and parent classes together. There was a subjective bias in classifying some observations to habitat levels and others to biotope levels of resolution. This uneven classification treatment has flow-on effects for the impact assessments because the coarser habitat categories hide or reduce the apparent sensitivity of biotic groups to impacts.

Mapping Limitations

The selective pooling of some groups and not others also presented a bias in describing and mapping biodiversity.

The EES mapped 16 habitat and biotope categories (Table 6-14, page 116). Only four of these were to the biotope level (Level 5), with nine at the biotope-complex level (Level 4) and three at the habitat complex level (Level 3).

Other studies in the project area have catalogued and mapped over 160 sublittoral biotopes (Level 5) in the project area (AME, unpublished data). It is likely that the EES studies are not to an appropriate biological resolution to inform the impact assessment.

Misclassification

At least two of the EES classes are misclassified. The class reported as mixed fucoids and green seaweeds on variable salinity reef is incorrect: the reefs at Kirk Point are not variable salinity (estuarine – SEE EES salinity data) and the actual biotope on the reefs represented a eutrophication (impact) biotope (AME, unpublished data). Mixed fucoids are not present in the EES image (Figure 1), or in the latest survey data from 2019 to 2023 (AME unpublished data).

The EES listed scallop beds on sublittoral sediment (Level 4) in the survey inventory. Scallop faunal beds have been abundant in the area, but the abundance and area of distribution have been contracting (AME unpublished data). It is likely that scallop biotopes are still present in the region, however there is also a likelihood that the EES has misclassified some or all of this biotope. This is evidenced by EES Figure 4-16 (Annexure E, page 52). This figure presents a bed of small bivalves *Electroma papillionacea* as representing a scallop bed (Figure 6.3). *Electroma* has a thin-walled shell and periodically settles in high densities. It is an important food source for demersal fishes but its widespread and ephemeral nature means it does not define biotopes. Scallops, predominantly *Pecten fumatus*, have much larger, thick-walled shells and different colouring.

There are other misclassifications apparent in Annexure E, based on the image catalogue of Table 4-2 (page 39):

- **ba5.73 Mixture of brown, red and green algae with sponges** – there is no structural sponge component apparent in this image. There are two species of *Caulerpa* present, which is significant;
- **ba5.83 *Zostera* and *Ruppia* bed** – Neither *Zostera* or *Ruppia* is apparent in this image.
- **ba5.b Non-reef sediment epibenthos** – the imagery required greater acuity to describe the nature of the determining structuring species, including *Caulerpa* spp, *Botryocladia* and finer drift algal species, *Pyura*, skeletal shell material and

scallops *Pecten fumatus*. This category is a parent category of other classes identified, making the classification confounded;

- **ba5.b1 Medium to low density ascidian clumps (non-reef forming)** – the image appears to include the drift alga *Botryocladia*, which would be significant, but the image acuity is poor;
- **ba5.b9 Mussels on sublittoral shell hash** – Mussels are not observable in the catalogue image and the presence of this category needs confirmation because its presence has ecological implications.

The classified seabed data and maps are potentially unreliable and incompetent, given the:

- Inability to recognise the eutrophicated reef impact status;
- Misclassification of obviously different species such as *Electroma* for *Pecten* scallops;
- Inability to document all classes to biotope level 5, including the distinction of different drift algal beds, *Caulerpa* sediment assemblages, *Pyura* assemblages and various bivalve assemblages; and
- A higher level of biotope diversity has bee catalogued from prior studies in the project area.

Figure 4-2 Typical mixed fucoids and green seaweeds on reduced or variable salinity subtidal rock (ba3.3c) in the nearshore area (image extracted from validation video)

Figure 6.2. Image in the EES (Figure 4-2, Annexure E, page 36) that misclassifies a eutrophicated reef biotope for a variable salinity (estuarine) biotope. The image does not contain mixed fucoid seaweeds.

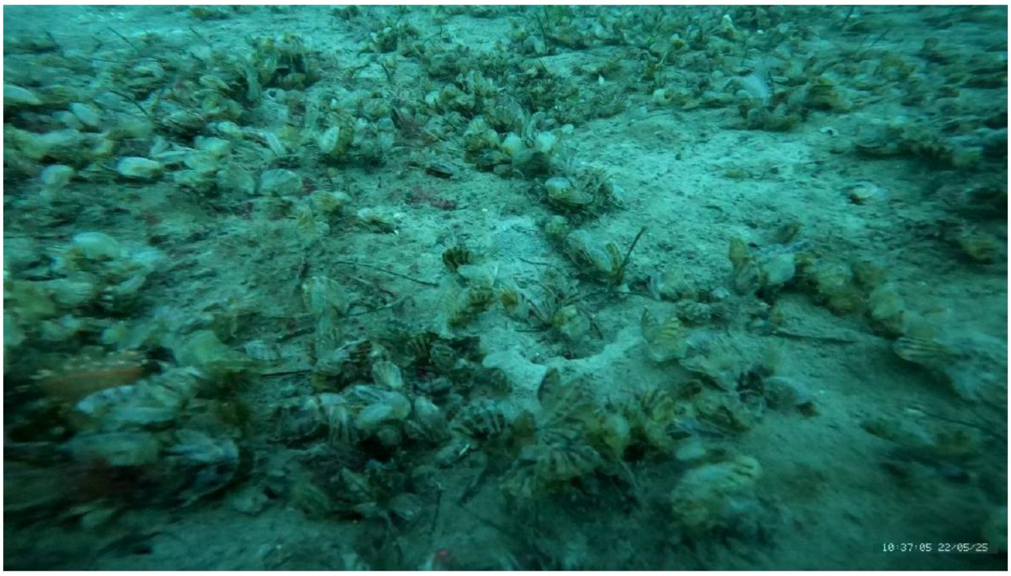

Figure 4-16 Scallop beds on sublittoral sediment (ba5.b3) to the south and outside the FSRU Envelope

Figure 6.3. Image in the EES (Figure 4-15, Annexure E, page 52) that misclassifies bivalves *Electroma papillionacea* as scallops *Pecten fumatus*.

6.2.3 Infaunal Grabs

Benthic infauna surveys were reported in Annexure F. The sediment infauna used Van Veen grabs of the sediment. This is a standard method in general, however diver venturi sampling and Smith-Macintyre grabs were the prominent methods previously. Data for different infauna methods can be difficult to compare, but this is of more relevance for the monitoring design than the EES impact assessment.

The sampling design included stratified sampling across different biotope groups. This was useful to reduce sampling errors. The design and also included sampling at reference or control stations, providing a basis for monitoring over time.

The sediment grab collected organisms on the sediment surface as well as within the sediments. The EES study did not separate these to groups, which confounded the results. For example, the bivalve *Electroma papillionacea* was abundant on the sediment surface in places (Figure 4-16 in Annexure E), but was assessed as infauna in Annexure F. *Electroma* is highly ephemeral in nature and had a high proportion of abundance (page 29). Consequently, its inclusion in the infaunal analysis would have confounded the infauna results with respect to both assemblage structure and diversity statistics.

6.3 Potential for Seabed Impacts

6.3.1 Construction Pressures

The proposed project has the potential for direct, physical impacts through the directional drilling and trenching of the power cables and gas pipeline. There is also potential for electromagnetic impacts during operations – this is addressed in a separate section.

The directional drilling under the shore habitats will greatly limit impacts on the littoral ecosystems. There may by significant releases of drilling muds at the sublittoral breakout point. These muds can disperse widely and form a clay-like layer on the seabed surface and change the habitat structure. This occurred during drilling processes for the Victorian Desalination Project, on the open Wonthaggi coast (*Pers. Obs*.). The risks to Port Phillip Bay habitats is greater because it is a low energy environment. There appeared to be no impact assessment of drilling mud releases on seabed habitats and biota.

The trenching process for subsea installations involves relatively narrow trenching widths of at least 5 m width. The length of the trenching is substantial (19.9 km) such that the total area affected would be considerable (28.5 ha, page 310). The actual impact area would be much wider than the trenched area. The installation is proposed to use cable-moored systems and these cables will create considerable scouring of the seabed. There was no modelling or estimate of the scouring and scraping effect of these cables. Mooring cables caused lasting damage to rock structures and reef biota during the Victorian Desalination Plant construction and the Port Phillip Bay biota on sediments would have little resistance to such scouring pressures.

Observations on the ethane pipeline trenching indicated the backfilling and raking had a considerable effect on the seabed, increasing the area of impacts either side of the trench (Watson 1973). Sedimentation caused mortality of seabed species some distance from the raking.

The EES modelled and mapped suspended sediment plumes, but did not apply the physical modelling as an input to any biological modelling and mapping of impact response. Physical modelling is not a surrogate for biological impacts, particularly given the diverse and patchy nature of biotopes in the area. Each biotope responds differently to pressures.

There was only one proposed route and there was no apparent assessment for optimising routes according to the seabed biology. It was unclear how each of the three power and gas lines would be separated, including whether: (1) the installations would effectively be a single linear disturbance; or (2) three separate linear disturbances.

6.3.2 Potential Biological Consequences

EES Seabed Impact Assessment

It is difficult to predict biological consequences of the project without proper mapping of the biota to a suitable resolution and an assessment of the sensitivity or responses and recovery to the predicted pressures. As described above, the EES biotic classification was confounded and not to an appropriate biological resolution. The EES had no clear appraisal of sensitivity of the biota. The EES impact assessment

The EES seabed impact assessment was generally approached as a subjective narrative without any objective quantitative or semi-quantitative evidence train. The assessment narrative made many broad-sweeping generalisations and assumptions that were not linked to evidence. The statements were often factually incorrect, based on existing evidence. Some examples of this 'assessment by assumption' follow.

> "*The recolonisation abilities of the algal species associated with the biotopes range from green algae, such as Caulerpa spp. which tend to be fast growing and opportunistic, red algae which have moderate recolonisation abilities and brown algae which have low to moderate recolonisation abilities. Thus, the biotopes are expected to recover in the short to medium term from the physical disturbance*" (page 311).

The above assumptions were inconsistent with the evidence. *Caulerpa* can be relatively stable through time and tends to vary seasonally or annually (if at all) in a regular successional cycle than opportunistically (Edmunds and Flynn 2016). The recoverability of seaweeds is unrelated to the green, red and brown groupings, but is species specific. For example, the red *Botryocladia* seaweed has much slow growth and production than the fine red algae such as *Ceramium* and *Hypnea*. The seaweed biotopes are in severe decline in the project area (AME data review). The only major brown seaweed in the project area is the introduced wakame kelp *Undaria pinnatifida*, which does not warrant impact assessment. This means there is unlikely to be any recovery from the addition of further pressures – an understanding of these declines is required before any recovery statements can be made. It would be precautionary to assume there would be no recovery.

> *Studies show that dredging activities result in small detectable changes in denitrification efficiencies as a result of loss of microphytobenthic biomass, however, recovery occurs quickly after the cessation of activities. Impacts will be localised with the footprint of disturbance and are unlikely to affect denitrification efficiencies within the bay.*

There has been only one dredging impact study on microphytobenthos in Port Phillip Bay (Edmunds *et al.* 2006). Monitoring has shown that microphytobenthos biomass is not quick to recovery from dredging and storm-related pressures (Edmunds *et al.* 2006;

Gilmour *et al.* 2007). Impacts on microphytobenthos can result in depressed abundances for months to seasons. This is likely to have substantial secondary impacts on localised production through the food webs. Microphytobenthos influences sediment nutrient cycling through oxygenation and trapping ammonia releases. Losses in microphytobenthos is likely to have some level of impact on denitrification. There is no evidence recovery would be quick. There is no evidence that impacts would be localised. In fact, the ecosystem linkages are strongly influenced by detritus (particulate organic material) pathways. Production of detritus in one area can be important to more distant areas, including from microphytobenthos resuspension, phytoplankton stimulation and sloughing and shedding of epiphytes and sediment seaweeds. Different areas of the Bay are also linked through demersal fish and other faunal movements. There cannot be any conclusions of only localised effects without evidence from an ecological model to show the system is contained at small scales. The EES did not provide this. The EES was selective in not assessing all footprints of disturbance and there will be substantial shipping movements over the Phillip Basin sediments, causing sediment winnowing and resuspension, and there is likely to be a substantial footprint and impact on denitrification efficiency in the southern Phillip Basin sediments.

Potential for Biological Impacts

Without doing a formal impact assessment with objective impact modelling, there was clear potential for consequential biological impacts.

The actual area of the disturbed seabed is unlikely to be a surrogate for biological impacts. The biotopes in the region are diverse and patchy, with some of them highly restricted or confined into small patches (AME review of existing data). Any subsea installations across restricted patches, such as scallop beds, *Pyura* biogenic reef or *Botryocladia* seaweed beds may cause local biotope extinction. A much large body of knowledge is required to assess this possibility.

Observations on the ethane pipe installation by Watson (1973) indicated that sponges and habitat forming ascidian *Pyura* had a poor survival rate. There was some sponge recolonisation with no observed *Pyura* colonisation. Scallops were observed to recover quickly, but through movement from adjacent populations (where present).

Many of the seabed structural components do not recover quickly after disturbance and, in the case of *Pyura* biogenic reef, this may take decades, if at all. Slow recovery can also occur for biota with quick growth rates, depending on the ecological context. For example, microphytobenthos has a turnover rate of approximately weeks, however recovery after impacts in Port Phillip Bay has been observed to be months to seasons (Edmunds and Ingwersen 2004; Edmunds *et al.* 2006; Gilmour *et al.* 2007). Such slow recovery can be through ecosystem interactions, such as biomass suppression by grazers.

The suspended sediment plumes, combined with seabed scouring, is likely to reduce primary production from the various seabed plant groups, including microphytobenthos, Caulerpa species, Botryocladia drift algae and finer drift algae. The loss of biomass and production for short periods (months) can have magnifying effects through the ecosystem, particularly for resident seabed fishes and potentially for mobile, demersal fishes, sharks and rays.

The review of existing biotope conditions and changes over time (AME, unpublished) indicated contractions and declines in naturally occurring biotopes, particularly those with strung habitat and functional roles. The declining trends and restricted distributions indicated the ecosystem in the project area is vulnerable to cumulative impacts from existing pressures and proposed pressures.

Environmental Safety Risk

The FSRU, pipe and cable installations present an increased environmental safety risk from gas release events. The area is close to shipping movements to and from anchorages, and shipping movements into the Point Richards Channel. An explosives delivery facility is to the southwest. The area is vulnerable to shipping and anchor drag incidences. The likelihood is quite possible, given such an event has occurred previously with the rupture of the ethane pipeline. The ecological consequences could be quite high, as with the consequences of potential tanker incidences in Port Phillip Heads.

6.4 Conclusions and Recommendations

The EES description of existing seabed biota and condition was limited and biased. The EES did not collate and integrate of the existing body of knowledge: it did not recognise that existing conditions are degraded and likely vulnerable to additional, cumulative impacts. The EES field studies focused on the impact envelope and did not place that biota into a wider spatial context. The data extraction from the EES field surveys was biased and confounded, including limiting classification and mapping to coarse-level groupings. This reduced the capacity to detect and understand biological impacts.

The EES lacked the necessary specific information and analysis to predict potential impacts on the seabed biota. While there was modelling of physical pressures, there was not an equivalent level of effort placed on biological modelling and prediction. The impact assessment was essentially approached as a subjective narrative, with no objective chain of evidence to support conclusions.

It is recommended that:

- The EES integrates and builds on existing biological information for the project area;
- There is additional survey imagery with distance from the impact envelopes to:
    - including monitoring control sites;
    - cross reference with other studies done in the area;
    - establish spatial relationships and patterns; and
    - establish isolation, rarity, patch fragmentation, populations to support recovery, *etc*;
- Existing and supplementary field imagery is reclassified, including:
    - to CBiCS biotope level 5;
    - abundances of key ecological species;
    - observers have adequate knowledge and training of natural, impacted and introduced biota and can identify Victorian marine biotopes.
- Description of ecological roles, functions, sensitivity and recoverability of the surveyed ecological inventory;
- Complete descriptions of physical effects, including mooring cable scouring and drilling muds; and
- There is an objective biological impact prediction process, which is extended from individual features to the ecosystem as a whole.

7 Electromagnetic Disturbance

7.1 Electromagnetic Pressures

The operational phase of the proposed project will involve two high voltage power cables from the shore to the FSRU. The cables consist of two cables and would be buried to a depth of 0.3 to 1 m. The predicted voltage in the EES is inconsistent, stating 220 kV on page 261 and 6.6 kV on page 484 of the Marine Ecology Technical Assessment.

The Marine Ecology assessment recognised the potential for biological impacts from the subsea power cable but did not evaluate them. Instead, it deferred to Technical Assessment E: "*A full assessment on the potential impacts of electromagnetic fields on marine receptors is provided within Technical Assessment E – Electromagnetic Interference Impact Assessment and has not been replicated here*" (page 485).

7.2 EES Impact Assessment

Technical Assessment E did not assess electromagnetic impacts on marine biota and the assessment in general was confusing.

It is stated on page 3 that the power cables would be 220 kV. There was a brief literature review of biological responses to magnetic fields in the range of 1-5-10 µT (page 18). There was no attempt to relate the literature review values to the potential species that may be affected in Port Phillip Bay. There was no attempt to model and predict the magnetic field for the proposed cables and whether this could disrupt the seabed biota. There is considerable scientific literature that identifies electromagnetic interference as an important issue and there is a need for the EES to have thoroughly addressed this (*e.g.* Hutchison *et al.* 2020a, 2020b; Harsanyi *et al.* 2022; Gill *et al.* 2023; Hermans *et al.* 2024; Hermans *et al.* 2025; James *et al.* 2025).

The scientific literature indicated the seabed cables, being buried to only a shallow depth, could cause behavioural disruptions, particularly in bottom and demersal skates, rays and sharks, but potentially also in eels, fishes and decapod crustaceans. The EES should have described the vulnerability and exposure of species within the project area.

Despite not doing a proper modelling and impact assessment, Technical Assessment E concluded impacts to be 'very low' (page 26). The impact assessment was not objective and was not supported by modelled electromagnetic fields and evidence from the literature.

The impact assessment also engaged in circular reasoning: "*Detailed design and future site-specific EMF modelling (MM-EMI-01 presented in Table 8-1) would verify that exposure remains below precautionary thresholds…*" (page 25). The EES presumed the arbitrary impact conclusions would be confirmed by future modelling. There should have been EES modelling to support the impact assessment and this should not be delayed into the future. The EES should be a final statement of impacts that supports decisions and there should not be room for 'future modelling for verification', outside the planning decision process.

7.3 Potential for Impacts

The demersal fishes play an important ecological role in Port Phillip Bay, with this component including a large abundance of sharks and rays (Officer and Parry 1996; Hobday *et al.* 1999). As noted above, sharks and rays are a dominant component of the demersal fish assemblages and particularly susceptible to magnetic interference. Fishes, eels and decapod crustaceans may also be affected. A particular issue is that the route traverses through a large proportion of the intermediate sediment biotopes that are key foraging grounds for sharks and rays, particularly where there epibenthic structures and bivalve populations.

The proposed cable route also bisects the migration routes of school shark pups, which migrate out of nursery grounds in the Corio region during autumn months (Olsen 1954; Figure 7.1). The breeding and nursery grounds are limited to only a few sites in southeastern Australia, including the Corio area in Port Phillip Bay (Stevens and West 1993). School sharks are a species of conservation concern and this disturbance would be cumulative over other pressures and habitat reductions that are occurring in the Corio pupping grounds.

The proposed EES route is through an area that is presently substantially impacted, with many overlapping cumulative pressures, and the existing conditions appear to be rapidly deteriorating (AME unpublished assessment to DEECA). The construction and operation components of the EES may trigger a collapse of the existing ecological states and functions. It is vital that the EES impact assessment of the seabed installations and operation is not considered in isolation of the present vulnerable condition. This requires a proper cumulative impact assessment.

Given the potential for effects on wide-ranging demersal fishes and school shark, the EES needs to do a proper biological evaluation, including mitigation options of different routing and burial depths. The present EES evaluation is inadequate for understanding potential impacts and making planning decisions.

7.4 Conclusions and Recommendations

The EES did not properly address the potential for impacts of the subsea power cables. Impact conclusions of the EES were not supported by evidence. There is considerable potential for a movement and migration barrier for mobile demersal fishes, sharks and rays. School shark migrations are particularly vulnerable and the proposed cable alignment represents a barrier to these migrations.

The seabed cables and pipeline are proposed to go through an area with an existing high level of cumulative pressures and impacts. These need to be incorporated into cumulative impact assessments. Key recommendations include:

- Implement a proper impact assessment based on a thorough information basis;
- Properly describe the ecosystem interactions of the seabed and demersal fish linkages, including spatial habitat usage, migrations and trophic relationships;
- Properly review existing scientific literature and comparable situations;
- Review existing knowledge of the demersal fishes in the project area and their sensitivity and behavioural responses to magnetic fields;
- Improve knowledge of school shark habitat use and autumn migration;
- Exploration of alternative subsea cable and pipe routes, including to the north to minimise barrier effects across intermediate sediment habitats;
- Assessment of deeper burial options, and associated impacts, to reduce field strengths at the seabed surface; and
- Cumulative impact assessments that properly combine existing impact pressures with combined impact pressures of the EES, and for biological features at a finer resolution than presented in the EES, including biotopes and school shark.

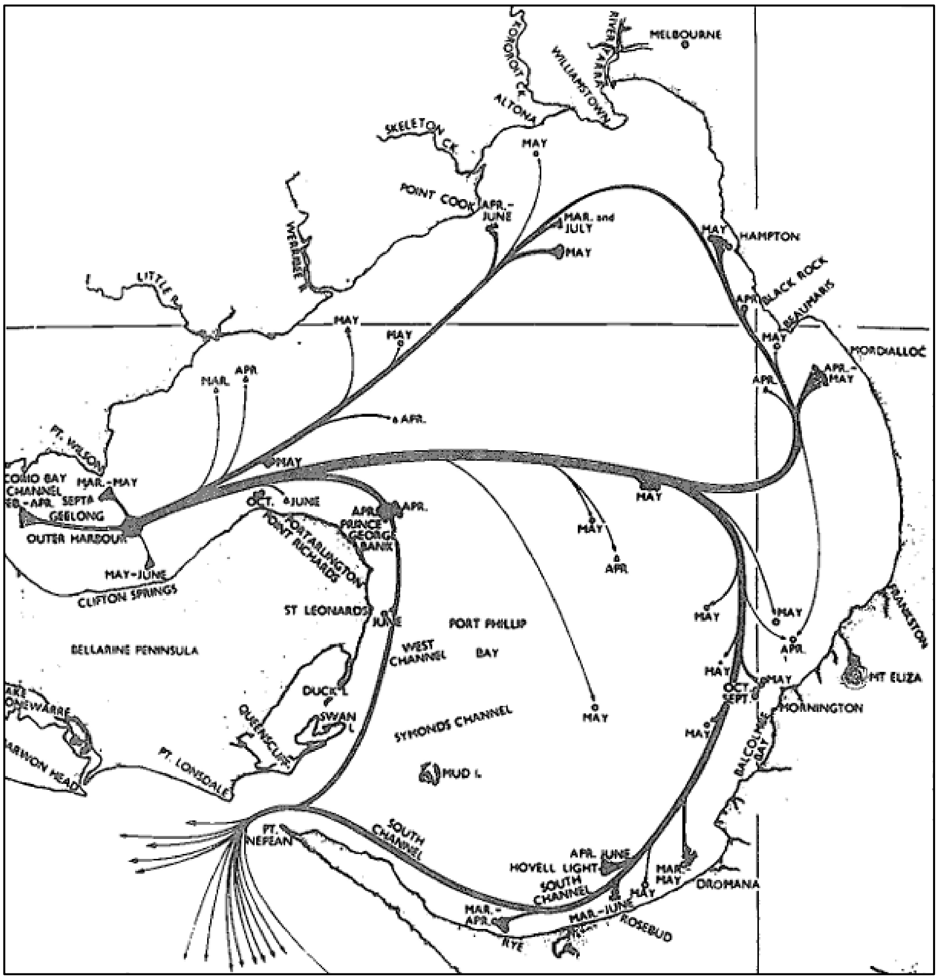

Figure 7.1. Autumn migratory route of EPBC listed school shark, from pupping and nursery grounds in Corio Bay across intermediate epibenthic biotopes, Phillip Basin and through Port Phillip Heads (Olsen 1984).

8 Intake and Discharges

8.1 Discharge Pressures

The operational phase of the proposed project will involve use of seawater for heating and gasification of the liquid natural gas. The seawater is cooled during this process and discharged. To prevent biofouling within the heat exchanges and piping, chlorine would be introduced into the seawater to produce an oxidative biocide, preventing growth and blockage of the system. This also kills any biota entrained into the intake. The discharged water is colder and denser, with disinfection chemical bi-products (DBP). The cooler, denser water forms a plume on the seabed and may be dispersed by bottom currents and density flows according to the bathymetry. The disinfection process may result in reduced oxygen concentration.

The discharge plume is expected to cause impacts from entrainment of biota, reduced temperature and toxicants.

8.2 Intake Entrainment

The intake will cause mortality from biota that enter the heating system, largely through the chlorine dosing. Entrainment has the greatest potential to affect animals with limited larval dispersal and recruitment, resulting in a ‘recruitment shadow’. The EES only considered plankton effects.

8.3 Seabed Plume Dispersion

The EES provided a map of potential plume dispersal on the seabed, which ranged up to 1.5 km (Figure 9-14, p 449). This modelling was not overlaid on the distribution of seabed biota.

The FSRU location is over the relict paleochannel of the Werribee River. There is potential for plume density flows to be directed into this channel and be directed towards the Phillip Basin sediments. This potential for wider impacts did not appear to be assessed in the EES.

8.4 Reduced Temperature

The EES predicted water temperature to be 1-2 degrees below ambient, once it has diluted and mixed after discharge. This change will be persistent throughout the year. The EES incorrectly dismisses temperature effects with a rationale that the temperature decrease is within monthly and seasonal variations: “*the species present in the vicinity* *of the FSRU location are likely resistant to changes in water temperature*" (Marine Ecology Impact Assessment, p 444)

This is a biologically incorrect assumption. The plant and invertebrate seabed biota do not regulate their temperature. Temperature directly affects physiological processes such as photosynthesis, growth and respiration. This is a well-known property and can be modelled by the Arrhenius equation. Most biota, other than warm blooded vertebrates, will experience reduced physiological rates and there is no resistance to temperature-driven physiology. The EES did not review the physiological consequences of temperature decreases, but referred to temperature increase experiments instead. Reduced temperatures are expected to reduce growth and production of nearly all biota on the seabed residing within the discharge plume.

The EES states that microphytobenthos communities would be the most exposed to the plume (map overlays not provided). The low-temperature plume is likely to reduce growth and production of microphytobenthos (MPB) in the FSRU area. This has consequences for the ecosystem. A significant proportion of MPB production supports the productivity of infauna within the sediments, as well as filter feeders and grazers on the sediment surface. Production is tightly coupled through the ecosystem and there are likely secondary effects on demersal fishes through reduced prey availability. There are also likely impacts on sediment biogeochemistry, including nutrient cycling, as MPB play several roles in sediment oxygenation and trapping ammonia releases for in-sediment denitrification. The population dynamics of MPB is thresholded, such that any depression of production can have sustained effects without recovery. This has been observed in Port Phillip Bay following storm and dredging disturbances (Edmunds and Ingwersen 2004; Gilmour *et al.* 2007). This is likely from intense grazing and consumption pressure and reduced sediment cohesion.

Reduced temperature will also have ecosystem effects on seabed filter feeders, including reduced filtration and growth rates. This may change aspects of coupling between the water column and sediments and the availability of prey for demersal fishes. No such ecological secondary effects were considered by the EES.

Temperature effects on seabed biota are likely to exacerbated (cumulative) with other pressures such as contaminants in the plume and effects of seabed disturbance from propellor wash.

8.5 Faunal Behavioural Effects

The discharge plume with have different temperature and chemical signatures than ambient conditions for moving and migrating pelagic and demersal fishes. This plume may cause behavioural avoidance effects wand act as a movement and exclusion barrier. The potential for disrupting demersal fish movements and feeding was not addressed by the EES. Such an effect would be compounded by electromagnetic interference by the electrical cables.

Behavioural barrier effects associated with the discharge plume may have cumulative effects with barrier effects of the magnetic fields from subsea cables.

8.6 Chlorination Disinfection Products

8.6.1 Formation of Toxicants

The use of chlorination for disinfection has major and emerging environmental concerns. These concerns can be divided into three levels:

- Initial generation of chlorination oxidation products (CPOs);
- Formation of volatile toxic brominated compounds that may not be persistent, such as bromoform;
- Formation of persistent and/or highly toxic brominated organic compounds.

8.6.2 Impacts of CPOs

The formation of CPOs is the deliberate process to acts a biocide within the heat exchanges. In seawater, the bromine in seawater substitutes for the chlorine in the CPOs. Brominated compounds are significantly more toxic than chlorinated compounds. The initial impacts from CPOs are likely to be restricted to within a short time and localised area because the products rapidly degrade chemically with other components in seawater.

The EES constrains itself to a consideration of CPOs. The EES presents evidence from the literature from laboratory experiments for acute CPO toxicity. The literature review is limited to just a few references and was inadequate considering the potential risks to the environment and human health.

The EES maps potential CPO concentrations on the seabed, but does not translate these maps into areas of biological impact. Although the CPOs do not persist because of chemical degradation, there is likely to be a seabed footprint of CPO chemical impacts.

8.6.3 Omissions in the EES

The EES omitted environmental concerns of the production of toxic brominated compounds as part of the disinfection process. The concerns are well detailed in the scientific literature and were raised as issues in the prior gas import EESs over recent years. This omission is highly significant with respect to the potential for impacts and should be addressed during the planning decision processes.

8.6.4 Review of Brominated Toxicants

The use of chlorine disinfection results in a large number of disinfection by-products (DBPs). 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).

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 DBPs are halogenated methanes, hydrocarbons, acetonitriles, amines, phenols and acetic acids (Werschkun *et al.* 2014; Menasfi *et al.* 2019; Summerson *et al.* 2019). Up to 462 brominated DBPs 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). Although bromoform may disperse into the atmosphere, it can also accumulate in sediments and biota (Boudjellaba *et al.* 2016; Manasfi *et al.* 2019). This means its volatility is reduced and the potential for toxic effects are much greater. The presence in biological tissue also means toxicants can be spread more widely from the source through animal movements. Bioaccumulation can occur up food chains. There have been prior EES claims that bromoforms are volatile and therefore not of concern. Such claims are not supported by the literature.

Some biota, such as some seaweeds, can produce bromoforms naturally and there are claims that bromoforms are not a toxicant issue because they can occur naturally. Natural biological production is orders of magnitude lower than discharges of DBPs (Fogelqvist and Krysell 1991; Goodwin *et al.* 1997). Effects have been found in natural fish populations where natural bromoform production is seasonally high. Claims that naturally produced bromoforms down-weights DSP bromoform production are not supported by the literature.

The nature of the DSP toxicants varies according to the intake water quality, particularly the nature and amount of organic material that is present during CPO formation (Zhang *et al.* 2015). The disinfection process can lead to highly toxic and persistent organo-bromines (Kurniawan *et al.* 2022). Modelling has shown that ballast water treatments may be causing concerning levels of DBP releases in Port Phillip Bay, including dibromoacetonitrile, monochloroacetic acid and dibromoacetic acid (Summerson *et al.* 2019). Given that many species of toxicant chemicals release, there is concern for synergistic toxicant effects (Summerson *et al.* 2019). Brominated DBPs can bioaccumulate and bio-magnify up the food chain (Losada 2009; Cacciatore *et al.* 2021).

8.6.5 Disinfection By-Products and Decision Consequences

Disinfection by-products can be accumulated in sediments and biota and have impacts over a much wider area and over long time-scales. Top predators may be susceptible through bio-magnification in the food chain. The effects of such discharges may not be apparent for some time after the installation of the FSRU. There is no environmental remedial action that can be implemented once toxicants are released. Usman *et al.* (2023) identified considerable knowledge gaps and concerns associated the release of DBPs and approaches to address these gaps.

It is recommended that the risks to environmental contamination are examined and well understood prior to any decisions. It is also recommended that alternative solutions are explored, including engineering solutions involving other heating options and modifications of the disinfection process, such as those considered for disinfection of shipping ballast waters.

The release of potential persistent and highly toxic chemicals has implications not only for ecosystem integrity, but for seafood contamination. The FSRU would have an influence on the adjacent scallop and recreational fisheries, and long-term goodness of environmental status for Port Phillip Bay (as per the Marine and Coastal Policy).

The potential for toxicant impacts should be recognised transparently as part of the decision process.

8.7 Conclusions and Recommendations

The EES assessment of discharge plumes from heat exchanging processes was inaccurate in ignoring well known temperature-driven changes in physiological processes. The literature indicates primary production could be limited, particularly where there are threshold effects, and this may flow to secondary production of infauna and sediment epibiota, which are prey for demersal fishes. The EES did not model or quantify the area or magnitude of temperature impacts or ecosystem processes. The potential for density flows through the Werribee River paleochannel was not considered.

The EES down-weighted the importance of disinfection by chlorination. The EES was inadequate by not addressing the potential for adverse effects on the ecosystem from disinfection by-products.

Recommendations include:

- Measurement and modelling existing and potential discharge density flows in the Werribee paleochannel and the potential for dispersal of toxicants into the Phillip Basin;
- Better resolution seabed mapping to properly predict and map discharge impacts;
- Improve the understanding of DBP contamination risks and options to avoid DSP discharges.

9 Ecosystem Assessment

9.1 Ecosystem Description and Model

9.1.1 Model Requirements

An ecosystem model is required to describe the relevant components, ecosystem functions and the network of relationships between the components. There are various ways of constructing and communicating ecosystem models. At the very least there should be a comprehensive listing or inventory of the important components, functions and relationships. This can be progressed to conceptual diagrams, as a network of nodes and links, through to quantitative network models.

The ecological model should then be applied to understand the potential pathways of initial and secondary impacts, predict biological responses, calculate cumulative impacts and assist with the environmental management framework and monitoring design.

9.1.2 Ecological Model Provided by the EES

The EES did not provide an ecosystem description or model for the project area.

A "conceptual schematic" of trophic structure was provided in Figure 12-1 (page 591). This is a generic representation of food chains for any marine ecosystem and has no specific relevance to the project area. This type of pyramidal diagram is used to convey trophic flows concentrating towards an apex of predators, with biomass and/or production decreasing with steps up the pyramid. This diagram is not a "*simplified PPB food we*b" diagram, as claimed on page 590.

The EES was inadequate with respect to ecosystem assessment because it did not provide any specific description of the ecosystem in the project area. Key omissions included:

- Review of the literature and prior studies that identify ecosystem properties (*e.g.* Crawford *et al.* 1992; Parry *et al.* 1995; Harris *et al.* 1996; Officer and Parry 1996; Murray and Parslow 1997; *etc.*);
- Field surveys to a sufficient biological resolution to provide an inventory of key ecosystem features and components (see review of benthic surveys, above); and
- Studies to describe and model functions and relationships for application to an ecological impact assessment.

There was a one-page discussion of ecosystem related effects (page 590). This discussion only referenced generic scientific literature and theoretical processes without any connection to the real-world ecosystem in the Geelong Arm and Werribee region.

9.2 EES Ecosystem Assessment Method

The ecosystem assessment was highly selective and biased in what ecosystem properties were assessed. The selected ecosystem properties were then addressed in a subjective manner without introducing any evidence specific to the project area.

In the first instance, the assessment restricting considerations to only three types of ecosystem relationships:

- Predator-prey relationships;
- Energy flow and 'balance'; and
- Diversity (page 590).

Within each of these three selected components, there was a further narrowing or confinement of considerations (Table 12-1, p 592). This further narrowing also considered of a subjective selection bias, without any rationale. For example, the sub-objective for predator-prey relationships was to maintain pelagic foraging availability; however, there was not sub-objective for seabed foraging availability (where the impacts would be most evident), sub-sediment infauna prey production or even effects on primary production, particularly benthic plants such as *Botryocladia*, *Caulerpa* and microphytobenthos (see review of seabed studies above).

Following the selection of a limited set of assessment categories, the EES proceeded to present assessment findings as a narrative in Table 12-1 (page 592). The findings are broad sweeping statements that do not follow any assessment logic and are not supported by evidence specific to Port Phillip Bay. There is no transparent methodology that related predicted activity pressures, to biological responses and through the ecosystem consequences. The narrative is subjective: it did not follow any objectively and independently repeatable procedure.

The selected criteria or objectives for the ecological assessment were inconsistent with the Sensitivity ratings described in Table 5-1 (page 26). The sensitivity ratings for ecosystems include aspects of habitat provision, bio-engineering, sediment stabilisation, biodiversity structure, keystone species and biogeochemistry. The EES did not present information and data to assess those ecosystem aspects either.

The EES omitted considering the full gamut of important considerations, including (but not limited to):

- Detritus pathways which are among the most important considerations for Port Phillip Bay;
- Biogenic habitat and diversity relationships;
- Interactions between of seabed epibiota with sub-sediment processes;
- Sediment biogeochemistry processes, including nutrient cycling;
- Steppingstone habitats for demersal fish movements and feeding grounds;

- Ecosystem services, including nutrient regulation, sequestration and cultural services;
- Existing trends and declines in the ecosystem, including those that may be exacerbated by the proposed project; and
- Recoverability or restoration of existing deleterious conditions under proposed added project pressures (or consideration of permanent changes).

9.3 EES Ecosystem Assessment Findings

The EES ecological assessment concluded: "*indicates the Project would not cause ecosystem-wide adverse impacts. The trophic structure, ecological function and genetic diversity within PPB will be maintained*" (page vi).

This conclusion should not be accepted as it is not supported by a scientific process, as explained above. Furthermore, this finding is contradictory to known ecological conditions in the project area and the magnitude of potential impacts that were omitted from the EES.

9.4 Potential for Ecosystem-Level Impacts

The potential for ecosystem-wide, adverse impacts includes (but not limited to):

- Exacerbated loss of seabed plant standing stocks, affecting nitrogen pools and cycling, primary production and sediment biogeochemistry, as well increasing the risk of eutrophication effects;
- Exacerbated loss of seabed biogenic habitat structure, affecting demersal fish feeding, movements and production;
- Barrier and behavioural effects on mobile fauna, including secondary effects on wider-area fish interactions and productivity;
- Bioaccumulation and bio-concentration of disinfection by-product toxicants, including effects on wider-ranging apex predators such as the Burrunan dolphin;
- Ecosystem phase changes into essentially unrecoverable states (hysteresis), given present states are in poor condition and may not be resilient or resistant to impacts.

9.5 Conclusions and Recommendations

The EES ecosystem assessment should not be accepted as adequate for environmental and planning decisions. The conclusion of no ecosystem-wide impacts was not supported by the evidence and methodology. The methodology was selective and subjective and not evidence based. A key weakness of the EES is that it did not present the existing knowledge of the ecosystem in the project area and build on this knowledge through the field studies. There was no construction of an ecosystem model, of any type, that could be applied to an ecosystem assessment.

Recommendations include:

- Comprehensive review and inventory of ecosystem components in the past and present for the Geelong Arm-Werribee-Phillip Basin segments – inventory of ***all*** relevant components;
- Field studies with adequate biological resolution to inform on present ecosystem conditions and relate this to prior conditions and changes, as well as mapping of key features (also required for cumulative impact assessment) – build on existing knowledge;
- Construction of a descriptive and representative ecosystem model;
- Clear description and mapping of impact pressures (also required for cumulative impact assessment);
- Inclusion of pressure-biotic response components; and
- Implementation of a methodology that is objective and independently repeatable.

10 Cumulative Impact Assessment

10.1 Need for Cumulative Impact Assessment

Cumulative impact assessments are becoming increasingly important as ecosystems come under increasing pressures from a wide range of activities. These pressures interact and magnify. It is essential that the proposed project has an integrated, cumulative impact assessment for three key reasons:

- The project has various and overlapping activity-pressures that can act cumulatively and synergistically;
- The project is in an area that already has substantial pressure exposures from a variety of activity sources; and
- The ecosystem in the project area is degraded and in poor condition and may be vulnerable to an unrecoverable phase change, *i.e.* it may be at an ecological tipping point.

10.2 Methods for Cumulative Impact Assessment

There are various methods for cumulative impact assessment, with varying degrees of resolution and quantification. The minimum information requirements include:

- Mapping of biota and ecological features to a valid resolution – high level groupings are not effective;
- Mapping of pressures and pressure levels;
- Establishment of biological sensitivity or response to each pressure level.

These three information components are then integrated across each spatial unit of assessment. The simplest approach is the Symphony sensitivity approach (*e.g.* Hammar *et al.* 2020; WIO Symphony 2023). More elaborate ecosystem model approaches are more accurate and better describe uncertainties (*e.g.* Dambacher and Dunstan 2021; Bozec *et al.* 2022). Cumulative impact assessments should be informed and supported by some level of socio-ecological or DPSIR modelling.

10.3 EES Cumulative Impact Assessment

10.3.1 Activities and Pressure Sources

The EES lists a range of activities and industries that create overlapping, cumulative pressures with the Project (pages 576-577). This was not a complete list, with other important activities including channel dredging, spoil disposal, shipping movements, stormwater drainage, toxicants, scallop fishing, recreational fishing, aquaculture and agricultural discharges into the Werribee River. The EES did not map and quantify the pressures that arise from these non-project activities. Neither did the EES map and quantify the pressures that arise from the Project itself. Both sets of information are required for a cumulative impact assessment. Although there is limited information, there is sufficient information for developing maps of cumulative pressures (*e.g.* Parry 2013).

10.3.2 Biota and Sensitivity

The EES did not map biota to a biological resolution appropriate for a cumulative impact assessment. There was no information provided to overlay the distribution of pressures over the distribution of species and biotopes. This was an issue for the general project impact assessment itself.

The EES did not provide an inventory of key biota and ecosystem features and determine the sensitivity or responses to impact pressures. A listing of the inventory, along with traits and sensitivity attributes would have assisted in the transparency and repeatability of the EES (*e.g.* Hewitt *et al.* 2014; d'Avack *et al.* 2014).

10.3.3 Integration of Impacts

The EES implemented the cumulative assessment as a subjective, qualitative narrative. This assessment had no formal or repeatable structure and the rationale and conclusions were arbitrary and without reference to supporting evidence (Table 11.1, page 583). The narrative omitted the integration of cumulative effects of the various pressures caused by the project itself, and the cumulative effects across all activities - activities were addressed separately rather than cumulatively.

The EES qualitative methodology was not appropriate to assess cumulative impacts. The cumulative or integration aspect requires a computational approach. Other cumulative impact assessments have found cumulative effects to occur in unexpected places, through combinations of more remote species having higher sensitivities (AME, unpublished analysis to Melbourne Water).

Even a simple situation requires a multi-element, multifactorial assessment and this cannot be done using a qualitative, opinion-based approach. In the case of the project, the range of pressures and biotic interactions are large and a computational method should be applied.

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10.3.4 EES Finding

The EES concluded: "Following consideration of other proposed projects, operations in PPB and approved developments within the bay… it was assessed that the Project will not contribute to cumulative impacts to marine receptors present." (page vi).

The EES conclusion should be disregarded because of the improper method of assessment. This finding is also inconsistent with the evidence on biological existing conditions in the project area – evidence not included in the EES (see below and review of seabed impacts).

10.4 Deleterious Existing Conditions

The existing scientific knowledge of the biota in the project area has been compiled as part of DEECA's CoastKit and Marine and Coastal Knowledge Framework. There has been ongoing standardisation and classification of these data into a single, coherent ecological data set (AME on behalf of DEECA and Melbourne Water). These data were then used to describe and map biotope distributions for different time periods between 1957 and 2023.

There have been substantial changes in the biotope types, diversity and distribution over the last 70 years. There were substantial changes with the onset of the scallop dredging fishery in the early 1960s, however there have also been significant changes apparent in the last 10 years, particularly in the Geelong Arm and Werribee segments. These changes were evidenced in the 2022-2023 ROV survey videos by Jenkins (2023).

The ecosystem recent changes in the project area included:

- Losses and disappearance of drift algal mat-forming biotopes;
- Losses of *Pyura* biogenic reef;
- Disappearance of sediment seaweed Caulerpa biotopes;
- Reduced abundance and contraction in distribution of scallop beds;
- Apparent reduction in sediment burrow density and seabed structuring;
- Increased severity of eutrophicated rocky reef seaweeds;
- Increased abundance of green, eutrophication seaweeds on sediments;
- Appearance of a new non-functional drift algal type;
- Appearance of insure, saccate brown algae sediment coverage;
- Appearance of fine and filamentous seaweed turfs on sediments; and
- Appearance of bacterial mats, indicative of excessive organic loading.

Many of these changes have included to biotope structures that are outside natural or baseline conditions and considered impact states. The trends in changes is unknown as there are no formalised ecological monitoring programs in Port Phillip Bay.

The existing deleterious states within the project area means there is much reduced capacity for the ecosystem to withstand additional pressures from the proposed construction and operation pressures. It is essential that the EES assesses the combined, cumulative impacts, from all aspects of the project, existing combined pressures and for the existing states.

The analysis should consider tipping points in the ecosystem and risks of driving the ecosystem changes into an unrecoverable state. Such risks were highlighted by the

CSIRO Environmental Study (Harris *et al.* 1996). The modelling showed the project area to be most at risk from ecological collapse (Murray and Parslow 1997).

10.5 Expectations

10.5.1 Data Requirements

A cumulative impact assessment (CIA) requires the development of, at a minimum, a semi-qualitative network model and this is preferably structured in accordance with a standard Driver-Pressure-Status-Impact-Response (DPSIR) or socio-ecological model structure (*e.g*. Figure 2.1). The cumulative assessment requires mapping of pressure levels and biota, with the biotic mapping to a fine biological resolution. A common mistake, or deliberate bias, is to group biotic elements into generic categories that are apparently less sensitive: such biases should be avoided.

For this EES, the biological studies were insufficient for a CIA (See seabed impact review section). There was no review and synthesis of data from prior surveys in the area. The mapping was limited to the impact corridor only and the biological resolution was poor, mixing biotopes with coarser-level habitat complexes.

10.5.2 Mapping Impacts

The outputs of cumulative impact assessments should be presented as maps of impact levels as there may be cumulative impacts that are not correlated with the distribution of pressures: ***abiotic pressures are not a surrogate for biological responses and impacts***.

10.5.3 Severity and Sources of Impacts

The severity and sources of cumulative impacts can be summarised as a Sankey flow diagram. A preliminary worked example is shown in Figure 10.1. This preliminary example indicated that the intermediate depth offshore biotopes were most at risk of cumulative impacts, as well as species of conservation concern such as school shark (EPBC listed) and southern hooded shrimp (FFG listed).

This example in Figure 10.1 demonstrates there are no technical excuses for the EES to have omitted a proper ecological assessment which includes cumulative impacts.

10.6 Conclusions and Recommendations

The EES cumulative impact assessment was selectively biased and did not properly combine and compute the full range of pressures and sensitive biota. The conclusions of the EES should not be accepted as valid. The assessment ignored the perilous state of the existing conditions. It is recommended that a rigorous cumulative impact assessment is completed to inform any planning decisions and approvals.

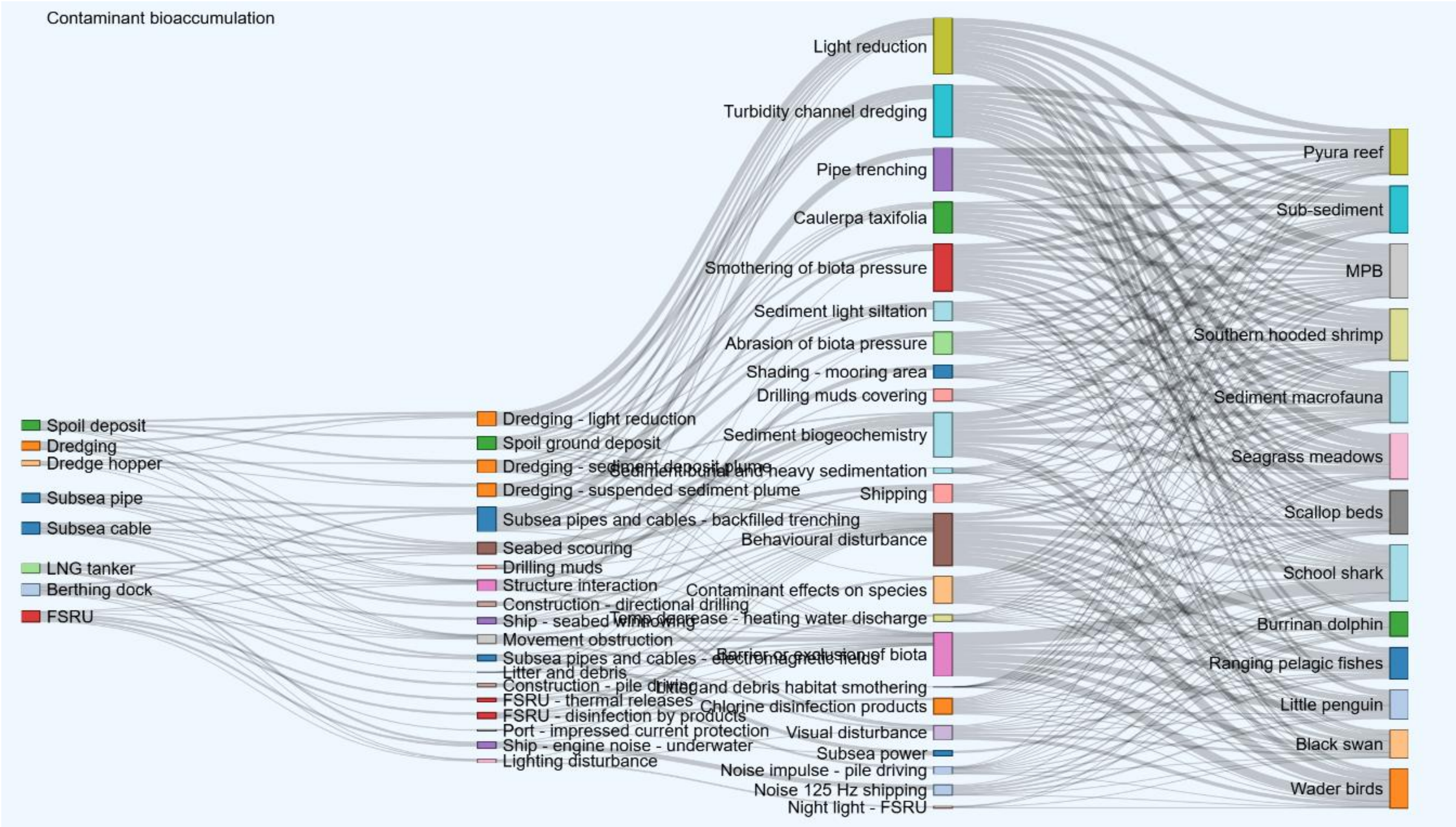

Figure 10.1. Simplified, non-spatial cumulative impact assessment for the Geelong Arm area to demonstrate the feasibility and type of knowledge gains for input into planning decisions (BioNet model, Australian Marine Ecology).

11 Environmental Management Framework

11.1 EMF Non-Compliance with Management Standards

The EES presents an Environmental Management Framework (EMF) in Chapter 15 of the EES. The whole structure of the EMF is based around input controls and assumptions that regulation of activities and pressures. The proposed EMF will not ensure the integrity of ecosystems, and the social services and benefits of the ecosystems. Maintenance of ecological integrity and sustainability is not the core objective of the presented EMF.

To be compliant with best-practice, including the Marine and Coast Act and Policies, the EMF should be structured with an outcomes basis, not inputs basis (Section 2; Figure 2.1). Recent gas import EESs also did not have an outcomes-based EMF and those processes also identified this as a major problem, including IAC reports.

A core aspect that should be embodied in the EMF is the clear objective of continually observing the status of ecosystem values and responding in a timely manner to avoid deleterious changes. This adaptive management framework has been established for decades (*e.g.* ISO 140001), but has since been improved to include the Ecosystem-Based Management (EBM) and Integrated Ecosystem Assessment (IEA) approaches.

11.2 Pseudo-Management Components

The EMF has an over-emphasis on administrative management which makes it obtuse with respect to achieving actual environmental management outcomes. There is a large focus on approvals, which have no regard for management processes. Conversely, regulators should not provide approvals where there is no commitment to meet commitments to ecological integrity, under both the Environment Protection Act and Marine and Coastal Act.

The governance structure does not commit to directly maintaining ecosystems and devolves responsibility to contractors; however, it does commit to meeting conditions of statutory approvals. The statutory approvals should require a direct and overarching commitment by Vopak and be directly responsible to ecological outcomes. This should entail a complete restructure of the EMF.

Risk assessments and risk registers do not provide tangible environmental management information. They are usually subjective, biased and typically not based on robust and reliable evidence. The likelihood estimations for ecological risk assessment are highly problematic and often manipulated to provide a desirable outcome (naively or deliberately). Likelihood and derived risk in biology is a distribution with different consequences and the selection of a particular likelihood is a known bias (among others). The distinction between initial and residual risk ratings are usually arbitrary 'guesses' with respect to ecological considerations. No trust or utility should be given to the risk assessments or risk register. There are alternative assessment methods, including sensitivity analysis approaches.

The sections on documentation and subordinate management plans are more to do with general project management than with actually managing the environment. The EMF should be structured to provide assurance and confidence that the environmental outcomes will be actually managed. Administrative handling should not be the focus of the EMF.

11.3 Mitigation and Management Measures

The mitigation measures are all input controls. While useful for minimising activity pressure levels, there is an assumption that these provide adequate environmental protection. The adequacy of the mitigation measures for maintaining ecosystems was not modelled or proven in the EES.

Mitigation measures are not something that can be 'set and forget'. They are required to be adapted with time, as more information comes available on actual biological responses. The 'set and forget' approach has been proven to be ineffective, and is not a rational approach with respect to management of dynamical systems.

The Management Measures are either a reiteration of up-front mitigation measures, devolve responsibilities to contractors or operators or are a list of information requirements that should have been addressed as part of the EES. For example, MM-EM-05 implies a need for plans to clearly detail monitoring requirements. It is a function of the EES and EMF to have already presented the monitoring requirements. This management measure indicates the EES was inadequate to properly design an Environment Monitoring and Reporting Plan and, therefore, inadequate to inform on potential ecological impacts.

11.4 Monitoring

The monitoring section of the EFM is very brief with respect to its importance in modern environmental management approaches. The proposed monitoring excludes an ecosystem outcomes or consequences approach and focuses on regulated input controls, mainly abiotic physico-chemical parameters. Of concern is that this monitoring is devolved to contractors and phases, rather than a project-wide, integrated focus.

The monitoring of the EMF generally excludes biological features, including key features of conservation concern, habitat, key ecological functioning, ecosystem services and effects on social benefits of ecosystem features.

11.5 Baseline Conditions and Monitoring

The EES claims to have established baseline environmental conditions through the EES technical considerations. This is not the case for the marine ecological assessments: There was no temporal monitoring to establish variations and natural patterns and relationships – temporal variations are needed to understand before-after changes and also to establish thresholds for implementing control-charting processes for triggering management responses;

- Benthic surveys were limited to the impact corridor only and did not establish reference or control area conditions. These are required to differentiate impact-related responses from natural or ambient level biological changes (which are not static through time);
- The EES surveys were not to a biological resolution for properly detecting impacts or deleterious trends; and
- The EES surveys omitted key considerations, such as school sharks and southern hooded shrimp and the relationship between demersal fishes and the habitats in the putative impact area.

A formal baseline monitoring program should be implemented for years prior to the construction works, and then continued through the construction, operation and decommissioning phases.

Further biological surveys with improved resolution are required to establish an appropriate and effective monitoring program. The program should be designed to have the power to detect and map deteriorating or out of control conditions in a timely manner. This requires a biological resolution better than the EES surveys, including control stations.

11.6 Outcomes-Monitoring and Adaptive Management

As presented in Section 2, there is an expectation that environmental management is based around the objective of maintaining ecosystem integrity. This can only be achieved through incorporating biological and ecological monitoring, suitably in a Before-After-Control-Impact design with frequent monitoring to understand and detect changes. The present Framework does not support this.

11.7 Socio-Ecological Model

For there to be a proper understanding and management of impact pathways through the ecosystem, there is a requirement for a model that relates activities, pressures, ecosystem features and ecosystem outcomes (Figure 2.1). This should be developed, at the very least, as a conceptual network model and resources could be applied to support 'digital twin' approaches to environmental management. A model helps communicate the rationale for impact predictions and the design of monitoring programs. A model also helps decisions with respect to management evaluations and responses to monitoring data.

The EES did not provide an overarching ecosystem model that could assess impacts and drive environmental management.

11.8 Recommendations

A demonstrated ability to ensure ecosystem integrity, *i.e.* sustainable outcomes, should form part of the approvals process. The EMF provides no such assurance. Past gas import EESs have attempted rectify the same EMF issues through added 'mitigation measures'. This would be ineffective and provides no assurances that ecosystems would be adequately managed. The Framework should be completely restructured and refocussed according to modern best-practices.

While there should be controls around actions and minimisation of pressures, there should be no assumption that these input controls will provide ecosystem sustainability. This is especially given the EES provide weak to no evidence associated with biological impact predictions.

A central component of the governance structure (EMF) should be around a MERI adaptive management cycle. There should be clear processes for identifying changes and trends. Where biological states are deleterious (out of control) and for timely management intervention and remediation. All other considerations of the EMF should be directed around implementing this process and ensuring ecologically sustainable development outcomes.

There should be a centralised responsibility for the outcomes (including for GED) and responsibilities should not be devolved to 'contractors' (although they should be held accountable as well).

The EMF should include the following:

- A central focus on ensuring and maintaining the integrity of ecosystems;
- A knowledge building component, proving that impacts were as predicted by the EES (noting that this EES does not make clear biological predictions);
- A responsive management component, such that unforeseen changes and events are addressed in a timely manner;
- Structure around a model that informs on potential impacts and responses;

- Integration with other monitoring and management systems in Port Phillip Bay; and
- Transparent and public reporting, enabling scrutiny, oversight and public trust.

12 Conclusions

In general, the EES marine ecology assessment did not meet the standards of contemporary, best practice assessments. The assessment was selectively biased and had an uneven treatment of different ecosystem components. This uneven treatment extended to assessing iconic, flagship species that do not occur in the project area. Most of the assessment was on grouped biotic components, such that it did not have the biological resolution to detect and understand impacts. There was incompetence in the fieldwork, with an inability to recognise existing impact conditions and common, easily recognisable biotopes. The EES did not build on the existing body of knowledge or adequately fill key knowledge gaps.

The impact assessment was not well supported by evidence and did not follow a transparent and independently repeatable method. The EES predicted there would be no significant impacts. Most of these predictions were based on assumptions rather than evidence. Some important areas of impact were omitted, including contamination effects of disinfection by-products and ecosystem chain effects.

The proposed project has the potential for considerable, ecosystem-level impacts, across a diverse range of habitats. These impacts include seabed disturbances to habitats that may take a long time to recover, barrier effects on demersal fish movements, including school shark and removal of fragmented, relict populations that are in decline.

The existing knowledge indicates Geelong Arm and Werribee biogeographical segments are presently in very poor ecological condition and in decline. The additional pressures of the proposed project may exacerbate this decline or, worse, tip the ecosystem into an unrecoverable state (known as hysteresis).

The poor standard of the marine ecology assessment means the information is unreliable for planning decisions and management. There is potential for the proposed project to cause considerable ecosystem-level harm. The full scope of potential impacts should be clearly incorporated into the environmental decision process.

The present level of evidence and knowledge indicates the proposed project would not be ecologically sustainable.

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